JOURNAL OF THE MALAYSIAN INSTITUTE OF PLANNERS

PLANNING MALAYSIA





MALAYSIAN INSTITUTE OF PLANNERS
PLANNING MALAYSIA VOLUME 24 ISSUE 2 (2026)
[ISSN 1675-6215] e-ISSN 0128-0945]
www.planningmalaysia.org

PLANNING MALAYSIA

Journal of the Malaysian Institute of Planners

Advisor

Datin TPr. Mazrina Dato' Abdul Khalid

Editor-in-Chief

Professor TPr. Dr. Mariana Mohamed Osman

International Islamic University Malaysia (IIUM)

Local Editorial Board Members

Professor Dato' TPr. Dr. Alias Abdullah - *International Islamic University Malaysia (IIUM)*

Prof. Dato' TPr. Gs. Dr. Ahmad Nazri bin Muhamad Ludin - *Universiti Teknologi Malaysia (UTM)*

Professor TPr. Dr. Ho Chin Siong - *Universiti Teknologi Malaysia (UTM)*

Professor TPr. Dr. Jamalunlaili Abdullah - *Universiti Teknologi Mara (UiTM)*

Profesor Datuk Dr. Mizan Hitam - *Universiti Teknologi Mara (UiTM)*

Professor. Dr. Ahmad Puad Mat Som - *Universiti Sultan Zainal Abidin (UniSZA)*

Professor. Dr. A. H. M. Zahirul Alam - *International Islamic University Malaysia (IIUM)*

Professor. Dr. Azizan Marzuki - *Universiti Sains Malaysia (USM)*

Datin Paduka TPr. Dr. Halimaton Saadiah Hashim - *Malaysia Institute of Planner (MIP)*

Assoc. Prof. TPr. Dr. Faris Abdullah - *International Islamic University Malaysia (IIUM)*

Assoc. Prof. TPr. Dr. Oliver Ling Hoon Leh - *Universiti Teknologi Mara (UiTM)*

Assoc. Prof. TPr. Dr. M. Zainora Asmawi - *International Islamic University Malaysia (IIUM)*

Assoc. Prof. TPr. Dr. Syahriah Bachok - *International Islamic University Malaysia (IIUM)*

Assoc. Prof. TPr. Dr. Marlyana Azyyati Marzukhi - *Universiti Teknologi Mara (UiTM)*

Datin TPr. Dr Chee Ping Ngang – Malaysian Institute of Planners (MIP)

International Editorial Board

Professor Emeritus Dr. Richard E. Klosterman - *University of Akron / Whatif? Inc., USA*

Professor Dr. Stephen Hamnett - *University of South Australia, Adelaide, Australia*

Professor Dr. Kiyoshi Kobayashi - *University of Kyoto, Japan*

Assoc. Prof. Dr. Belinda Yuen - *University of Singapore, Singapore*

Dr. Davide Geneletti - *University of Trento, Italy*

Dr. Boy Kombaitan - *Institut Teknologi Bandung, Indonesia*

© 2026 by MIP

Editorial & Business Correspondence
PLANNING MALAYSIA
Journal of the Malaysian Institute of Planners
B-01-02, Jalan SS7/13B, Aman Seri, Kelana Jaya
47301, Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: +603 78770637 Fax: +603 78779636 Email: mip@mip.org.my
www.planningmalaysia.org



Copyright © MIP, 2026

All rights reserved.
No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise without the prior permission of the publisher.

The views expressed in this publication are those of the author(s) and do not necessarily represent the views of MIP.

This journal is a refereed journal.
All articles were reviewed by two or three unanimous referees identified by the Institute (MIP).

Published By
Malaysian Institute of Planners

ISSN Number
1675-6215
e-ISSN
0128-0945



Date Published: 14th April 2026

CONTENTS

1.	A PRELIMINARY STUDY ON SOCIAL HOUSING NEEDS AMONG M40 EARNERS IN MALAYSIA *Masitah Zulkepli, Ahmad Ariffian Bujang, Kolony anak Gunting, Idatul Farita Mohamad Toha, Azizah Ismail*	1 – 16
2.	ENVIRONMENTAL VALUATION PRACTICES AND CHALLENGES IN MALAYSIA *Nurfarisha Ezzaty Mohammed Yuswan, Fitriyah Razali, Noramirah Nabilah Sulaiman, Raja Nurul Sakinah Raja Syamsuddin, Hariati Abdullah Hashim*	17 – 30
3.	VALIDATING THE INFLUENCE OF MEMORABLE SUSTAINABLE TOURISM EXPERIENCES ON REVISIT INTENTIONS: A STRUCTURAL EQUATION MODELLING APPROACH *Nurzehan Abu Bakar, Normah Abdul Latip, Marlisa Abdul Rahim, Nik Alif Amri Nik Hashim, Nor Maizana Mat Nawi*	31 – 47
4.	STRATEGIC HUMAN DEVELOPMENT IN THE ZAKAT INSTITUTION OF THE ISLAMIC RELIGIOUS COUNCILS AND PERAK MALAY CUSTOM (MAIPk) *Raudha Md Ramli, Fazirah Rais, Azrin Ibrahim, Sali Sofia Saliturahim*	48 – 62
5.	MADANI PLANNING IN THE ERA OF AI: STRATEGIES FOR BALANCING TECHNOLOGICAL INNOVATION AND COMMUNITY WELL-BEING *Abdul Hanis Embong, Wan Mohd Khairul Firdaus Wan Khairuldin, Shahir Akram Hassan*	63 – 79
6.	WAQF-BACKED URBAN REGENERATION IN KUALA TERENGGANU, MALAYSIA: A TAYYIB APPROACH TO HOUSING AND COMMUNITY WELL-BEING *Nadhirah Nordin, Muhammad Ridhwan Ab. Aziz, Azhar Alam, Ririn Tri Ratnasari*	80 – 95
7.	OMAN'S FOREIGN POLICY DURING THE YA'ARUBA DYNASTY THROUGH THE BOOK MANHAJ AL-TALIBIN WA BALAGH AL-RAGHIBIN BY SHEIKH KHAMIS BIN SAEED AL-SHAQSI *Habib Marhoon Al Hadi, Mohd Syakir Mohd Rosdi, Faiz Marhoon Al Hadi*	96 – 111
8.	FROM WORSHIP TO COMMUNITY HUB: EXPLORING HOW MOSQUE-BASED INITIATIVES INSPIRE TOURISM ENGAGEMENT *Murni Yusoff*	112 – 124
9.	SUSTAINABILITY IN GREEN BUILDINGS: A FAITH-BASED APPROACH *Hayati Saleh, Shereeza Mohamed Saniff*	125 – 137

© 2026 by MIP

10.	PLANNING FOR URBAN POVERTY TRANSFORMATION: LIVELIHOOD TYPOLOGIES AND COMMUNITY RESILIENCE IN MALAYSIA *Shereeza Mohamed Saniff, Mohd Sadiq Mohd Mokhtar, Ahmad Shaifful Anuar Ahmad Shukor*	138 – 152
11.	SUSTAINABLE URBAN DEVELOPMENT IN ISLAMIC PERSPECTIVE: A SYSTEMATIC SYNTHESIS *Wan Mohd Khairul Firdaus Wan Khairuldin, Shahir Akram Hassan, Abdul Hanis Embong, Wan Nur Izzati Wan Nor Anas, Mohamad Zaidin Mat@Mohamad, Muhammad Fuad Kamaludin, Mohd Sufi Ibrahim*	153 – 172
12.	NAVIGATING NUSANTARA'S URBAN GREEN FABRIC: EXPLORING CULTURAL AND SOCIAL INFLUENCES IN SELECTED CITY PARKS *Najah Md Alwi, Syafiqah N. Mukhtar, Nor Hafizah Anuar, Khalilah Hassan*	173 – 199
13.	A SYSTEMATIC REVIEW ON THE KEY ELEMENTS OF SUSTAINABLE CAMPUS INITIATIVES IN HIGHER EDUCATION INSTITUTIONS *Nurzalikha Sa'adi, Nur Azfahani Ahmad, Faisal Tamrulan, Nur Fasihah Ngah Seron*	200 – 216
14.	USER-CENTERED FURNITURE DESIGN FOR PET CO-LIVING SPACES *Wei Wenchao, Athira Azmi, Noranita binti Mansor, Wan Mstura Shaik Mohamed Mossadeq*	217 – 232
15.	THE IMPACT OF GREEN BUILDING MAINTENANCE PRACTICES IN MITIGATING PROMINENT DEFECTS AT UNIVERSITI TEKNOLOGI MARA (UiTM): A SYSTEMATIC LITERATURE REVIEW (SLR) *Zaimah Zainal Abidin, Nur Azfahani Ahmad, Nor Rima Mohamad Ariff, Wan Norizan Wan Ismail*	233 – 251
16.	INTEGRATING PASSIVE AND ACTIVE STRATEGIES: A CONCEPTUAL FRAMEWORK FOR BUILDING ENERGY EFFICIENCY IN HIGHER EDUCATION INSTITUTIONS *Mohd Mubarak Shamsuddin, Wan Norisma Wan Ismail, Fadli Arabi, Norsafiah Norazman*	252 – 269
17.	VIRTUAL VISIONS FOR TANGIBLE TREASURES: A BIBLIOMETRIC ANALYSIS OF EXTENDED REALITY'S ROLE IN URBAN HERITAGE SAFEGUARDING *Noor Farhana Alias, Nurul Syala Abdul Latip, Noor Hayati Ismail, Osama Elrawi*	270 – 288
18.	SERVICE INFRASTRUCTURE ALONG THE SILK ROAD: INNOVATIVE SOLUTIONS FOR SUSTAINABLE TRANSPORTATION CORRIDORS *Azamat Khasanov, Ziad Baydoun, Shakhboz Mustafoev, Madina Adilova, Zarifjon Adilov*	289 – 306

© 2026 by MIP

19.	DECODING SPATIAL PATTERNS IN LOW INCOME URBAN HOUSING THROUGH VERNACULAR REFERENCES. *Ahmad Shuib Yahya, Nurul Syala Abdul Latip, Nasrudin Sharkawi, Ahmadsyafii'ei Abdul Kudos, Azrul Izwan Ismail*	307 – 324
20.	PARAMETRIC OF DAYLIGHT PERFORMANCE THROUGH FACADE ENVELOPE RATIO OF HIGH-RISE OFFICE BUILDING IN TROPICAL CLIMATES *Elina Mohd Husini, Shaza Liyana Shamri, Fadli Arabi, Wan Zakiah Wan Ismail, Wan Norisma Wan Ismail*	325 – 340
21.	THE DIGITAL DOCUMENTATION OF HERITAGE BUILDINGS USING HISTORIC BUILDING INFORMATION MODELLING (HBIM) TOOLS *Noor Hayati Ismail, Siti Azira Abd Rahim, Nurul Syala Abdul Latip, Wan 'Iffah Wan Ahmad Nizar, Siti Azreendayani binti Abd Rahim*	341 – 351
22.	GREEN WALL FAÇADE AND IOT-BASED SYSTEM FOR OPTIMAL INDOOR ENVIRONMENT OF 'SAKINAH' LIVING *Elina Mohd Husini, Madihah Mat Idris, Azhani Abdul Manaf, Noor Hayati Ismail, Azamat Khasanov*	352 – 370
23.	SUSTAINABLE ARCHITECTURE APPROACH IN REVITALISING RELIGIOUS TOURISM SITES TOWARDS ENERGY MANAGEMENT IN MAQASID SYARIAH: A GENDER PERSPECTIVE *Elina Mohd Husini, Ahmad Guspul, Hermawan, Nor Haslina Jaafar, Masharipova Sayyora*	371 – 385
24.	STRUCTURAL INTERGRATION OF ARCHITECTURAL HERITAGE AND TENSILE MEMBRANE TECHNOLOGIES FOR SUSTAINABLE URBAN REGENERATION *Tariq Mahmoud Abdul-Jabbar Amer, Wan 'Iffah binti Wan Ahmad Nizar*	386 – 407
25.	AN EXAMINATION OF DESIGN FOR SAFETY LEGISLATION IN CONSTRUCTION ACROSS MALAYSIA, UNITED KINGDOM, NEW ZEALAND, AUSTRALIA, AND SINGAPORE: A DOCTRINAL ANALYSIS APPROACH *Mashitah Mohamad Hanafiah, Mazlina Zaira Mohammad, Nor Syamimi Samsudin, Natasha Khalil, Siti Azira Abd Rahim*	408 – 421
26.	SAFETY ASSESSMENT IN THE CONSERVATION OF HERITAGE BUILDINGS: A CASE STUDY OF TRADITIONAL MOSQUES IN NEGERI SEMBILAN, MALAYSIA *Siti Azira Abd Rahim, Mashitah Mohamad Hanafiah, Zurinoor Ahmad, Mohamed Ahmed Said Mohamed, Syahrul Rahmat*	422 – 435
27.	THE ARCHITECTURE OF THE LOST MAUSOLEUM OF NUR AL-DIN BASIR IN SAMARKAND: HISTORY OF ITS CONSTRUCTION AND DESTRUCTION, DIGITAL RECONSTRUCTION OF THE MONUMENT *Mavlyuda Abbasova-Yusupova, Fatima Khudaikulova*	436 – 457

© 2026 by MIP

28. STREET CHARACTER AND URBAN IDENTITY: DEFINING PHYSICAL DESIGN PARAMETERS OF BUILDING APPEARANCE IN THE HISTORIC URBAN FABRIC OF KUALA KANGSAR PERAK MALAYSIA 458 – 475
Wan Norisma Wan Ismail, Elina Mohd Husini, Fadli Arabi, Norsafiah Norazman, Shakhboz Mustafoev Shukhratovich

29. INCREASING ALLEY COGNISANCE TO IMPROVE COMMUNITY SAFETY IN KUALA LUMPUR: A CRITICAL STUDY OF REVITALISED URBAN ALLEY 476 – 494
Wan 'Iffah Wan Ahmad Nizar, Nor Syahila Ab Rashid, Nurul Syala Abdul Latip, Noor Hayati Ismail, Azhani Abd. Manaf

30. PILOT STUDY FINDINGS ON MULTI-GENERATIONAL HOUSING ENVIRONMENT PREFERENCES FEATURES FOR QUALITY OF LIFE AND ACTIVE AGEING IN MALAYSIA 495 – 509
Hafiszah Ismail, Kushairi Rashid, Nor Rima Muhamad Ariff, Mariam Felani Shaari, Aifaa Nur Syahirunnisaa Zakariya

31. SMART HOME FEATURES TO ENHANCE ELDERLY WELL-BEING AND QUALITY OF LIFE IN MALAYSIA: A SCOPING REVIEW 510 – 524
Hafiszah Ismail, Aida Wati Zainan Abidin, Aifaa Nur Syahirunnisaa Zakariya

32. HOMEOWNERSHIP CHALLENGES FOR MIDDLE-INCOMES GROUP IN SMART CITY BATU KAWAN, PULAU PINANG 525 – 540
Nurin Anis Syazwani Binti Mohamad Yazan, Norazmawati Binti Md. Sani @ Abd. Rahim

33. THE DYNAMIC RELATIONSHIP BETWEEN MULTIDIMENSIONAL GLOBALIZATION IN MARITIME LOGISTICS PERFORMANCE ASEAN 541 – 565
Heru Wahyudi, Andi Kusnadi, Sandra Mei Leny, Ja'far M. Yahya

34. MAPPING ROAD ACCIDENT HOTSPOTS ON MALAYSIAN INTER URBAN EXPRESSWAYS AN ANALYSIS ON SEVERITY LEVEL 566 – 581
Sharifah Zuraidah Syed Abdul Jalil, S. Sarifah Radiah Shariff, Saiful Aman Sulaiman, Zaharah Mohd Yusof, Fazzami Othman

35. BUILDING TO CITY: INTEGRATING BIM INTO CIM FOR A COMPREHENSIVE DIGITAL URBANISM 582 – 610
Mohammed Faisal Ghazi Al Kazee, Islam Sallam

36. COASTAL EROSION AND MONSOON STORMS DRIVING FISHERMEN TOWARD AN ALTERNATE OCCUPATION IN THE TOURISM SECTOR 611 – 632
Effi Helmy Ariffin, Zaleha Mohamad, Lee Shin Yun, Noorhaslinda Kulub Abd. Rashid, Mohd Nizam Lani

37. GLOBAL TRANSPORTATION EXPENDITURE AND ECONOMIC PERFORMANCE: A COMPREHENSIVE ANALYSIS OF TRANSPORTATION EXPENDITURE'S IMPACT ON ECONOMIC DEVELOPMENT IN KEY GLOBAL ECONOMIES (1990-2023) 633 – 647
Diana Al-Nabulsi, Valerian Kwigizile, Jun-Seok Oh, Ahnaf Shahin Chowdhury

38. ENCAPSULATES THE MALAY SETTLEMENTS 648 – 667
Azli Abdullah

39. MUSLIM FAITH-BASED NEEDS IN TOURISM FROM THE PERSPECTIVE OF MOBILE SERVICES: A BIBLIOMETRIC ANALYSIS 668 – 690
Nur Shuhadah Mohd, Ummi Noorjuwairiah Abdullah, Siti Salwa Md Sawari, Muhammad Aizat Jamaludin, Siti Syahirah Saffinee, Azhar Alam

40. EVALUATING AND ENHANCING SUSTAINABLE LIVELIHOODS AMONG URBAN POOR COMMUNITIES IN KUALA LUMPUR 691 – 704
Mohd Khairi Ismail, Suhaiza Hanim Mohd Zailani, Muhammad Nooraiman Zailani, Muhammad Faizuddin Ahmad Fadullah, Nurul Ashikin Alias

41. COASTAL ENGINEERING USING RHIZOPHORA SP. MANGROVE NATURAL STRUCTURE FOR WAVE DAMPING 705 – 724
Ahmad Herison, Yuda Romdania, Masdar Helmi, Laksmi Irianti, Arif Mahasin Sondani, M. Fariq Khadafi, M. Fatih Naban

42. MAPPING THE SCIENTIFIC LANDSCAPE OF URBAN EMISSIONS IN PORT CITIES: A BIBLIOMETRIC REVIEW 725 – 740
Ibnu Fauzi, Ade Ratih Ispandiari, Maria Nooza Airawati, Nofika Cahyani Putri

43. FROM POLICY TO PRACTICE: ANALYSING BEHAVIOURAL PATTERNS IN THE UTILISATION OF TEACHERS' QUARTERS IN MALAYSIA 741 – 756
Nur Nabila Ahmad Azam, Mariana Mohamed Osman, Abdul Razak Sapian, Syafiee Shuid

Notes to contributors and guidelines for manuscript submission 757

Ethics Statement 759

© 2026 by MIP

MIP Council Members
2025 - 2027 Session

President
Datin TPr. Mazrina Dato' Abdul Khalid (559/09)

Immediate Past President
Datin TPr. Hjh Noraida Saludin (468/02)

Vice President
TPr. Hj. Abdul Hamid Akub (450/01)
TPr. Wan Andery Wan Mahmood (572/10)

Honorary Secretary
TPr. Annie Syazrin Ismail (670/17)

Honorary Treasury
TPr. Fathuddin Kamaruddin (524/16)

Council Members
TPr. Abdul Halim Ali Hassan (407/98)
TPr. Saiful Azman Abdul Rashid (474/03)
Asst. Prof. TPr. Dr. Syafiee Shuid (813/21)
TPr. Hj Nik Mohd Ruiz Ahmad Fakhrul Razy (570/10)
TPr. Rene Fu Swee Yun (553/99)
TPr. Dr. Marlyana Azyyati Marzukhi (582/11)
TPr. Dr. Muhammad Hakimi Hussain (867/24)
TPr. Fauziah Abdul Jalil (878/24)
TPr. Muhammad Syafiq Norhizan (685/18)
TPr. Lee Lih Shan (267/92

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 1 – 16

A PRELIMINARY STUDY ON SOCIAL HOUSING NEEDS AMONG M40 EARNERS IN MALAYSIA

Masitah Zulkepli[1], Ahmad Ariffian Bujang[2] , Kolony anak Gunting[3], Idatul Farita Mohamad Toha[4], Azizah Ismail[5]

[1,2] *Faculty of Business and Management,*
SOUTHERN UNIVERSITY COLLEGE
[3]*Faculty of Busines,*
UNIVERSITY MALAYA WALES
[4]*Housing Planning Division,*
MINISTRY OF HOUSING AND LOCAL GOVERNMENT
[5]*Faculty of Built Environment and Surveying,*
UNIVERSITI TEKNOLOGI MALAYSIA

Abstract

Housing affordability is a major concern in both the developed and developing nations. In Malaysia, middle income families (M40 earners) are gradually experiencing issues of affordable and quality housing especially in the urban regions. Although government programs like rent and income-related subsidies have been put in place, the issue of affordability in housing is still significant. Recognising this issue, the Twelfth Malaysia Plan (2021–2025) highlights the need to improve housing provision for the M40 earners. This study aims to identify suitable criteria for the equitable allocation of social housing for M40 earners in Malaysia. The study examined definitions, criteria, and practices of the available housing programs to conceptualise the social housing, and a questionnaire survey was conducted among the M40 earners in Johor Bahru to investigate their housing preferences and the level of their affordability. The results propose key criteria in social housing development that will be in a better position to accommodate housing needs of M40 earners. These findings may assist policymakers in improving housing policies and strengthening existing housing legislation in Malaysia.

***Keywords**:* M40 earners, social housing concept, criteria, housing need, housing affordability

[1] Corresponding author. Email: masitah@sc.edu.my

INTRODUCTION

Housing is a fundamental human requirement. Housing has a significant impact on people's health and well-being, contributing to their physical and emotional health, education, work, and security. Social housing is a part of public housing scheme which has been widely practice in Malaysia (Bilal et al.,2019) and is one of the government-led alternatives to the housing crisis. The concept is to give subsidised housing to individuals who cannot afford the private housing, either through rental or purchase. Notwithstanding, the provision of public housing has continuously been difficult in developing countries like Malaysia. Bilal et al (2019) also argue that Malaysia's public housing industry has failed to reach its targets for low- and medium-cost housing due to restricted funding, convoluted land rules, and the increasingly demand for low-cost housing, particularly in metropolitan areas. Another study by Mohit and Nazyddah (2011) classified social housing as low-cost housing that receives some form of government assistance in its construction.

Bank Negara Malaysia (BNM) (2022) identified substantial housing challenges to include a structural mismatch of supply and demand, the necessity to keep house prices in check, and which accentuates the need for a strong rental market for persons prematurely or unwillingly to buy. Financings are not the solution to housing affordability itself, the Governor remarked, as that was something quite a number of Malaysians found homes they hope to own were beyond their reach especially households in the M40 middle-income bracket. Despite policies focused on lower-income earners, house prices have escalated, making home ownership difficult for M40 earners. The Khazanah Research Institute reports that housing affordability has not improved significantly, with houses considered seriously unaffordable. In 2019, the average house price in Malaysia was RM426,155, while the average per capita income was RM45,034, with house prices increasing 5.6 times over 30 years compared to 2.8 times increase in income, indicating that housing costs have outpaced real income growth (Das, 2020; Khazanah Research Institute, 2019; Ong T.S, 2013).

Malaysian National Housing Department (2019) has reveal that the idea of social housing in Malaysia still in early stage and need to have clear concept in order to resolve the urban poverty and housing need for B40 and M40 earners.

Several factors have contributed to the challenges in introducing social housing in Malaysia. Liu and Ong (2021) provides evidence in their research that our National Affordable Housing Policy (DRMM) can increase housing affordability by more precisely offering affordable housing, lowering housing costs, and improving home financing ability.

Social housing is emerging in other developed nations such as United Kingdom (UK) but in Malaysia, it is still in the phase of promoting the idea (Jayaselan, 2019). National Housing Department (2019) introduced the idea of social housing as the next stage of developing affordable housing for the B40 an

M40 earners. This housing scheme will gives this group lower rent homes than privately rented housing and provides longer term of tenancy and giving tenants an opportunity to live in a house. This scheme also suggested to own by housing association which are independent of the local councils to less the burden handed to the government, developer, and local authorities. However, it is still not clear on how to define social housing in Malaysian context.

Due to urban poverty and manifest housing market failure such as shortage of affordable rental housing, purchasing power declined due to inadequate income levels, the increase of housing prices, limited mid-range housing supply and insufficient policy support has denied the access to the housing free market among Malaysians household especially M40 earners who constitute about 40% of Malaysia's population (Norhasliya Mohd Daud et al., 2017). Although numerous housing programs focus on the B40 earners, a large part of the M40 earners exists in an affordability gap, affording neither low-cost accommodation nor the market-priced housing (Mohamed and Baqutayan, 2014; Mohd Zaidi Md Zabri, 2023). This situation is further intensified by restrictive financing conditions and loan approval processes, highlighting the urgent need to better understand and address the housing needs of the M40 earners within Malaysia's evolving housing landscape (A. Ismail et al., 2023a).

In response to this situation, there is growing interest to reconceptualize social housing in Malaysia since this concept is still under-planning thus prominently unable to meet the housing need especially for M40 earners. Thus, this research focuses at this issue; identifying the important criteria for social housing specific to the M40 earners in Johor Bahru. This research also determines the significant relationship between the social housing criteria and housing need among M40 earners.

LITERATURE REVIEW

Housing Need, Demand and Supply

The concept of "housing needs," introduced by Rossi in 1955, clearly states the level of satisfaction experienced by individuals in their living environment. Rossi argues that households go through various stages of the life cycle, which lead to changing housing demands and aspirations. This can result in a "mismatch" between current and ideal housing, causing stress or dissatisfaction. To address this, households may migrate to readjust their housing situation to changing needs. Changes in the life cycle lead to varying spatial requirements, making them important determinants of housing demand. When a dwelling and neighbourhood fail to meet these changing needs, dissatisfaction will occur (Mohit and Raja, 2014). This dynamic view of housing needs underlines the importance of meeting the changing needs of households over time.

According to economic theory, housing is a marketable item, with supply and demand determining both the quantity produced and the selling price.

© 2026 by MIP

The interaction of buyers and sellers is critical for the market to function properly. (Cardenete et al., 2017). Furthermore, researchers point out that in an equilibrium situation, each residence is purchased by the household with the greatest bid price among all others. In contrast, market disequilibrium develops when there is an imbalance between supply and demand resulting in a surplus or deficit. (Ismail et al., 2023; DiPasquale and Wheaton, 1996).

The discussion on the housing needs and market dynamics points to the fact that the housing markets are not always efficient in addressing the needs of the entire income groups. In most nations, especially in fast growing urbanising economies, market-driven housing supply is not able to deliver proper and affordable housing to some sections of the population. Such a discrepancy between the demand and supply of housing has made governments to implement policy interventions to have fair access to housing (Aishah et al., 2023; Whitehead and Scanlon, 2007). Social housing is one of such interventions and has become a prominent policy tool to implement to ensure affordability and enhance the housing availability of underserved households in the private housing market.

Defining Social Housing

The term "floating signifier" was used to denote social housing. That is, a word with no universally accepted definition. There are times when there is no description at all. This leads to misunderstandings instead of a serious discussion regarding the pros and drawbacks of such a scheme (Hansson and Lundgren, 2019). Social housing is a part of public housing that has been widely practice in Malaysia (Bilal et al., 2019) and is one of the government-led solutions to the housing crisis. The idea is to give subsidised housing to individuals who cannot afford private housing, either through rental or sale. The supply of public housing in developing countries, such as Malaysia, has always been a concern (Bilal et.al, 2019). In 2019, National Housing Department (Malaysia) has reveal that the idea of social housing in Malaysia still in early stage and need to have clear concept in order to resolve the urban poverty and housing need for B40 and M40 earners. Recent Malaysian housing policy discussions have also highlighted the need to strengthen social housing frameworks to address increasing housing affordability challenges, particularly in urban areas where housing prices continue to rise faster than household incomes (Khazanah Research Institute, 2025; Ismail et al., 2023; Mohd Daud et al., 2022).

The definitions of social housing and council housing is different from countries to countries. There is no one fix agreed definitions for this two types of housing. In US, the social housing is referred as residential rented accommodations provided at sub-markets prices and allocated according to specific rules rather that market piece mechanism (Del Pero et al, 2016). Whereas in China, the government has launch a large public housing project since 2007,

which two-tiered system focusing on the lower income group but as well as moderate income citizen, mostly build in urban areas (Sisson & Rogers,2020). Social housing normally is provided and manage by the state government and rented to the citizen with a lower rent. In certain country social housing has been functioning in whole different term. In UK, social housing is known as council housing which the state government provide housing facilities with a lower rent.

In the Malaysian context, several affordable housing initiatives such as the People's Housing Programme (PPR) and PR1MA have been introduced to improve housing access; however, studies indicate that gaps remain in addressing the housing affordability needs of the middle-income earners, particularly the M40 earners (Willis and Mohsin, 2025).

Social housing aims to provide affordable housing for those unable to access the free market, ensuring they can pay controlled rent or buy at fixed prices (Beretic and Talu, 2020). Recognizing that safe and adequate housing is essential for health, well-being and socioeconomic outcomes, social housing addresses market failures where low- and middle-income groups struggle to find suitable housing due to affordability issues, supply deficits and discrimination (Flanagan et al., 2019; Masram & Misnam, 2019). It also involves a range of stakeholders, including financial institutions and property operators, in solving the affordable housing challenge (Canelas and Alves, 2024). Given the experimental nature of social housing in addressing the mismatch between housing prices and household affordability, there is a need for effective policies and innovative models to improve housing security and urban well-being. Social housing must evolve into a flexible environment to adapt to changing demands, thus improving housing policies to better meet the needs of the M40 income group (Beretic and Talu, 2020).

Social Housing Criteria

Table 1 shows the main criteria for social housing which are divided into six main categories with detailed sub-criteria. Income is the first criterion which covers eligibility and affordability, while price considers aspects such as delivery systems, subsidies and price interventions to ensure affordability. Next, financing facilities cover loan options, affordability measures and repayment capacity, making home ownership more accessible. Housing suitability covers property size and type, household size, sustainability and ownership options. In addition, location and amenities emphasise accessibility and availability of utilities. Finally, community quality and amenities highlight the importance of safety, standards and communal spaces, thus contributing to a safe and cohesive living environment.

© 2026 by MIP

Table 1: Summary of Social Housing Criteria Involves in the Research

No	Criteria	Sub criteria	Sources
1	Income	Income Eligibility Affordability	Hansson & Lundgren (2019), Drixler et al. (2014), (DOSM, 2022), Braga M. and Palvarini (2013), Aziz, Hanif & Singaravello, (2007), Bujang et al., (2010); Gan & Hill (2009), Elforgani and Rahmat, (2011), Hassanudint (2021), Irawan H., (2023), Wood, (1961), Hassan et al., (2021), Azmi and Bujang (2021), Azmi et al (2016), Ismail et al., (2023); Mohd Daud et al., (2022). Willis and Mohsin, (2025)
2	Price	Delivery System Subsidies Price Intervention	
3	Financing Facilities	Loan Financing Long Term Affordability Income Affordability Purchase Affordability Repayment Affordability	
4	Housing Suitability	Size of Property Type of Property Size of Households Green and Sustainable Design Form of Tenure	
5	Location and Amenities	Location and Accessibility Utilities and Amenities	
6	Quality and Community Facilities	Quality Standards Security and Safety Community Facilities	

Source: Author (2024)

M40 Earners

Four decile categories (M1 to M4) were identified based on the income distribution of Malaysian M40 earners. The highest category, denoted by M4, has a household income range of RM9,450 to RM11,819, with a median of RM10,552. The M3 group's income ranges from RM7,690 to RM9,449, with a median of RM8,523. The M2 group is in the RM6,340 to RM7,689 income range, with a median income of RM6,979. At the lower end, the M1 group earned between RM5,250 and RM6,339, with a median income of RM5,770. Hence, it is necessary to comprehend the economic variability within the M40 category thorough analysis in order to create targeted housing projects (Department of Statistics Malaysia, 2024).

RESEARCH METHODOLOGY

Quantitative research employ statistical methods and numerical data to evaluate information gathered from closed-ended surveys (Creswell, 2018). The criteria under investigation were identified earlier and connected to the research questions. The data collection for this research was based on the questionnaire survey. Convenience sampling was selected due to its cost effective and ease of use. Data from M40 earners in Johor Bahru was obtained using both online and in-person survey.

The structured questionnaire consisted of four main sections: Section A (Socio-Demographic Profile), Section B (Housing Preferences), Section C

(Social Housing Criteria for M40 Income Group), and Section D (Open-ended Questions). A total of two hundred questionnaires were distributed to the respondents in Johor Bahru, consisting of current homeowners and potential homebuyers in the M40 earners category. This research obtained 102 completed surveys, with a response rate of 51%. Babbie (2014) stated that a response rate of 50% was sufficient for analysis and reporting. Furthermore, Wu et al. (2022) stated that the average appropriate response rate for an online survey in the field of education is 44%, confirming the appropriateness of the response rate achieved in this study.

ANALYSIS AND DISCUSSION

Data Analysis

The survey data was examined using descriptive analysis and Pearson correlation analysis to generate the final results. Descriptive analysis was used to investigate the respondents' socio-demographic characteristics, including gender, age, race, income, number of dependents, marital status, education level, employment, average spending, and income allocation for home loans.

In the subsequent section, respondents were required to rank the importance of social housing criteria for M40 earners. The measure of reliability was examined to ensure the quality of the research instrument utilized in this research. Furthermore, the average index of each criteria was calculated in relation to the level of importance as determined by respondent opinion. As a result, each criteria was ranked based on its average index. These criteria was also analyzed using the Pearson correlation coefficient to see whether any of them were expressively related to one another. The Pearson correlation coefficient values vary from -1 to 1. The greater the coefficient, the more significant the relationship between the variables. This method was chosen because descriptive analysis effectively summarizes the socio-demographic profile of the respondents, while the Pearson correlation identifies the relationship between the criteria which directly in line with the research objective to evaluate and evaluate social housing criteria for the M40 income earners.

Socio-demographic Profile

The respondent profile as shown in Table 2 provides a detailed summary of the demographic and socioeconomic characteristics of the sample population. The distribution of gender is approximately equal, with females accounting for 54.9% and males accounting for 45.1%. In term of age, the most prevalent is group is 31 to 40 years old, represents 43.1% of responses, followed by 41 to 50 years old (23.5%) and 21 to 30 years old (22.5%). Most of respondents (63.7%) are married, while 36.3% are single. The educational level varies, with bachelor's degrees representing the highest percentage (30.4%), followed by pre-

© 2026 by MIP

university/diploma (28.4%) and master's degrees (21.6%). However, only 12.7% and 4.9% have completed secondary school or obtained a doctoral degree.

Table 2: Socio-demographic profile of respondents.

Profile of Respondents		Percentage	Profile of Respondents		Percentage
Gender	Male	45.1	**Marital Status**	Single	36.3
	Female	54.9		Married	63.7
Age	21 to 30 years old	22.5	**Educational Level**	Secondary school	12.7
	31 to 40 years old	43.1		Pre-university / Diploma	28.4
	41 to 50 years old	23.5		Bachelor's degree	30.4
Race / Ethnicity	Malay	50.0		Master's degree	21.6
	Chinese	25.5		(Doctoral degree / PhD)	4.9
	Indian	22.5	**Number of dependent / households size**	No dependent	26.5
				1 to 3 persons	50.0
Occupation	Self-employed	13.7		4 to 6 persons	21.6
	Private sector	69.6		Above 6 persons	2.0
	Government sector	11.8			
Average monthly expenditure (households)	Less than RM 1,000	9.8	**Housing loan expenditure (monthly)**	RM 500 and below	6.9
	RM 1,001 ~ RM 2,000	29.4		RM 501 ~RM 1,000	5.9
	RM 2,001 ~ RM 3,000	20.6		RM 1,001 ~ RM 1,500	23.5
	RM 3,001 ~ RM 4,000	13.7		RM 1,501 ~ RM 2,000	12.7
	More than RM 4,000	26.5			

Source: Author (2024)

The findings indicate that in term of ethnicity, half of the respondents (50.0%) are Malays, followed by Chinese (25.5%) and Indians (22.5%), who represent another large ethnic group. The size of household varies, with the majority (50.0%) having 1 to 3 dependents, 26.5% having no dependents, 21.6% having 4 to 6 dependents, and 2.0% having more than 6 dependents. Regarding occupation, majority of respondent work in the private sector (69.6%), followed by self-employment (13.7%) and the government sector (11.8%).

The number of households with high spending capacity is quite high, 26.5 percent households spend more than RM 4000. Conversely, the proportion of monthly spending of less than RM 1000 is at 9.8% of the population and could

be attributed to the low-income earners or more likely the cost-conscious spending habits. In particular, 50 percent of the respondents fall within the range of RM 1001 to RM 2000 (29.4 %), and RM 2001 to RM 3000 range (20.6%) respectively. This distribution shows that majority of middle-income households maintain sensible financial constraints in regard to their living expenses.
Regarding housing loan expenses, the majority of respondents with 23.5% fall into the highest expenditure category, which is between RM 1001 and RM 1500. This suggests that households have reasonable housing commitments. Afterwards, 12.7% of respondents allocate between RM 1501 and RM 2000 per month for housing loan.

Reliability Test

A reliability analysis was carried out to assess the consistency of the responses received. Cronbach's Alpha value above 0.7 indicates reliable data for further analysis and reporting (Stanojev and Stojić, 2015; George and Maller, 2003). The Cronbach's Alpha value in this research was 0.973, indicating a high level of internal consistency and confirming the reliability of the data from respondents.

Social Housing Criteria for M40 Earners

Figure 1 depicts the mean scores for key criteria relevant to social housing. Each important criteria (Income, Price, Financing Facilities, Housing Suitability, Location and Amenities, Quality, and Community Facilities) is assessed based on particular sub-criteria, with the mean score for each criterion reported on a scale ranging from 1 (Not Important), to 7 (Extremely Important).

The findings of the research presented in Figure 1 indicate that M40 earners value income, financing facilities, and pricing in social housing. The eligibility and income affordability (6.36), financing affordability (6.33), and price-related factors (6.21) scores are high, indicating that affordable housing prices, availability of financing options, and proper pricing mechanisms are extremely important. Nevertheless, outstanding amenities and community, place and facilities are vital. The above findings suggest that policymakers and developers ought to focus on aligning housing prices with the incomes of the M40 earners to offer systematic financial assistance, balance price, and quality to meet the needs of M40 earners.

© 2026 by MIP

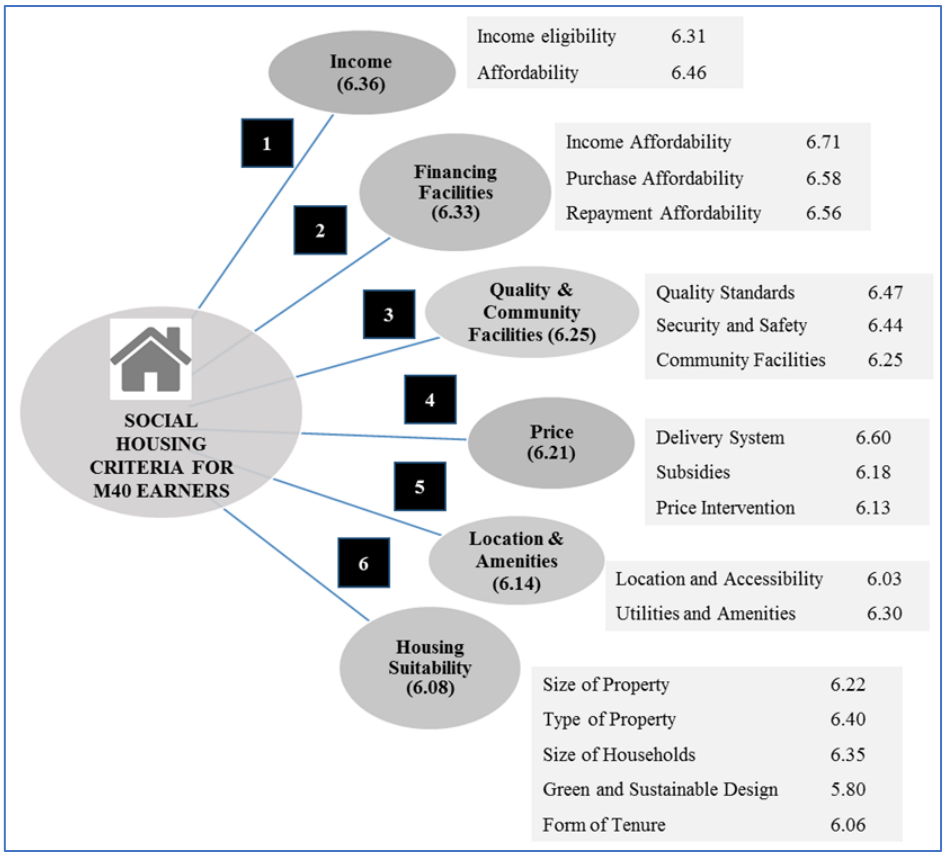


Figure 1: Important Social Housing Criteria for M40 Earners
Source: Author (2024)

In the subsequent section, the average index for each criteria was calculated using the specified scale and method provided below.

$$\text{Average index} = \frac{\text{Sum of all the scales given by respondents}}{\text{Total respondents}}$$

Table 3 illustrate the average index and ranking of six important social housing criteria for M40 earners. The highest rank is income with an average index of 6.36. It indicates that income level is the highest priority when respondents considering their housing options since income holds significant importance when assessing home affordability. Moreover, ensuring that housing costs are tailored to income levels is critical for making social housing accessible to this group.

Financing facilities is ranked second with an average index of 6.33 and it shows that adequate access of financing options is a critical criteria for M40 earners in their decision for purchasing social housing. This finding suggest that M40 earners need a strong financial support mechanism such as affordable financing and mortgage option, manageable housing loan repayment and flexible loan term to assist them on homeownership. Hence, policymakers should emphasis on improving the financing options to help middle income families in reducing their financial burden.

Table 3: Average Index and Ranking of Important Social Housing Criteria for M40 Earners

No.	Criteria	Rate							Average Index	Rank
		1	2	3	4	5	6	7		
1.	**Income**	0	0	0	0	15	42	46	6.36	**1**
2.	**Price**	0	0	0	4	13	42	43	6.21	**4**
3.	**Financing Facilities**	0	0	0	3	11	37	51	6.33	**2**
4.	**Housing Suitability**	0	0	0	2	19	50	31	6.08	**6**
5.	**Location & Amenities**	0	1	0	2	18	41	40	6.14	**5**
6.	**Quality & Community Facilities**	0	0	1	1	13	43	44	6.25	**3**

Source: Author (2024)

The third rank criteria are quality and community facilities with an average index of 6.25. This result highlights that M40 earners are concerned on the overall quality of housing along with the availability of community facilities such as parks, playgrounds, community centers, and healthcare clinic. Therefore, the government and developers must guarantee that social housing projects fulfill high quality standards while providing community facilities that are necessary for the M40 earners. This is preceded by price, location and amenities and housing suitability with average indices of 6.21, 6.14, and 6.08 respectively. Price is a key factor for respondents in determining housing affordability. Increased prices imply an increase in mortgage-and-down-payment requirements and may restrict access to financial options. Developers and policymakers must strike a balance between price and quality to offer high quality affordable housing. Subsequently, location and amenities hold the fifth rank. The finding indicate that the M40 earners may be prepared to make a location sacrifice in order to secure affordable and high-quality housing. However, their choices are influenced by proximity to work, schools, healthcare facilities, and other amenities. This is followed by housing suitability which was least prioritized criteria with ranked

© 2026 by MIP

sixth. Housing suitability includes sub criteria such as size of property, type of property, size of household, green and sustainable design and form of tenure which influenced the suitability of housing. Hence, to ensure long-term stability and satisfaction, policymakers and developers should make sure that social housing meets the specific demands of M40 earners by accommodating their family size and lifestyle. This average index indicates the relative importance of each criterion as perceived by respondents, while following Pearson correlation test identifies the strength and direction of relationships between criteria, helping to interpret which factors are most influential in M40 social housing preferences.

Pearson Correlation Test

Table 4 illustrates the Pearson correlation coefficient matrix between the criteria. The correlation study found substantial, statistically significant links between all of the analyzed social housing criteria among M40 earners, with all correlations significant at the 0.01% level. Income demonstrate a strong correlation with price (0.716) and availability of financing (0.708), which implies that the two variables are interrelated in evaluating affordability of housing. Housing suitability, on the other hand, displays a substantial relationship with price (0.754), quality and community amenities (0.729), signifying the importance of these factors in choosing appropriate housing. Location and amenities and the quality of community amenities shows strong relationship (0.825), representing the availability of amenities expressively expands housing quality. These findings highlight the importance of a unified approach to social housing policy and development that deliberates income, affordability, quality and amenities to successfully address the needs of the M40 earners.

Table 4: Pearson correlation coefficient matrix between the criteria.

Criteria	Income	Price	Financing Facilities	Housing Suitability	Location & Amenities	Quality & Community Facilities
Income	1	0.716**	0.708**	0.664**	0.624**	0.658**
Price	0.716**	1	0.700**	0.754**	0.660**	0.699**
Financing Facilities	0.708**	0.700**	1	0.679**	0.524**	0.565**
Housing Suitability	0.664**	0.754**	0.679**	1	0.711**	0.729**
Location & Amenities	0.664**	0.660**	0.524**	0.711**	1	0.825**
Quality & Community Facilities	0.624**	0.699**	0.565**	0.729**	0.825**	1

** Correlation is significant at the 0.01% level

Source: Author (2024)

CONCLUSION

This study has explored the social housing needs of the Malaysian M40 earners and demonstrating a diverse economic landscape. Most of the respondents are between 31 to 40 years old, are married, have either bachelors or pre-university degrees, and are employed in the private sector. They manage moderate to high monthly expenses with large amount being utilized in housing loans.

The research discovered that the three most important factors of social housing among M40 earners are income, financing options and community and quality amenities. Income was the most crucial factor to consider, and it emphasizes the necessity to find affordable housing solutions. Financing facilities were also required with emphasis on the accessible and effective financing options. The third factor was quality and community facilities, which stressed the importance of quality housing with proper amenities. Understanding these criteria is necessary to develop social housing that effectively meets the needs of the M40 earners.

Based on this research, some key recommendations are proposed to meet the housing needs of M40 earners in Malaysia. Affordability should be the main concern of policy makers and developers by ensuring that the prices of houses are adjusted to M40 incomes. Reduced interest rates, subsidies, and flexible terms of the loan, with the eligibility and repayment policies, should be implemented to improve the opportunities of owning a home. Banks and developers might come up with tailored financing programs and incentive to finance mid-range housing projects within the region of M40 affordability ranges. It is also important to provide quality housing with essential facilities such as schools and medical centers to ensure satisfaction among the residents. Government, developers, and financial institutions ought to be in constant association to ensure that the policies are updated and all responsive to the emerging needs. Customized solutions should be created for the different groups within the M40 category. Implementing these measures will assist Malaysia to meet its objective of providing affordable and inclusive social housing as well as enhancing the quality of life for M40 earners.

This study reached its objectives, however it has certain drawbacks The convenience sampling method was used to gather the sample size of 102 respondents from Johor Bahru which could have restricted the representativeness and generalizability of the study due to small number of respondents were taken in the one geographical location. Therefore, it might not be reflective of the entire spectrum of M40 earner in Malaysia. Future study might consider increasing the sample size and incorporating various regions to enhance representativeness. It would also be beneficial to employ qualitative approaches, such as interviews or focus groups, to acquire a better understanding of M40 earners' housing options and challenges. To conclude, assessing the long-term effects of housing policy on

© 2026 by MIP

this particular group could provide valuable information for policymakers and all housing industry players.

ACKNOWLEDGEMENT

This research was supported by Ministry of Higher Education and Southern University College under the Fundamental Research Grant Scheme FRGS/1/2022/SS04/SUC/02/1.

REFERENCES

Aishah, W., Zairul, M., Kozlowski, M., & Shukor, S. F. A. (2023). Social housing and psychological issues discussed in literature: A thematic review. *International Journal of Academic Research in Business and Social Sciences, 13*(8), 1301–1317. https://doi.org/10.6007/IJARBSS/v13-i8/18224

Aziz, W. N. A. W. A., & Singaravello, N. R. H. D. K. a/l. (2011). Affordable housing within the middle-income households in Malaysia: Challenge to enter homeownership in. *Australian Journal of Basic and Applied Sciences, 5*(8), 258–267.

Azmi, N., & Bujang, A. A. (2021). The gap between housing affordability and affordable house: A challenge for policy makers. *Planning Malaysia, 19*(17). https://doi.org/10.21837/pm.v19i17.1016

Babbie, E. R. (2014). *The basics of social research* (6th ed.). Wadsworth, USA: Cengage Learning.

Beretić, N., & Talu, V. (2020). Social housing as an experimental approach to the sustainable regeneration of historic city centers: An ongoing study of Sassari City, Italy. *Sustainability (Switzerland), 12*(11). https://doi.org/10.3390/su12114579

Bernama. (2022, February 22). Bank Negara says housing supply and demand mismatch needs to be addressed. *The Star.Banking*. https://www.thestar.com.my/business/business-news/2022/02/11/bank-negara-says-housing-supply-and-demand-mismatch-needs-tobe-addressed#.YgYVGMcMvKk.facebook

Bilal, M., Meera, A. K. M., & Abdul Razak, D. (2019). Issues and challenges in contemporary affordable public housing schemes in Malaysia: Developing an alternative model. *International Journal of Housing Markets and Analysis, 12*(6), 1004–1027. https://doi.org/10.1108/IJHMA-11-2018-0091

Braga, M., & Palvarini, P. (2013). *Social housing in the EU*. Brussels: European Parliament, Directorate General for Internal Policies.

Canelas, P., & Alves, S. (2024). The governance of affordable housing through public-private partnerships: Critical entanglements. *Land Use Policy, 143*, 107193.

Cardenete, M. A., Guerra, A.-I., & Sancho, F. (2017). *Applied general equilibrium: An introduction* (2nd ed.). Springer.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Los Angeles: SAGE.

Das, P. A. M. (2020). *The effect of macroeconomic factors, ageing population and government housing policies on residential housing prices in Malaysia*.

Del Pero, A. S., Adema, W., Ferraro, V., & Frey, V. (2016). *Policies to promote access to good-quality affordable housing in OECD countries* (OECD Social, Employment and Migration Working Papers No. 176). OECD Publishing: Paris, France.

Department of Statistics Malaysia, & Ministry of Economy. (2024). *Jabatan Perangkaan Malaysia Department of Statistics Malaysia, 70*. Retrieved from www.dosm.gov.my

Dipasquale, D., & Wheaton, W. C. (1996). *Urban economics and real estate markets*. Englewood Cliffs, NJ: Prentice Hall.

Gan, Q., & Hill, R. J. (2009). Measuring housing affordability: Looking beyond the median. *Journal of Housing Economics, 18*(2), 115–125. https://doi.org/10.1016/j.jhe.2009.04.003

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference, 11.0 update*. Boston: Allyn & Bacon.

Hansson, A. G., & Lundgren, B. (2019). Defining social housing: A discussion on the suitable criteria. *Housing, Theory and Society, 6096*, 1–18. https://doi.org/10.1080/14036096.2018.1459826

Hassan, M. M., Ahmad, N., & Hashim, A. (2021). A review on housing affordability in Malaysia: Are we doing fine? *Malaysian Journal of Consumer and Family Economics, 26*. 2021.

Hassanudint, M. (2021). *Housing prices and affordability in Malaysia*. Sunway University Press. Retrieved from https://press.sunway.edu.my/blog/housing-prices-and-affordability-malaysia https://www.thebalancesmb.com/real-estate-supply-and-demand-2866979

Ismail, A., Mamat @ Ghazali, S. N. A., & Anthony Jiram, W. R. (2023). Housing affordability stress among the middle-income (M40) group in Johor Bahru. *Planning Malaysia, 21*(27). https://doi.org/10.21837/pm.v21i27.1296

Khazanah Research Institute. (2019). *Rethinking housing: Between state, market and society: A special report for the formulation of the National Housing Policy (2018–2025), Malaysia*. Khazanah Research Institute, Kuala Lumpur, Malaysia. April 2019, ISBN: 978-967-16335-8-8.

Khazanah Research Institute. (2025). *Making housing affordable*. Kuala Lumpur: Khazanah Research Institute.

Liu, J., & Ong, H. Y. (2021). Can Malaysia's National Affordable Housing Policy guarantee housing affordability of low-income households? *Sustainability, 13*, 8841. https://doi.org/10.3390/su13168841

Masram, & Misnan. (2019). Evolution of policy for affordable housing programmes in Malaysia. *International Journal of Accounting, Finance and Business, 4*(17), 86–98.

Mohd Daud, M. A., Rosly, S. A., & Muhamad Sori, Z. (2022). Understanding issues of affordable housing in Malaysia to attract investment. *Planning Malaysia, 20*(20). https://doi.org/10.21837/pm.v20i20.1074

Mohit, M. A., & Al-Khanbashi Raja, A. M. M. (2014). Residential satisfaction - concept, theories and empirical studies. *Planning Malaysia, 12*(3). https://doi.org/10.21837/pm.v12i3.131

© 2026 by MIP

Ong, T. S. (2013). Factors affecting the price of housing in Malaysia. *Journal of Emerging Issues in Economics, Finance and Banking, 1*(5), 414–429.

Sisson, A., & Rogers, D. (2020). *Housing, 5*, 196–200. https://doi.org/10.1016/B978-0-08-102295-5.10269-0

Stanojev, M. L., & Stojić, D. (2015). Reliability analysis of structures. *Facta Universitatis, Series: Architecture and Civil Engineering*, 265–272.

Whitehead, C. M. E., & Scanlon, K. (2007). Social housing in Europe. In C. M. E. Whitehead & K. Scanlon (Eds.), *Social housing in Europe* (pp. 8–33). London School of Economics and Political Science.

Willis, C. M. A., & Mohsin, A. B. (2025). Affordable housing schemes in Malaysia: A review of systematic gaps. *International Journal of Real Estate Studies, 19*(2), 12–22.

Wong. (2019). Social housing mooted for 12th Malaysian Plan. *Property*. https://www.thestar.com.my/business/business-news/2019/08/02/social-housing-mooted-for-12th-malaysia-plan

Wu, M. J., Zhao, K., & Fils-Aime, F. (2022). Response rates of online surveys in published research: A meta-analysis. *Computers in Human Behavior Reports, 7*(April), 100206. https://doi.org/10.1016/j.chbr.2022.100206

Received: 5th July 2025. Accepted: 15th November 2025

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 17 – 30

ENVIRONMENTAL VALUATION PRACTICES AND CHALLENGES IN MALAYSIA: A REVIEW OF METHODS AND POLICY IMPLICATIONS

Nurfarisha Ezzaty Mohammed Yuswan[1], Fitriyah Razali[2*], Siti Zaleha Daud[3], Noramirah Nabilah Sulaiman[4], Raja Nurul Sakinah Raja Syamsuddin[5], Hariati Abdullah Hashim[6]

[1,2,3,4,5,6] *Real Estate Department, Faculty of Built Environment and Surveying,*
UNIVERSITI TEKNOLOGI MALAYSIA
[2,6] *Centre for Real Estate Studies (UTM CRES),*
Institute for Smart Infrastructure and Innovative Construction (ISIIC),
UNIVERSITI TEKNOLOGI MALAYSIA

Abstract

This study highlights the critical role of environmental valuation in informing sustainable development in Malaysia, focusing on its role in assessing the economic value of environmental goods and services. Environmental valuation is crucial for providing policymakers and stakeholders with essential information to conserve and manage natural resources effectively. The study identified four primary environmental valuation methods used in Malaysia: Travel Cost Method (TCM), Contingent Valuation Method (CVM), Cost-Benefit Analysis (CBA), and Willingness to Pay (WTP). TCM emerged as the most frequently applied method due to its simplicity and effectiveness in estimating recreational benefits derived from ecosystems, while CVM was employed to gauge public willingness to pay for conservation. The study also highlighted several challenges faced by valuers, including difficulties in obtaining reliable data, identifying appropriate sampling methods, constructing effective questionnaires, time constraints, and determining suitable valuation techniques. Strengthening policy frameworks for environmental valuation is vital to enhance the adoption of accurate methods and improve valuation practices in Malaysia. This research explores the challenges of environmental valuation practice in Malaysia that hinder the effective valuation practices.

Keywords: Environmental valuation, Valuation method, Valuation practices, Real estate, Built environment, Sustainability

[2] Corresponding author. Email: fitriyahrazali@utm.my

INTRODUCTION

Malaysia's economic boom has brought forth environmental challenges, including pollution, deforestation, and biodiversity loss. To address these issues, the government has introduced environmental policies, emphasizing the importance of environmental valuation in decision-making. Environmental valuation assesses the economic worth of environmental goods and services. Despite its importance, there's a lack of awareness among Malaysian valuers about its application and benefits (Biswas, 2023; Vaghefi et al., 2015).

Valuers need to adapt traditional valuation methods to account for the unique characteristics of environmental resources. Recent government policies prioritize sustainable development and environmental conservation, but awareness among valuers about environmental valuation remains low (Guijarro & Tsinaslanidis, 2020). Environmental valuation awareness among practitioners is important, this could be enhance through the integration valuation results into the policymaking process (Pearce & Seccombe-Hett, 2000). Failure to incorporate environmental factors in property valuation could lead to overexploitation of natural resources and environmental degradation. Valuers' limited understanding of environmental valuation methods poses challenges.

Insufficient literature and integration of valuation results into decision-making processes hinder effective environmental policy implementation (Abdullah et al., 2018). Additionally, there's a need to develop holistic valuation approaches that capture diverse ecosystem values and consider environmental aspects in property transactions. The research aims to identify environmental valuation practices and challenges in Malaysia. By strengthening valuers' comprehension and addressing existing implementation gaps, this study aims to enhance the economic assessment of natural resources, support more informed decision-making, and advance sustainable development practices. In this context, there is a pressing need for environmental studies in Malaysia to further improve environmental behaviour and awareness within the community (Razali et al., 2025).

This study holds significant potential for enhancing the understanding and utilization of environmental valuation among valuers in Malaysia. It aims to provide insights to various stakeholders, including valuation professionals, environmental organizations, property investors, academia, and researchers. The research scope focuses on the practices of environmental valuation in Malaysia and the challenges faced by valuers regarding its implementation. Qualitative data collection methods, such as in-depth interviews with key informants like environmental valuation experts, policymakers, and valuers, are utilized to gather insights into the current state of environmental valuation practices in Malaysia.

LITERATURE REVIEW

Classification of Valuations: Direct Vs. Indirect

Valuation methods are categorized into direct and indirect approaches. Direct valuation involves assessing individuals' preferences and behaviours to estimate the economic value of environmental goods and services. Contingent valuation (CV) and stated preference methods, like choice experiments, are commonly used in direct valuation. CV presents hypothetical scenarios to individuals, eliciting their willingness to pay or accept compensation for environmental changes. Stated preference methods gauge individuals' preferences and value trade-offs for environmental attributes. Direct valuation methods are valuable internationally but may face challenges in Malaysia due to cultural differences and the complex nature of environmental goods (Pek, 2014).

Indirect valuation, or revealed preference methods, estimate environmental resource value indirectly through market behaviour or existing market data (Pek et al., 2010). Hedonic pricing examines the relationship between market prices of goods and their environmental attributes, while Travel Cost Analysis assesses the economic value of recreational sites based on travel expenses. While indirect valuation methods offer insights into the economic value of environmental resources, their application may be limited by data availability and market relevance in the Malaysian context.

Environmental Valuation Method

Environmental valuation methods provide frameworks for quantifying the economic value of ecosystem services and resources. The environmental valuation methods in Malaysia include Discounted Cash Flow (DCF), Cost-Benefit Analysis (CBA), Contingent Valuation Method (CVM) and Empirical and Analytical Models. Discounted Cash Flow (DCF) estimates the intrinsic value of an investment by projecting future cash flows and discounting them to their present value (Schumacher & Klönne, 2018). Key steps include projecting cash flows, discounting them using a suitable rate, and conducting sensitivity and scenario analyses. While widely used, DCF relies on accurate projections and is sensitive to discount rate selection.

Next, Cost-Benefit Analysis (CBA) evaluates ecosystem-related projects by comparing economic benefits with costs (Turner, 2016). In Malaysia, CBA is used for valuation projects like reforestation. The challenges of CBA implementation include monetizing non-market values and capturing the full range of ecosystem services. Therefore, the opportunities for improvement include refining estimation techniques and considering the distributional impacts. Meanwhile, the Contingent Valuation Method (CVM) assesses individuals' willingness to pay for environmental improvements (Samdin, 2008). In Malaysia,

© 2026 by MIP

CVM is used for valuing water quality improvements (Mahirah et al., 2015). Challenges of implying CVM include survey design and cultural differences, while CVM opportunities lie in refining techniques and incorporating local factors for valuation. The last environmental valuation method are Empirical and Analytical Models. Empirical and Analytical Models estimate the economic value of ecosystem services. In Malaysia, studies have used hedonic pricing to value the proximity to green spaces. Challenges of Empirical and Analytical Models include data availability and representativeness, while opportunities exist in leveraging geospatial analysis and remote sensing technologies alongside the method application (Li et al., 2016).

Practices of Environmental Valuation in Malaysia

Environmental valuation in Malaysia spans into various domains, including biodiversity, ecosystem services, environmental quality, natural resource extraction, and ecosystem restoration and conservation efforts (Islam et al., 2024, Sunoto et al., 2020). Studies in Malaysia employ methods like contingent valuation and choice experiments to estimate the economic value of biodiversity. Past studies by Mzek and Mohamad, (2022) used choice experiments to indicate public willingness to pay for Malayan tiger conservation attributes in Taman Negara Park in Pahang, Malaysia, emphasizing its economic importance. Efforts have been made to value ecosystem services like water provisioning and quality regulation using methods such as market price and replacement cost analysis.

Study by Nitanan et al. (2020) highlighted the economic benefits of protecting and sustainably managing forests for water resources in Malaysia. Studies employ contingent valuation and hedonic pricing to assess the economic value of improved environmental quality. Other research such as Freeman et al. (2019) used contingent valuation to measure the willingness to pay for cleaner air in urban areas, offering insights into potential air pollution reduction policies. Methods like cost-benefit analysis and resource rent analysis are used to estimate the economic value of natural resource extraction. Asnor et al. (2022) assessed the economic viability of mineral extraction projects in Malaysia, considering financial returns and associated costs. Valuation methods, including contingent valuation, assess public willingness to pay for ecosystem restoration projects. Meanwhile study by Pindilli et al. (2018) demonstrated the economic value of peatland restoration in terms of carbon sequestration and biodiversity conservation.

Based on the past studies it is shown that the practices of environmental valuation in Malaysia reveals the economic significance of biodiversity, ecosystem services, and environmental quality. Diverse methods like contingent valuation and choice experiments showcase public willingness to pay for conservation and restoration efforts (Yusoh et al., 2022; Sunoto et al., 2020).

These findings of the past studies could guide sustainable policies, promote environmental preservation to enhance the ecological and economic resilience.

Challenges of Environmental Valuation Practices

In Malaysia, valuers play a crucial role in assessing the value of property, assets and land development including natural resources. However, limited awareness and understanding of environmental valuation among valuers pose significant challenges. Many valuers in Malaysia predominantly rely on conventional methods that emphasize comparison and market-based approaches. This preference is because of limited exposure and familiarity with environmental valuation method. This leads to challenges in assessing the economic value of non-market ecosystem services, potentially resulting in undervaluation or neglect of environmental aspects in the valuation process (Abdullah et al., 2018). Initiatives have been undertaken to enhance valuers awareness and education regarding environmental valuation.

There is a pressing need for continued professional development through training programs by professional organizations, academic institutions, and government agencies to familiarize the valuers with environmental valuation. Collaboration between environmental experts, economists, and valuers is encouraged to facilitate knowledge exchange and discussion. Interdisciplinary dialogue and collaboration provide valuers with insights into valuation method and data sources required to effectively integrate environmental factors into assessments. Opportunities exist to further enhance valuers awareness of environmental valuation in Malaysia. Continued professional development programs focusing on environmental valuation can equip valuers with necessary knowledge and skills. Additionally, promoting research and case studies showcasing successful environmental valuation practices can inspire valuers to adopt these methods in their valuation practice (Vejaratnam et al., 2023; Al-Saleh & Taleb, 2010).

RESEARCH METHODOLOGY

This study adopts a qualitative research approach, employing a purposive sampling technique. The qualitative analysis is used to explore and examine the challenges and practices associated with environmental valuation among valuers in Malaysia. Qualitative methods, such as in-depth interviews, were utilized to gather rich, detailed insights directly from the individuals involved in the valuation process (Gerring, 2017).

The selection of key informants, namely valuers from reputable organizations involved in property assessment and valuation, ensured that the collected data represented a diverse range of perspectives and experiences within

© 2026 by MIP

the field. These interviews were conducted in the year 2023 using semi-structured guides, allowing for a balance between predefined questions and the flexibility to explore emerging themes and ideas raised by the interviewees. Before conducting the interviews, the researchers took steps to establish the credibility and authenticity of the study. Support letters from academic institutions were obtained to validate the research's legitimacy, which also served as a means of gaining trust and cooperation from the participants. Additionally, participants were encouraged to suggest other potential interviewees from their networks, further broadening the scope of the study. Once the interviews were completed, the data underwent thorough analysis using content analysis techniques.

Content analysis involves systematically organizing and categorizing the interview transcripts to identify recurring themes, patterns, and relationships within the data. The content analysis is manually done by the researchers to extract meaningful insights from the respondents, provide findings on the challenges faced by valuers in environmental valuation practices and the various approaches they employ to overcome these challenges. By focusing on the primary data collection, the research aimed to ensure the reliability and validity of the findings. Primary data, gathered directly from the participants, is considered more credible than secondary data sources as it reflects the firsthand experiences and perspectives of those involved. Overall, this approach provided a comprehensive understanding of the insight of environmental valuation practices in Malaysia, offering valuable insights for both research and practical application in the field

RESULTS AND DISCUSSION

The qualitative approach in this study involved collecting essential data from selected respondents to achieve the research objectives. Nine respondents were carefully chosen based on their qualifications and experience in the property valuation field. Each brought valuable insights to the study, contributing from their respective professional backgrounds. For instance, the first respondent, with 12 years of experience, holds the position of *Pegawai Penilaian Kanan* at the Valuation and Property Services Department (JPPH) Perak. Respondent 2, with 16 years of experience, serves as *Penilai Daerah* at JPPH Taiping. Respondent 3, representing the Institut Penilaian Negara (INSPEN), brings 10 years of expertise as a *Pegawai Penilaian*. Similarly, Respondent 4, a *Pegawai Penilaian Kanan* at JPPH Alor Setar, has 13 years of experience in the valuation field. The study also includes respondents from the National Property Information Centre (NAPIC) Putrajaya, JPPH Kuantan, JPPH Sandakan, JPPH Kelantan, and JPPH Gombak, with valuation experience ranging from 8 to 14 years. This diverse panel of respondents, with their varied roles and extensive experience, provided

comprehensive perspectives on property valuation practices, contributing significant data to the study's findings.

Based on the interview that was conducted with the respondents, the common practice for environmental valuation in Malaysia among the nine respondents is Travel Cost Method as shown in Table 1. The interviews conducted with nine respondents in Malaysia revealed that the Travel Cost Method (TCM) is commonly used for environmental valuation. However, the respondents showed diverse expertise in various property valuation practices. For instance, some respondents were proficient in methods like the Contingent Valuation Method (CVM), Cost-Benefit Analysis (CBA), and Willingness to Pay (WTP), while others were familiar with the Travel Cost Method and Inventory Log. These insights provide a comprehensive understanding of the different approaches employed by valuers in Malaysia. Furthermore, the respondents shared their experiences and challenges encountered in their valuation practices. Issues ranged from difficulties in data collection and constructing questionnaires to challenges in obtaining accurate information and securing respondent cooperation. Some respondents expressed satisfaction with the feedback received, while others highlighted specific obstacles they faced, such as the time-consuming nature of deriving values or the lack of commitment in survey responses for data collection. These varied responses shed light on the diverse perspectives and experiences of valuers for environmental valuation Malaysia.

Table 1: Common Methods used for Environmental Valuation in Malaysia

Common Methods used for Environmental Valuation in Malaysia	R1	R2	R3	R4	R5	R6	R7	R8	R9
Travel Cost Method (TCM)	/		/	/	/	/	/	/	/
Contingent Valuation Method (CVM)	/							/	
Cost Benefit Analysis (CBA)		/							
Willingness To Pay (WTP)			/						

Source: Author's analysis (2023)

Table 1 highlights the common methods used for environmental valuation in Malaysia, as identified by nine respondents (R1-R9). Methods such as the Travel Cost Method (TCM) and Cost-Benefit Analysis (CBA) are widely recognized, while the Contingent Valuation Method (CVM) and Willingness to

© 2026 by MIP

Pay (WTP) have more limited application, reflecting varying familiarity among practitioners.

Regarding regulatory or policy frameworks affecting environmental valuation, the responses are varied. While some respondents indicated the presence of guidelines within their departments for assessing natural resources, others expressed uncertainty or stated the absence of specific frameworks. This suggests a range of awareness and understanding among valuers regarding the regulatory landscape for environmental valuation in Malaysia. Additionally, challenges related to data quality and availability were addressed by the respondents as shown in Table 2.

Table 2: Difficulties Encounter by Valuers in Environmental Valuation

Difficulties Encounter by Valuers in Environmental Valuation	R1	R2	R3	R4	R5	R6	R7	R8	R9
Difficulty in obtaining respondent feedback and the time-consuming nature	/	/			/				
Data collection from other agencies			/						
Challenge of constructing a questionnaire				/					
Limited data availability						/			
Data accuracy						/			
Determination of the actual costs									/
None							/		

Source: Author's analysis (2023)

While some respondents acknowledged limitations in data availability and challenges in obtaining suitable comparative information, others perceived no specific issues with data quality or availability. This variation in perspectives underscores the complexity of factors affecting the accurate valuation of environmental resources in Malaysia. The respondents' feedback revealed methodological challenges faced by valuers in choosing and implementing environmental valuation practices in Malaysia. These challenges include the time-consuming nature of obtaining respondent feedback and deriving values, difficulties in acquiring precise and high-quality data, challenges related to sampling data and ensuring representative datasets, issues with questionnaire construction, and the determination of a suitable methodology. While one respondent perceived no particular methodological challenges, others

emphasized the complexities involved in deciding on the most appropriate approach and data availability.

Additionally, insights were provided into the challenges related to monetizing non-market environmental goods and services in Malaysia. Respondents highlighted the need for a clearer understanding and a more refine approach compared to conventional valuation methods. While some respondents directly acknowledged the existence of challenges in this aspect, others expressed doubts about the reliability and accuracy of the process. Overall, the responses reflected a mixed perception among the respondents regarding the challenges associated with monetizing non-market environmental goods and services in Malaysia, with varying levels of emphasis on the complexities involved. Overall, the responses provided valuable insights into the practices, experiences, and challenges encountered by valuers in Malaysia when employing environmental valuation method. The diversity of perspectives and experiences highlighted the need for tailored approaches and continued efforts to address challenges in environmental valuation practices in Malaysia.

While some participants perceive no challenges related to data quality and availability, others encounter difficulties in accessing reliable data, which can affect the accurate valuation of environmental resources. Methodological challenges faced by valuers include the time-consuming nature of data collection, acquiring high-quality data, sampling, constructing questionnaires, and determining suitable methodologies as shown in Table 3. Challenges in monetizing non-market environmental goods and services arise from the increased complexity associated with economic assessments and the lack of access to reliable data. These findings collectively underscore the multifaceted nature of environmental valuation in Malaysia and the need for addressing various challenges to ensure accurate and reliable valuation outcomes.

© 2026 by MIP

Table 3: Methodological challenges encountered by valuers in choosing and implementing environmental valuation methods

Methodological challenges encountered by valuers in choosing and implementing environmental valuation methods	R1	R2	R3	R4	R5	R6	R7	R8	R9
Acquiring Precise and High-Quality Data / Data Reliability		/				/			
Identification of Data Sampling			/			/			
Constructing a Questionnaire for data collection				/				/	
Time-Consuming	/								
Determination of Valuation Method									/
None							/		

Source: Author's analysis (2023)

Table 3 identifies various methodological challenges faced by valuers in implementing environmental valuation methods. A key issue highlighted by respondents is acquiring precise and reliable data, which is critical for accurate valuation. Challenges in identifying appropriate data sampling methods and constructing effective questionnaires for data collection were also noted by several respondents. The time-consuming nature of these processes poses an additional hurdle, reflecting the complexity and effort required for environmental valuation. Furthermore, some respondents highlighted difficulties in determining suitable valuation methods, underscoring a gap in expertise and familiarity with advanced techniques. These challenges collectively impact the efficiency and accuracy of valuation practices.

The research findings highlight various aspects of environmental valuation in Malaysia, including common methods used, challenges encountered, policy frameworks affecting valuation practices, difficulties faced by valuers, and challenges related to data quality, availability, and methodology. The most common methods used for environmental valuation in Malaysia include the Travel Cost Method (TCM), Contingent Valuation Method (CVM), Cost Benefit Analysis (CBA), and Willingness To Pay (WTP). TCM is particularly popular due to its practicality and applicability in Malaysia's diverse natural attractions, especially for assessing the economic value of natural sites visited by tourists.

However, challenges such as difficulties in obtaining accurate data, participant engagement, and determining the actual costs are encountered by valuers using these methods. Many participants are unaware of regulatory or policy frameworks affecting the selection and use of environmental valuation methods, suggesting a need for clearer guidelines and regulations in this area. Difficulties in using environmental valuation techniques include resource constraints, interagency collaboration challenges, methodological complexity, and the importance of comprehensive and accurate data.

CONCLUSION

The study aimed to explore the practices and challenges of environmental valuation in Malaysia, recognizing it as a tool to assess the economic value of environmental goods and services. Environmental valuation provides critical information for policymakers and stakeholders to effectively conserve natural resources. This study identified both the practices and challenges faced by valuers in Malaysia. Based on the findings, four main environmental valuation methods are commonly used in Malaysia: the Travel Cost Method (TCM), Contingent Valuation Method (CVM), Cost-Benefit Analysis (CBA), and Willingness to Pay (WTP). TCM emerged as the most widely used method due to its simplicity and effectiveness in estimating the recreational benefits generated by ecosystems. CVM was also utilized to measure public willingness to pay for environmental conservation. However, CBA and WTP were less frequently applied, possibly due to issues of complexity and perceived appropriateness.

The study also highlighted several challenges faced by valuers, including difficulties in obtaining accurate data, identifying appropriate sampling techniques, designing reliable questionnaires, time constraints, and selecting suitable valuation methods. To address these issues, the government should introduce training programmes to strengthen valuers' competencies in environmental valuation techniques and improve the overall quality and consistency of practice. The development of policy frameworks for environmental valuation practices is crucial to facilitate the selection and application of accurate methods for valuing environmental goods and services. This study had some limitations, including a small sample size, a focus exclusively on the Malaysian context, and the qualitative nature of the research. Future studies could address these limitations by increasing the sample size, extending the research timeline, and adopting a mixed-methods approach. The findings of this study provide a foundational basis for strengthening environmental valuation practices in Malaysia, particularly in the context of the country's diverse ecosystems and rapid urbanisation. By addressing these challenges, the study contributes to advancing sustainability initiatives,

© 2026 by MIP

enhancing environmental preservation, and promoting greater ecological and economic resilience.

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to Universiti Teknologi Malaysia and the Ministry of Education Malaysia for their financial support through the Fundamental Research Grant Scheme (FRGS) (Grant No: FRGS/1/2024/SS06/UTM/02/7). The authors also gratefully acknowledge the Government of Sarawak for providing research funding under the SWK 4.3 Research Grant (Cost Centre No: R.J130000.7352.1R048).

DISCLOSURE STATEMENT

The author(s) declare that there is no conflict of interest regarding the publication of this paper.

REFERENCES

Abdullah, L., Rasid, W. N. A. W. A., & Mohd, T. (2018). The Role of Valuer in Sustainable Valuation: A Review. *Int. J. Acad. Res. Bus. Soc. Sci*, *8*(2), 740-749. http://dx.doi.org/10.6007/IJARBSS/v8-i2/3981

Al-Saleh, Y. M., & Taleb, H. M. (2010). The integration of sustainability within value management practices: A study of experienced value managers in the GCC countries. *Project Management Journal*, *41*(2), 50-59. https://doi.org/10.1002/pmj.20147

Asnor, A. S., Al-Mohammad, M. S., Wan Ahmad, S., Almutairi, S., & Rahman, R. A. (2022). Challenges for implementing environmental management plans in construction projects: the case of Malaysia. *Sustainability*, *14*(10), 6231. https://doi.org/10.3390/su14106231

Biswas, R. (2023). Malaysia records buoyant GDP growth in 2022. IHS Markit.

Freeman, R., Liang, W., Song, R., & Timmins, C. (2019). Willingness to pay for clean air in China. *Journal of Environmental Economics and Management*, *94*, 188-216. https://doi.org/10.1016/j.jeem.2019.01.005

Gerring, J. (2017). Qualitative methods. *Annual review of political science*, *20*(1), 15-36. https://doi.org/10.1146/annurev-polisci-092415-024158

Guijarro, F., & Tsinaslanidis, P. (2020). Analysis of academic literature on environmental valuation. *International journal of environmental research and public health*, *17*(7), 2386. https://doi.org/10.3390/ijerph17072386

Islam, M. A., Billah, M. M., Idris, M. H., Bhuiyan, M. K. A., & Kamal, A. H. M. (2024). Mangroves of Malaysia: a comprehensive review on ecosystem functions, services, restorations, and potential threats of climate change. *Hydrobiologia*, *851*(8), 1841-1871. https://doi.org/10.1007/s10750-023-05431-z

Li, S., Dragicevic, S., Castro, F. A., Sester, M., Winter, S., Coltekin, A., ... & Cheng, T. (2016). Geospatial big data handling theory and methods: A review and research

challenges. *ISPRS journal of Photogrammetry and Remote Sensing*, *115*, 119-133. https://doi.org/10.1016/j.isprsjprs.2015.10.012

Mahirah, K., Alias, R., Zuraini, A., & Azlina, A. A. (2015). *Developing efficient water price in Terengganu, Malaysia: an application of double bounded Contingent Valuation Method (CVM)*. Proceedings of the International Conference on Natural Resources, Tourism and Services Management 2015, Sabah, Malaysia, 15-17 April 2015. https://www.cabidigitallibrary.org/doi/full/10.5555/20153355677

Mzek, T., Samdin, Z., & Mohamad, W. N. W. (2022). Assessing visitors' preferences and willingness to pay for the Malayan Tiger conservation in a Malaysian National Park: A choice experiment method. *Ecological Economics*, *191*, 107218. https://doi.org/10.1016/j.ecolecon.2021.107218

Nitanan, K. M., Shuib, A., Sridar, R., Kunjuraman, V., Zaiton, S., & Herman, M. A. (2020). The total economic value of forest ecosystem services in the tropical forests of Malaysia. *International Forestry Review*, *22*(4), 485-503. https://doi.org/10.1505/146554820831255551

Pearce, D. W., & Seccombe-Hett, T. (2000). *Economic valuation and environmental decision-making in Europe*. 1419-1425. https://doi.org/10.1021/es9906711

Pek, C. K. (2014). Environmental valuation and environmetrics for sustainability in Malaysia. *International Journal of Green Economics*, *8*(3-4), 226-235. https://doi.org/10.1504/IJGE.2014.067726

Pek, C. K., Tee, C. H., & Ng, P. Y. (2010). A contingent valuation estimation of hill recreational and services values in Malaysia. MPRA Paper. https://mpra.ub.uni-muenchen.de/id/eprint/23125

Pindilli, E., Sleeter, R., & Hogan, D. (2018). Estimating the societal benefits of carbon dioxide sequestration through peatland restoration. *Ecological Economics*, *154*, 145-155. https://doi.org/10.1016/j.ecolecon.2018.08.002

Razali, F., Daud, D., Choong, W. W., Anthony Jiram, W. R., Sulaiman, N. N., & Raja Syamsuddin, R. N. S. (2025). Facilities management as moderator in improving waste separation behaviour among households. *Property Management*, *43*(1), 100-125. https://doi.org/10.1108/PM-05-2024-0046

Samdin, Z. (2008). Willingness to pay in Taman Negara: A contingent valuation method. *International Journal of Economics and Management*, *2*(1), 81-94. http://www.ijem.upm.edu.my/vol2_no1.htm

Schumacher, K. F., & Klönne, H. (2018). Discounted Cash Flow Method. In *Contemporary and Emerging Issues on the Law of Damages and Valuation in International Investment Arbitration* (pp. 205-230). Brill Nijhoff. https://doi.org/10.1163/9789004357792_009

Sunoto, Y. N., Ponrahono, Z., & Osman, M. M. (2020). Profiling the perceived mangrove forest use value and community's willingness to pay for mangrove conservation. *Planning Malaysia*, *18*. https://doi.org/10.21837/pm.v18i13.788

Turner, R. K. (2016). Ecological economics and ecosystem services. In *Routledge Handbook of Ecosystem Services* (pp. 243-255). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315775302-22/ecological-economics-ecosystem-services-kerry-turner

© 2026 by MIP

Vaghefi, N., Siwar, C., & Aziz, S. A. A. G. (2015). Green GDP and sustainable development in Malaysia. *Current World Environment*, *10*(1), 1. http://dx.doi.org/10.12944/CWE.10.1.01

Vejaratnam, N., Chenayah, S., Mohamad, Z. F., & Appolloni, A. (2023). Strategic responses to environmental performance monitoring barriers: a case study of Malaysian Government green procurement. *Sustainability Accounting, Management and Policy Journal*, *14*(3), 515-537. https://doi.org/10.1108/SAMPJ-07-2021-0307

Yusoh, M. P., Dering, N. F., Mapjabil, J., Latip, N. A., Kumalah, M. J., Noor, H. M., & Hanafi, N. (2022). Assessment Of Payment Rates and Willingness to Pay At Tourist Destination-A Comparison Between Kundasang and Kota Belud, Sabah, Malaysia. *Planning Malaysia*, *20*. https://doi.org/10.21837/pm.v20i23.1148

Received: 5th July 2025. Accepted: 15th November 2025

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 31 – 47

VALIDATING THE INFLUENCE OF MEMORABLE SUSTAINABLE TOURISM EXPERIENCES ON REVISIT INTENTIONS: A STRUCTURAL EQUATION MODELLING APPROACH

Nurzehan Abu Bakar[1], Marlisa Abdul Rahim[2], Nik Alif Amri Nik Hashim[2], Normah Abdul Latip[3], Nor Maizana Mat Nawi[2], Mohamad Pirdaus Yusoh[2]

[1]*Faculty of Hotel and Tourism Management,*
UNIVERSITI TEKNOLOGI MARA (UiTM), PUNCAK ALAM
[2]*Faculty of Hospitality, Tourism and Wellness,*
UNIVERSITI MALAYSIA KELANTAN
[3]*Borneo Institute for Indigenous Studies (BorIIS),*
UNIVERSITI MALAYSIA SABAH

Abstract

In response to the growing demand for sustainable experiences, this study aims to examine how Memorable Sustainable Tourism Experiences (MSTE) influence tourists' intention to revisit a destination. Grounded by Kim's (2017) Memorable Tourism Experience (MTE) model, this research introduces two additional dimensions, local guide and responsible practices, to better reflect the unique dynamics of sustainable tourism experience. These additions represent the novelty of the study, offering a more comprehensive understanding of what makes memorable sustainable tourism experiences. A structured survey was administered to 233 tourists who participated in sustainable tourism experience. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results revealed that hedonism, local culture, refreshment, and responsible practices significantly influence revisit intention. Interestingly, the role of local guides showed a negative effect, while knowledge, meaningfulness, novelty, and involvement were not statistically significant. This study contributes to the academic discourse by expanding the theoretical model of MTEs to incorporate sustainable features, while also providing practical insights for destination managers seeking to enhance tourist satisfaction and loyalty through meaningful, sustainable tourism experiences.

Keywords: Exploratory sequential mixed-method study, Memorable sustainable tourism experience, Memorable tourism Experience, Sustainable tourism, Experience and Revisit intention

[3] Corresponding author. Email: nikalifamri@gmail.com

INTRODUCTION

In recent years, the travel industry has seen an increase in demand for sustainable tourist experiences (Seeler et al., 2021; Spence et al., 2022). Today's tourists are no longer satisfied with passive sightseeing; instead, they seek meaningful, immersive experiences that allow them to fully engage with their surroundings. Activities such as participating in wildlife conservation, supporting local artists, choosing eco-friendly accommodations, and contributing to local businesses have steadily gained prominence and are now regarded as vital components of a rewarding travel experience (Paulauskaite, 2017; World Economic Forum [WEF], 2021).

This shift provides a significant opportunity for the tourism industry to fully embrace sustainability. Sustainable tourist experiences, when carefully planned and implemented, have the potential to save natural ecosystems, preserve cultural heritage, and promote equitable economic development. In addition, it can also simultaneously increase tourist satisfaction, strengthen emotional ties with destinations, and encourage revisit intention and loyalty towards the destination (Breiby et al., 2020; Moscardo, 2015; Sofronov, 2017).

Despite this great potential, the tourism industry continues to face challenges in delivering MSTE. This is because tourists often struggle to distinguish between genuinely sustainable experiences and those merely marketed with superficial "green" claims, thereby hindering the industry's efforts to promote authentic sustainable tourism experiences (Yusoh et al., 2023; Bausch et al., 2021). Many operators combine sustainability with basic eco-friendly policies, such as minimizing plastic use, while overlooking crucial sociocultural factors, including local community involvement and inclusion in the tourism sector (Gopal, 2023). This restricted approach undermines the essence of sustainable tourism, which requires not only environmental responsibility but also active participation and empowerment of local communities through meaningful employment and decision-making opportunities.

Furthermore, a significant impediment is the lack of a complete and unambiguous framework for understanding and implementing MSTEs. Despite research highlighting the importance of MSTEs in creating perceived value and promoting tourists' revisit intention (Breiby et al., 2020; Rahim et al., 2023), the concept remains poorly defined and inconsistently used. The lack of clarity hinders tourism stakeholders from effectively planning, promoting, and assessing these experiences, resulting in missed opportunities for impactful and memorable offerings (WEF, 2022).

Although research on MTE has expanded in recent years, the exploration of MSTE remains relatively underrepresented in academic literature as scholars are focusing on other type of MTE such as Memorable Gastro-

Tourism Experiences (García Pérez & Castillo-Ortiz, 2024), Memorable Heritage Tourism Experience (Sthapit et al., 2024) and memorable wellness tourism experience (Sthapit, et al., 2023). The limited focus on MSTE suggests an opportunity for further investigation into how sustainable practices contribute to memorable tourism experiences.

To address this conceptual gap, the present study extends Kim's (2017) Memorable Tourism Experience (MTE) framework by incorporating two sustainability-focused dimensions: local guide and responsible practices. These additions offer a more comprehensive representation of memorable experiences within the Malaysian sustainable tourism context, where cultural interpretation and environmental stewardship play crucial roles.

Hence, this study aims to explore the elements of MSTEs and assess their influence on tourists' propensity to revisit a destination. The findings aim to provide tourism stakeholders with clear directives for the design, management, and promotion of MSTEs, ensuring that these experiences meet tourists' expectations while promoting the long-term sustainability of tourism destinations.

Based on the conceptual gaps identified above, the present study is guided by the following research questions:

RQ1: What are the key dimensions of memorable sustainable tourism experiences (MSTE) in the Malaysian tourism context?
RQ2: How do specific MSTE dimensions, particularly local guide and responsible practices, shape tourists' revisit intention?
RQ3: Which MSTE constructs significantly predict revisit intention for sustainable destinations such as Langkawi Island?

LITERATURE REVIEW

Memorable Sustainable Tourism Experience

The tourism literature has only recently shifted its focus to link sustainability and tourism experiences, with scholars around the world researching both topics independently for years (Breiby et al.,2020). However, the assembly between these two fields remains relatively new and, in many cases, underdeveloped, as underlined by Signori et al. (2019).

Understanding the concept of a sustainable experience has proven challenging, partly due to limited research and the absence of precise definitions (Abdul Latip et al., 2023; Chen et al., 2011; Liu et al., 2016; Lu et al., 2017; Poudel & Nyaupane, 2013). While several experts have examined this subject, there is no consensus yet on what genuinely characterises a sustained experience. One notable effort came from Breiby et al. (2020), who classified sustainable

© 2026 by MIP

experience as "an experience that awakens deep, significant emotions and memories that can stimulate tourists' commitment toward destination sustainability." This definition has laid some groundwork for understanding sustainable experiences, which have since been examined in various contexts, including national park (Obradović, 2022), social tourism (Torres-Moraga, 2021), responsible tourism (Nowacki et al., 2023) and lake tourism (Breiby et al., 2020).

Previous studies have revealed numerous dimensions that contribute to the formation of MTE. Kim (2017) identified 7 experience domains that are likely to affect one's memorable experience, including engagement, hedonism, refreshment, local culture, meaningfulness, knowledge, and novelty. Building upon this basis, Breiby et al. (2020) highlighted crucial components include interaction with nature, cultural immersion, and emotional connections. In the context of sustainable tourism, Lu et al. (2017) and Hwang & Lee (2019) highlighted that the co-creation of experiences with a local guide as well as responsible practices boosts the memorability and perceived authenticity of the experience.

Finally, scholars in sustainable tourism recommend that tourism suppliers prioritize the design of memorable, sustainable tourism experiences (Zhang, 2022). Doing so not only helps tourism suppliers to preserve a competitive edge but also promotes the destination's sustainability and the value of the whole experience (Lu et al., 2017; Smit & Melissen, 2018; Hashim et al, 2020). When tourists build a meaningful connection with a destination through sustainable experiences, they are more likely to consider returning in the future and spread good word of mouth (Breiby et al., 2020; Shien et al., 2022). For these reasons, sustainable and memorable tourism experiences serve as the core focus of the present study.

Revisit Intention

Revisit intention refers to a tourist's likelihood of returning to a destination based on their past experiences. Research has consistently shown that positive travel experiences increase the chances of tourists revisiting a destination (Nik Hashim et al, 2019; Breiby et al., 2020; Rahim et al., 2023). Additionally, incorporating sustainable tourism practices helps to create a strong emotional connection with the destination, making tourists more inclined to return (Chen et al., 2020). When a destination aligns with a tourist's personal values, such as environmental responsibility and cultural appreciation, it further reinforces their desire to revisit in the future (Sofronov, 2017; Patwary et al, 2023). Therefore, integrating sustainable practices and memorable experiences into tourism offerings is crucial in fostering lasting impressions and encouraging revisit intention among tourists.

Hence, the following hypothesis is proposed:

H1: There is a significant relationship between MSTE and revisit intention

RESEARCH METHODOLOGY

To address the limited research setting on sustainable tourism experiences highlighted by Bai et al. (2023), this study adapted a questionnaire based on previous works by Kim (2017) and Hwang & Lee (2019) on Memorable Tourism Experiences (MTEs) and sustainable tourism. Specifically, seven variables were drawn from Kim (2017): hedonism, involvement, local culture, refreshment, knowledge, meaningfulness, and novelty. In addition, two dimensions local guide and responsible practices were incorporated from Hwang and Lee (2019) to enhance the sustainability context of the study.

To ensure content clarity and construct validity, the final set of nine variables were pre-tested using expert reviews and cognitive interviews with tourist academics, industry professionals, and survey methodologists. The questionnaire, consisting of 45 items on a 7-point Likert scale, was distributed to 250 tourists who had participated in sustainable tourism experiences in Langkawi Island, with 233 valid responses collected between July and September 2024. The data were then analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS to test relationships between MSTE components and revisit intention. The model showed strong predictive and discriminant validity, offering a comprehensive understanding of how memorable and sustainable experiences impact tourists' intention to revisit Langkawi.

This study complied with institutional research ethics requirements. All respondents participated voluntarily, provided informed consent, and were assured of full anonymity. No identifying information was collected, and the survey procedure received ethical clearance from the Universiti Malaysia Kelantan research ethics process.

RESULTS

Based on Table 1 below, nearly two–thirds (57.5 percent) of the respondents were females, while one-third (42.5 percent) were males. The majority of respondents (n = 83, 35.6%) were 31–40 years old, married (n = 122, 52.4%), and had a degree (n = 95, 40.8%). In addition, most of them had indulged in sustainable experience at least once (n = 178, 76.4 per cent).

© 2026 by MIP

Table 1: Demographic profiles

Respondent's profile	**Classification**	**Frequency N = 233**	**Percentage (%)**
Gender	Male	99	42.5%
	Female	134	57.5%
Age	< 20	15	6.4%
	21–30 years old	46	19.8%
	31–40 years old	83	35.6%
	41–50 years old	58	24.9%
	51 years old and above	31	13.3%
Marital Status	Married	122	52.4%
	Single	102	43.8%
	Others	9	3.8%
Education	Secondary School	34	14.6%
	Form 6	11	4.7%
	Diploma	72	30.9%
	Bachelor's Degree	95	40.8%
	Master	17	7.3 %
	PhD	4	1. %
Frequency of purchasing sustainable experience	Once	178	76.4%
	Twice	46	19.7%
	More than twice	9	3.9%

Source: Primary Data

Measurement model

Table 2 shows the mean scores and reliability of each item and the measurement model. The mean scores ranged from 5.142 to 6.554, while the standard deviation ranged from 0.654 to 1.264. In the measurement model, the loadings, Cronbach's Alpha (CA), Average Variance Extracted (AVE), and Composite Reliability (CR) were assessed. The loading values should be ≥0.5, while the AVE should be ≥ 0.5 and the CR should be ≥ 0.7. As shown in Table III, all AVEs and CRs are higher than 0.5 and 0.7, respectively. The loadings were also acceptable since the values are more than 0.7 (Hair et al., 2019), which indicates that convergent validity has been established.

Table 2: Measurement model results including loadings, reliability coefficients, and AVE.

Code	MSTE Dimension	Mean	SD	Loading	CA	CR	AVE
	Hedonism			0.872	0.797	0.881	0.715
HE01	I am thrilled to have a new sustainable experience	6.305	0.710				
HE02	I took part in sustainable experience	6.399	0.747				
HE03	I really enjoyed my sustainable experience	6.395	0.763				
	Involvement			0.895	0.863	0.916	0.785
IN01	I actively participated in sustainable experience	6.043	0.939				
IN02	I was interested in interacting with the natural and cultural surroundings	6.120	0.909				
IN03	I enjoyed the sustainable experience offered to me	5.948	1.014				
	Knowledge			0.934	0.926	0.944	0.772
KN01	I gained a lot of information from participating in sustainable experience	5.884	0.980				
KN02	I learned a new culture from participating in sustainable experience/	5.412	1.097				
KN03	I gained a new skill from participating in sustainable experience	5.627	1.132				
KN04	The sustainable experience was exploratory	5.867	1.000				
KN05	The sustainable experience made me more knowledgeable	5.807	1.053				
	Local Culture			0.881	0.865	0.908	0.713
LC01	I had a good impression of the local culture thanks to my sustainable experience	5.674	1.026				
LC02	I had the chance to experience the local culture in a sustainable way	5.562	1.071				
LC03	The local people were friendly to me	5.983	0.963				

© 2026 by MIP

Code	MSTE Dimension	Mean	SD	Loading	CA	CR	AVE
LC04	I participated in local cultural customs and festivals	5.142	1.264				
	Meaningfulness			0.914	0.906	0.930	0.727
ME01	I felt like I did something meaningful when engaging in a sustainable experience	6.009	0.989				
ME02	I felt like I did something worthwhile by engaging in a sustainable experience	5.768	1.047				
ME03	I learned something about myself from this sustainable experience	5.794	1.089				
ME04	I felt like I gained valuable experience from the Langkawi Island trip	5.403	1.089				
ME05	I felt inspired to continue participating in a sustainable experience	6.112	0.853				
	Novelty			0.925	0.922	0.941	0.763
NO01	I had a once-in-a-lifetime experience	5.975	1.139				
NO02	I had a unique experience	5.773	1.102				
NO03	Compared to my previous travel experiences elsewhere, this one was unique.	5.451	1.145				
NO04	I experienced something new.	5.674	1.072				
NO05	I felt like I was in a different world when participating in a sustainable experience	5.391	1.134				
	Refreshment			0.910	0.908	0.932	0.732
RE01	I relieved stress when participating in sustainable experience	6.180	0.855				
RE02	I had a refreshing experience	6.232	0.853				
RE03	I had a peaceful soul from participating in sustainable experience	6.300	0.853				

Code	MSTE Dimension	Mean	SD	Loading	CA	CR	AVE
RE04	I felt revitalised from participating in sustainable experience	6.039	0.886				
RE05	I felt better after participating in a sustainable experience	6.197	0.946				
	Local Guide			0.820	0.774	0.866	0.683
LG01	The local guide was knowledgeable	6.236	0.741				
LG02	The local guide was very helpful	6.554	0.654				
LG03	The local guide was friendly	6.176	0.775				
	Responsible practices			0.776	0.775	0.869	0.690
RP01	The tour company managed the experience in a sustainable way	5.931	0.861				
RP02	The tour company engaged with local communities and promoted socio-economic benefits	5.639	0.828				
RP03	The tour company integrated environmental conservation into the sustainable experience	6.163	0.874				
	Revisit intention			0.897	0.895	0.934	0.826
RI01	I'm looking forward to revisit Langkawi Island.	6.322	0.910				
RI02	I will make a plan to revisit Langkawi Island	5.970	1.109				
RI03	I will make an effort to revisit Langkawi Island.	5.940	1.181				

Source: Primary Data

Subsequently, discriminant validity was assessed using the heterotrait-monotrait (HTMT) criterion as suggested by Henseler et al. (2015) and updated by Franke and Sarstedt (2019). The HTMT values should be ≤ 0.85 for the stricter criterion and the mode lenient criterion should be ≤ 0.90. As can be seen in Table 3, the HTMT values are all lower than the stricter criterion of ≤ 0.85; therefore, it can be concluded that the respondents understood the distinctness of the 9 constructs. Taken together, the validity tests have shown that the measurement items were both valid and reliable.

© 2026 by MIP

Table 3: HTMT

	Hedonism	Involvement	Knowledge	Local Culture	Local Guide	Meaningfulness	Novelty	Refreshment	Responsible Practices
Hedonism									
Involvement	0.898								
Knowledge	0.714	0.657							
Local Culture	0.648	0.693	0.841						
Local Guide	0.371	0.251	0.237	0.214					
Meaningfulness	0.796	0.765	0.859	0.719	0.187				
Novelty	0.646	0.601	0.836	0.767	0.281	0.808			
Refreshment	0.844	0.814	0.748	0.65	0.268	0.768	0.608		
Responsible Practices	0.356	0.236	0.315	0.225	0.622	0.275	0.238	0.254	

Source: Primary Data

Structural model

The structural model in Table 4 depicts the connections (paths) between the constructs in the suggested research model. In general, the model's quality is measured by the strength of each structural path, which should be equal to or greater than 0.1 (Falk & Miller,1992). Based on the results in Table 4, the R^2 value is more than 0.1. Hence, predictive capability has been established. Additionally, Q^2 confirms the predictive relevance of the endogenous construct. Accordingly, the Q^2 value of 0.334, which is greater than zero, indicates that the model has predictive relevance.

Hypotheses were also verified to determine the significance of relationships between variables. Out of the 9 hypotheses tested, 5 were supported. Hedonism ($\beta = 0.268$, $p < 0.01$), local culture ($\beta = 0.233$, $p < 0.05$), refreshment ($\beta = 0.276$, $p < 0.01$), and responsible practices ($\beta = 0.149$, $p < 0.05$) had significant and positive effects on revisit intention. However, local guide had a significant but negative effect ($\beta = -0.118$, $p < 0.05$). The remaining variables (knowledge: $\beta = 0.135$, $t = 1.059$, p-value = 0.290; meaningfulness: $\beta = -0.112$, $t = 1.062$, p-value = 0.289; involvement: $\beta = -0.063$, $t = 0.698$, p-value = 0.485; novelty: $\beta = 0.071$, $t = 0.816$, p-value = 0.415) did not show significant relationships with revisit intention. The negative effect of local guides on revisit intention may be attributed to over-dependence on guides, which can reduce tourists' sense of autonomy and personal discovery (Kuo et al., 2016). This

finding suggests that while guides are essential for providing information, excessive reliance on them may detract from the tourists' ability to create their own memorable experiences.

Table 4: Structural model results showing path coefficients, t-values, p-values, and hypothesis decisions.

Relationship	β	T Values	P Values	Decision
Hedonism → Revisit	0.268	3.149	0.002	Significant
Involvement →Revisit	-0.063	0.698	0.485	Not Significant
Knowledge → Revisit	0.135	1.059	0.290	Not Significant
Local Culture -> Revisit	0.233	2.351	0.019	Significant
Local Guide → Revisit	-0.118	2.102	0.036	Significant
Meaningfulness → Revisit	-0.112	1.062	0.289	Not Significant
Novelty → Revisit	0.071	0.816	0.415	Not Significant
Refreshment →Revisit	0.276	2.703	0.007	Significant
Responsible Practices → Revisit	0.149	2.593	0.01	Significant
	R^2	**Q^2**		
	0.517	0.334		

Source: Primary Data

DISCUSSION

The present study offers insights into how well MSTE elements impact tourists' intention to revisit Langkawi Island, Malaysia. These elements function through interconnected variables such as psychological engagement (hedonism, refreshment, meaningfulness) enriches emotional and cognitive connections; cultural immersion (local culture, local guides) deepens understanding and appreciation of the destination; learning and discovery (knowledge, novelty) foster curiosity and personal growth; active participation (involvement) strengthens tourists' sense of contribution; and ethical practices (responsible practices) create authentic and impactful experiences. To recapitulate, quantitative surveys was employed in this study to fill important gaps in the literature on how MSTE affect tourist's revisit intention. The quantitative analysis in this study validated the beneficial correlations between hedonism, local culture, local guide, refreshment, and responsible practices with revisit intention. These results suggest that tourists are more likely to return when they experience enjoyment, local culture immersion, excellent local guiding,

© 2026 by MIP

relaxation, and sustainable engagement (Muhamad Nor et al., 2024; Baruca & Čivre, 2022; Solís-Radilla et al., 2019; Aziz et al, 2019).

Local culture immersion strengthens tourists' attachment to a destination (Min & Yong, 2021), while skilled local guides enhance satisfaction and revisit intentions (Nandika et al., 2023; Manav & Soybalı, 2020). However, Kuo et al. (2016) caution that excessive reliance on guides may limit personal exploration, an essential element of memorable experiences, which explains the significant negative relationship. Similarly, refreshments play a vital role in tourism satisfaction, with relaxation being linked to higher revisit rates (Damijanic, 2020; Choi et al., 2020). Responsible tourism also fosters fulfillment, reinforcing positive perceptions of a destination and encouraging future visits (Mercadé Melé et al., 2020).

In contrast, knowledge, meaningfulness, involvement, and novelty did not significantly impact revisit intention. While these factors enrich the travel experience, prior studies suggest they do not necessarily drive tourist to re-visits (Lee et al., 2011; Tung & Ritchie, 2011; Prayag & Ryan, 2012). Novelty, for instance, may encourage exploration of new destinations rather than repeat visits (Jang & Feng, 2007). These findings highlight the complexity of sustainable tourism experiences, where not all memorable aspects translate into repeat visits (Da Cruz Andrade et al., 2023). Ultimately, sustainable tourism creates lasting memories, ensuring long-term profitability while preserving destinations for future tourists (Islamiyati & Chairy, 2021).

Theoretical and practical implications

The present study makes a significant contribution to both the theoretical and practical aspects of sustainable tourism by developing the MSTE model. Using structural equation modelling, the research identifies key factors hedonism, local guide, local culture, refreshment, and responsible practices that significantly influence revisit intention, enriching the academic understanding of MSTE. Practically, the study provides valuable insights for destination managers and tourism suppliers, highlighting the importance of incorporating these elements to enhance tourist satisfaction and encourage repeat visits.

Limitations and future research

Nonetheless, several limitations should be acknowledged. Firstly, since the current study was conducted in a specific destination, namely Langkawi Island, the generalisability of the findings to other contexts might be limited. Thus, future studies should consider replicating this study in diverse tourism settings to validate the MSTE model across different destinations. Additionally, the study only focuses on tourists who participated in sustainable experience organised by a local tour operator. Future research may, therefore, employ a comparison

analysis for domestic and international tourists (Rasoolimanesh et al., 2021), or other characteristics such as travel frequency and type of activity since the results are presumably more interesting to explore. In addition, this study focuses on the positive aspects of MSTE to align with its goal of enhancing sustainable tourism and revisit intention. While negative experiences are important (Hosany et al., 2022; Zainuddin et al, 2023), they were excluded to maintain focus on practical insights for fostering positive tourist experiences. Future research could examine how negative experiences influence the overall memorability of sustainable tourism experience. Lastly, to provide a more interesting insight, future research may also conduct a longitudinal study to assess the enduring impacts of remarkable sustainable tourism experience on tourists' desire to revisit a destination over an extended period.

ACKNOWLEDGEMENT

The authors would like to thank the Ministry of Higher Education Malaysia for providing the FRGS grant (FRGS/1/2020/WAB01/UMK/03/2) and Universiti Malaysia Kelantan for supporting this work.

REFERENCES

Abdul Latip, N., Umar, M. U., Yusoh, M. P., Mansur, K., Hua, A. K., Hussin, R., & Datu Nordin, D. S. N. (2023). SUSTAINABLE URBAN PARK: A CASE STUDIES OF TAMAN AWAM TELUK LIKAS, KOTA KINABALU, SABAH. MALAYSIA. *PLANNING MALAYSIA*, *21*(28). https://doi.org/10.21837/pm.v21i28.1333

Aziz, R. C., Hashim, N. A. A. N., Omar, R. N. R., Yusoff, A. M., Muhammad, N. H., Simpong, D. B., Abdullah, T., Zainuddin, S. A., & Safri, F. H. M. (2019). Teaching and Learning in Higher Education: E-Learning as a Tool. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 9(1), 458-463.

Bai, W., Lai, I. K. W., & Wong, J. W. C. (2023). Memorable Tourism Experience Research: A Systematic Citation Review (2009–2021). *SAGE Open, 13*(4). https://doi.org/10.1177/21582440231218902

Baruca, P. Z., & Čivre, Ž. (2022). Unique destination attributes as a basis of tourism experience. *Academica Turistica*, *15*(3), 349–361. https://doi.org/10.26493/2335-4194.15.349-362

Bausch, T., Schröder, T., Tauber, V., & Lane, B. (2021). Sustainable Tourism: The Elephant in the Room. *Sustainability*, 13(15), 8376. https://doi.org/10.3390/SU13158376

Breiby, M. A., Duedahl, E., Øian, H., & Ericsson, B. (2020). Exploring sustainable experiences in tourism. *Scandinavian Journal of Hospitality and Tourism*, *20*(4), 335–350. https://doi.org/10.1080/15022250.2020.1748706

Chen, C. M., Chen, S. H., & Lee, H. T. (2011). The destination competitiveness of Kinmen's tourism industry: Exploring the interrelationships between tourist

 © 2026 by MIP

perceptions, service performance, customer satisfaction and sustainable tourism. *Journal of Sustainable Tourism*, *19*(2), 247–264. https://doi.org/10.1080/09669582.2010.517315

Chen, X., Cheng, Z. F., & Kim, G. B. (2020). Make it memorable: Tourism experience, fun, recommendation and revisit intentions of Chinese outbound tourists. *Sustainability*, *12*(5), 1904. https://doi.org/10.3390/su12051904

Choi, S., Jin, B., & Kah, J. A. (2020). Exploring the effect of tourism experience on tourist satisfaction and destination loyalty: Moderating effect of visit experience. *Journal of Tourism Management Research*, *24*, 187–211.

Da Cruz Andrade, D. A., & Ricci-Cagnacci, R. (2023). Analysis of the attributes of memorable tourism experiences (MTE) on Airbnb. *Turismo: Visão e Ação*, *25*(2), 175–197. https://doi.org/10.14210/rtva.v25n2

Falk, R. F., & Miller, N. B. (1992). *A primer for soft modeling*. University of Akron Press.

Franke, G., & Sarstedt, M. (2019). Heuristics versus statistics in discriminant validity testing: A comparison of four procedures. *Internet Research*, *29*(3), 430–447. https://doi.org/10.1108/IntR-12-2017-0515

Gopal, B. (2023). The role of community involvement in promoting sustainable tourism practices. *ShodhKosh Journal of Visual and Performing Arts*, *4*(2). https://doi.org/10.29121/shodhkosh.v4.i2.2023.3196

Hair, J. F., Risher, J., Sarstedt, M., & Ringle, C. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hashim, N.A.A.N., Awang, Z., Yusoff, A.M., Safri, F.H.M., Fatt, B.S., Velayuthan, S.K., Hashim, H., & Novianti, S. (2020). Validating the Measuring Instrument for Determinants of Tourist's Preferences Toward Revisit Intention: A Study of Genting Highland. *Journal of Advanced Research in Dynamical and Control Systems*, 12(7), 2236-2240.

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: Updated guidelines. *Industrial Management & Data Systems*, *116*(1), 2–20. https://doi.org/10.1108/IMDS-09-2015-0382

Hosany, S., Sthapit, E., & Björk, P. (2022). Memorable tourism experience: A review and research agenda. *Psychology & Marketing*, *39*(8), 1467–1486. https://doi.org/10.1002/mar.21667

Hwang, J., & Lee, J. (2019). Relationships among senior tourists' perceptions of tour guides' professional competencies, rapport, satisfaction with the guide service, tour satisfaction, and word of mouth. *Journal of Travel Research*, *58*(8), 1331–1346. https://doi.org/10.1177/0047287518803199

Islamiyati, D., & Chairy, C. (2021). The influence of memorable souvenirs shopping experience and place identity on revisit intention (The case of Yogyakarta). *Jurnal Muara Ilmu Ekonomi dan Bisnis*, *5*(1), 205–213. https://doi.org/10.24912/jmieb.v5i1.11054

Jang, S., & Feng, R. (2007). Temporal destination revisit intention: The effects of novelty seeking and satisfaction. *Tourism Management*, *28*(2), 580–590. https://doi.org/10.1016/j.tourman.2006.04.024

Kim, J.-H. (2017). The impact of memorable tourism experiences on loyalty behaviors: The mediating effects of destination image and satisfaction. *Journal of Travel Research*, *57*(7), 856–870. https://doi.org/10.1177/0047287517721369

Kuo, C. M., Chen, L. C., & Tseng, C. Y. (2016). Investigating the impact of tour guide performance on tourist satisfaction and behavioral intentions. *Asia Pacific Journal of Tourism Research*, *21*(7), 1–18. https://doi.org/10.1080/10941665.2015.1068196

Lee, S. H., Jeon, S. M., & Kim, D. Y. (2011). The impact of tour quality and tourist satisfaction on tourist loyalty: The case of Chinese tourists in Korea. *Tourism Management*, *32*(5), 1115–1124. https://doi.org/10.1016/j.tourman.2010.09.016

Liu, C. H., Horng, J. S., Chou, S. F., Chen, Y. C., Lin, Y. C., & Zhu, Y. Q. (2016). An empirical examination of the form of relationship between sustainable tourism experiences and satisfaction. *Asia Pacific Journal of Tourism Research*, *21*(7), 717–740. https://doi.org/10.1080/10941665.2015.1068196

Lu, D., Liu, Y., Lai, I., & Yang, L. (2017). Awe: An important emotional experience in sustainable tourism. *Sustainability*, *9*(12), 2189. https://doi.org/10.3390/su9122189

Manav, A., & Soybalı, H. H. (2020). Turist rehberi adaylarının uygulama gezilerinden beklentilerinin ve memnuniyet düzeylerinin araştırılması. *Turist Rehberliği Dergisi (TURED)*, *3*(1), 18–31.

Maslow, A. H. (1964). *Religions, values, and peak-experiences*. Ohio State University Press.

Mercadé Melé, P., Molina Gómez, J., & Sousa, M. J. (2020). Influence of sustainability practices and green image on the revisit intention of small and medium-size towns. *Sustainability*, *12*(3), 930. https://doi.org/10.3390/su12030930

Moscardo, G. (2015). Sustainability education for tourists. In G. Moscardo & P. Benckendorff (Eds.), *Education for sustainability in tourism* (pp. 1–20). Springer. https://doi.org/10.1007/978-3-662-47470-9_11

Min Young Park, & Yong Muk Kim. (2021). *The Effects of Local Culture Experience on Revisit Intention*. https://doi.org/10.1109/snpdwinter52325.2021.00031

Muhamad Nor, A. N., Abas, M. A., Arumugam, J., Yusoh, M. P., & Abdul Latip, N. (2024). LAND SUITABILITY ANALYSIS USING GEOGRAPHIC INFORMATION SYSTEM (GIS) FOR SUSTAINABLE LAND DEVELOPMENT IN JELI, KELANTAN, MALAYSIA. *PLANNING MALAYSIA*, *22*(34). https://doi.org/10.21837/pm.v22i34.1571

Nandika, I., Koeswiryono, D., & Praminatih, G. (2023). Pengaruh kualitas pemandu wisata lokal terhadap tingkat kepuasan wisatawan. *Jurnal Ilmiah Pariwisata dan Bisnis*, *2*(6), 1320–1325. https://doi.org/10.22334/paris.v2i6.445

Nik Hashim, N.A.A., Yusoff,A.M., Awang,Z., Aziz,R.C., Ramlee, S.I.F., Bakar,N. A., Noor, M.A.M. & Fatt, B.S. (2019). The Effect of Domestic Tourist Perceived Risk on Revisit Intention in Malaysia. *International Journal of Innovative Technology and Exploring Engineering (IJITEE),*8(10),4591-4596.

Nowacki, M., & Kowalczyk-Anioł, J. (2023). Experiencing islands: Is sustainability reported in tourists' online reviews? *Journal of Ecotourism*, *22*(1), 59–79. https://doi.org/10.1080/14724049.2022.2119577

© 2026 by MIP

Obradović, S., Stojanović, V., Tešin, A., Šećerov, I., Pantelić, M., & Dolinaj, D. (2022). Memorable tourist experiences in national parks: Impacts on future intentions and environmentally responsible behavior. *Sustainability*, *15*(1), 547. https://doi.org/10.3390/su15010547

Patwary, A.K., Aziz, R.C. & Hashim, N.A.A.N (2023). Investigating tourists' intention toward green hotels in Malaysia: a direction on tourist sustainable consumption. *Environmental Science and Pollution Research*. 30, 38500–38511.

Paulauskaite, D., Powell, R., Coca-Stefaniak, J. A., & Morrison, A. M. (2017). Living like a local: Authentic tourism experiences and the sharing economy. *International Journal of Tourism Research*, *19*(6), 619–628. https://doi.org/10.1002/jtr.2134

Poudel, S., & Nyaupane, G. P. (2013). The role of interpretative tour guiding in sustainable destination management: A comparison between guided and nonguided tourists. *Journal of Travel Research*, *52*(5), 659–672. https://doi.org/10.1177/0047287513478496

Prayag, G., & Ryan, C. (2012). Antecedents of tourists' loyalty to Mauritius: The role and influence of destination image, place attachment, personal involvement, and satisfaction. *Journal of Travel Research*, *51*(3), 342–356. https://doi.org/10.1177/0047287511410321

Rahim, M. A., Bakar, N. A., Nawi, N. M. M., Hashim, N. A. A. N., Wee, H., & Saidin, S. S. (2022). Conceptualizing experience-rich sustainable tourism. In *International Conference on Business and Technology* (pp. 815–823). Springer. https://doi.org/10.1007/978-3-031-08020-7_80

Rasoolimanesh, S. M., Seyfi, S., Rastegar, R., & Hall, C. M. (2021). Destination image during the COVID-19 pandemic and future travel behavior: The moderating role of past experience. *Journal of Destination Marketing & Management*, *21*, 100620. https://doi.org/10.1016/j.jdmm.2021.100620

Seeler, S., Schänzel, H., & Lück, M. (2021). Sustainable travel through experienced tourists' desire for eudaemonia and immersion. *Scandinavian Journal of Hospitality and Tourism*, *21*(5), 494–513. https://doi.org/10.1080/15022250.2021.1974541

Shien, L.-Y., Liu, C.-H., & Li, Y.-M. (2022). How positive and negative environmental behaviours influence sustainable tourism intentions. *Sustainability*, *14*(11), 6922. https://doi.org/10.3390/su14116922

Signori, P., Gozzo, I., Flint, D. J., Milfeld, T., & Satinover Nichols, B. (2019). Sustainable customer experience: Bridging theory and practice. In A. Thrassou et al. (Eds.), *The synergy of business theory and practice* (pp. 1–20). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-17523-8_7

Smit, B., & Melissen, F. (2018). *Sustainable customer experience design: Co-creating experiences in events, tourism and hospitality*. Routledge.

Sofronov, B. (2017). Impact of sustainable tourism in the travel industry. *Annals of Spiru Haret University. Economic Series*, *17*(85), 85–94. https://doi.org/10.26458/1747

Spence, J., Benckendorff, P., & Chien, P. M. (2022). Sustainable high yield luxury tourism experiences. In A. S. Kotur & S. K. Dixit (Eds.), *The Emerald handbook of luxury management for hospitality and tourism* (pp. 1–20). Emerald Publishing. https://doi.org/10.1108/9781803823115-005

Sthapit, E., Björk, P., & Coudounaris, D. N. (2023). Towards a better understanding of memorable wellness tourism experience. *International Journal of Spa and Wellness*, *6*(1), 1-27.

Sthapit, E., Garrod, B., Coudounaris, D. N., Seyfi, S., Cifci, I., & Vo-Thanh, T. (2024). Antecedents of memorable heritage tourism experiences: an application of stimuli–organism–response theory. *International Journal of Tourism Cities*. https://doi.org/10.1108/ijtc-02-2024-0051

Torres-Moraga, E. I., Alonso-Dos-Santos, M., Arboleda, D. Q., & Carvajal-Trujillo, E. (2021). The role of experience and trustworthiness on perception sustainable touristic destinations. *Journal of Hospitality and Tourism Management*, *49*, 471–480. https://doi.org/10.1016/j.jhtm.2021.10.008

Tung, V. W. S., & Ritchie, J. R. B. (2011). Investigating the memorable experiences of the senior travel market: An examination of the reminiscence bump. *Journal of Travel & Tourism Marketing*, *28*(3), 331–343. https://doi.org/10.1080/10548408.2011.563168

Turner, V. W., & Bruner, E. M. (Eds.). (1986). *The anthropology of experience*. University of Illinois Press.

Tussyadiah, I. P. (2014). Toward a theoretical foundation for experience design in tourism. *Journal of Travel Research*, *53*(5), 543–564. https://doi.org/10.1177/0047287513513172

World Economic Forum. (2022, November). *The promise and challenges of sustainable travel products*. https://www.weforum.org/agenda/2022/11/sustainable-travel-and-tourism/

World Economic Forum. (2021). *Travel & tourism development index 2021: Rebuilding for a sustainable and resilient future insight report*. https://www3.weforum.org/docs/WEF_Travel_Tourism_Development_2021.pdf

Yusoh, M. P., Abdul Latip, N., Hanafi, N., Hua, A. K., Zakaria, Z., & Mohamad Ridzuan, M. I. (2023). SOCIAL CARRYING CAPACITY AS A PLANNING TOOL FOR SUSTAINABLE TOURISM: A CASE OF PANGKOR ISLAND, PERAK, MALAYSIA. *PLANNING MALAYSIA*, *21*(28). https://doi.org/10.21837/pm.v21i28.1329

Zainuddin, S. A., Abdullah, B., Md Nasir, N. A., Abdullah, T., Che Nawi, N., Patwary, A. K., & Nik Hashim, N. A. A. (2023). Sustainable risk management practice in the organization: A Malaysian case study. *Environmental Science and Pollution Research*, *30*(9), 24708–24717

Zhang, Y. (2022). Sustainability as a Consequence of Memory and Memorable Experience (pp. 181–202). IGI Global eBooks. https://doi.org/10.4018/978-1-6684-4645-4.ch009

Received: 28th June 2025. Accepted: 15th November 2025

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 48 – 62

STRATEGIC HUMAN DEVELOPMENT IN THE ZAKAT INSTITUTION OF THE ISLAMIC RELIGIOUS COUNCILS AND PERAK MALAY CUSTOM (MAIPk)

Raudha Md Ramli[1*], Fazirah Rais[2], Sali Sofia Saliturahim[3], Azrin Ibrahim[4], Nurul Atasha Jamaludin[5]

[1,2,3,5] *Faculty of Economics and Management,*
UNIVERSITI KEBANGSAAN MALAYSIA, 43600 BANGI SELANGOR
[4]*Centre for Islamic Development Management Studies* (ISDEV),
UNIVERSITI SAINS MALAYSIA, 11800 MINDEN PULAU PINANG

Abstract

This study examines strategic human development within the zakat institution of the Islamic Religious Council and Perak Malay Customs (Majlis Agama Islam dan Adat Melayu Perak – MAIPk) in strengthening institutional performance and socio-economic impact. Human development in zakat administration extends beyond operational efficiency and encompasses the cultivation of competent, ethical, and visionary personnel capable of fulfilling the broader mandate of MAIPk in community empowerment. Using a qualitative research design, this study analyses institutional documents, policy frameworks, and semi-structured interviews with key officers of MAIPk to identify the strategic dimensions of human development practices within the organisation. The findings indicate three key strategies: (1) aligning staff competencies with the values of Islamic governance, (2) strengthening leadership and managerial capabilities to support organisational transformation, and (3) integrating professional development training with spiritual and ethical reinforcement. These strategies collectively enhance institutional resilience, promote innovation in zakat distribution, and strengthen public trust in zakat governance. The study proposes that a comprehensive human development model that encompasses spiritual, intellectual, and professional dimensions is essential for sustaining institutional effectiveness in zakat institutions. The findings contribute to the literature on institutional planning and governance by highlighting human development as a strategic driver for organisational effectiveness in zakat institutions in Malaysia.

Keywords: Human Development; Zakat Institution; MAIPk; Institutional Governance; Islamic Human Resource; Organizational Effectiveness

[1] Corresponding author. Email: raudha@ukm.edu.my

INTRODUCTION

One of the pillars of Islam, which plays a crucial role in promoting social justice and economic justice within the Muslim community, is zakat. Beyond being a religious obligation, zakat also functions as an economic mechanism for wealth redistribution from the rich to the needy. In the Malaysian context, zakat institutions not only administer zakat funds but also play a significant role in human development and community welfare (Rashid et al., 2019; Daud et al, 2025).

In the state of Perak, the collection and distribution of zakat are managed by the Islamic Religious Councils and the Perak Malay Customs (MAIPk). The success of zakat management activity largely depends on the integrity of the organisational structure and the efficiency and integrity of human resources that sustain the institution. A solid organisational structure is fundamental in defining the allocation of tasks and their coordination within an organisation, including a zakat management institution. This structure encompasses the formal rules and regulations that govern work processes, communication, and other activities, thereby constraining and shaping interaction processes. The strategic human development planning establishes the values of efficiency, increase accountability, commitment, and trust to ensure their sustainability (Lateff et al, 2014; Zakiy et al, 2025). Other scholars, such as Wahid & Noor (2019) and Zaid & Hashim (2022), also pointed to the competence and professionalism of human resources as the primary factors in enhancing the productivity and reliability of zakat institutions, thereby facilitating the proper and trustworthy distribution of zakat to asnaf.

Since the 1990s, zakat institutions in Malaysia, such as MAIPk, have undergone various processes of institutional improvement, including corporatisation and approaches to power decentralisation (Paizin & Sarif, 2021). This approach aims to enhance governance efficiency and responsiveness to the needs of the Muslim community. However, despite these institutional reforms, limited attention has been given to the strategic role of human development within zakat institutions. Most existing studies emphasise governance mechanisms and operational efficiency, with less focus on how leadership development, competency alignment, and Islamic governance values contribute to long-term institutional effectiveness and public trust.

Human development within Islamic institutions encompasses not only professional competence but also ethical and spiritual values. This approach is consistent with the concept of *Insan Kamil*, which understands human development holistically, encompassing intellectual, spiritual, and moral dimensions. Accordingly, this study examines the strategic human development practices implemented by MAIPk and analyses how these initiatives contribute to strengthening institutional capacity, organisational effectiveness, and public

© 2026 by MIP

trust in zakat governance. This study is expected to make a meaningful contribution to the discourse on institutional planning and Islamic governance by highlighting human development as a strategic driver of sustainable zakat management in Malaysia.

LITERATURE REVIEW

This section is divided into two themes for discussion. The first theme concerns the concept and significance of human development within zakat institutions, and the second concerns the strategic dimension of human development within these institutions.

The Concept and Importance of Human Development in Zakat Institutions

The primary focus of zakat management effectiveness is human development as a means of advancing social and economic justice for Muslims. In zakat institutions, human development involves not only strengthening employees' technical competencies but also cultivating values, character, and spiritual integrity in accordance with Islamic principles. Mansor & Kasim (2008) emphasise that Islamic human development requires a balance between spiritual, intellectual, and professional dimensions, resulting in personnel to perform administrative duties but also be aware of the *maqasid al-shariah* underlying zakat management. Similarly, Kusumaningtyas et al. (2021) highlight that holistic human development includes technical competencies such as *fiqh* knowledge, marketing and information technology, as well as strong ethical values and social skills such as trustworthy, honest and committed.

Wahid & Nor (2019) also noted that the quality of human resources is the primary determinant of the efficiency and transparency of zakat institutions. In this context, human development within zakat institutions should not be limited to financial management but must involve a structured process that integrates economic, educational and social development dimensions. Officers serving as *amils* are not only the implementers of policies but are the agents of the development of the ummah who are supposed to manage the public funds in complete trust and righteousness. In this regard, human development must be planned strategically to align with organisational objectives, current management issues, and the ever-growing needs of the zakat recipient society. This strategic model requires systematic human resource planning to be carried out through continuous training, enhancement of work values based on Islamic work ethics, and development of appropriate digital and social skills.

There should also be a connection between strategic human development and the long-term aim of zakat institutions to build public trust in the institutions. Ikhwandha & Hudayati (2019) argue that employee transparency and responsibility should be significant factors that help ensure zakat institutions

are recognised as trustworthy bodies. Human development, therefore, does not involve only responding to administrative needs but also serves as a mechanism for establishing the organisation's reputation and credibility. This factor plays a crucial role in the context of MAIPk, where all efforts must preserve the social and economic goals of asnaf, maintain confidence in the administration of Perak state zakat, and ensure that the distribution of zakat yields direct benefits.

Strategic Dimension in Human Development of Zakat Institutions

The management of human resources in zakat institutions should be based on values and a holistic approach to strategic human development. Romli & Daud (2021, 2023) introduced a novel model of competencies, the Amil Competency Model, which comprises five major competency dimensions: personality, knowledge, skills, innovation, and consulting. This model emphasises that competence regarding amil is evaluated not only in terms of technical competence but also in terms of spiritual, moral, and social competence in the execution of the role of managing zakat funds. The aspects of personality and knowledge are central to powerful Islamic values. In contrast, the aspects of skills, innovation, and consultation reinforce their ability to adapt to the contemporary pressures, including the digitalisation of data systems, the efficiency of customer service, and communication with the asnaf community.

Within the scope of strategic human development, Islamic knowledge should be the primary focus to ensure that zakat human resources remain consistently aligned with the principles of faith, piety, and *ihsan* in all actions (Azizi et al., 2011). The *fardhu 'ain* and knowledge of *shariah* should be enhanced to ensure that none of the decisions made in respect of collection and distribution is made on any other principle other than the principles of justice, transparency, and accountability. Moreover, recent management capabilities such as zakat data analysis, strategic planning, and the efficiency of digital technologies are emerging skills that must be implemented to enable zakat organisations to compete and remain relevant in the digital world (Kusumaningtyas et al., 2021 and Jaria et al., 2025).

The challenges of integrity and ethics must also be addressed within the context of strategic human development, a frequent issue in zakat management. As Noor et al (2017) and Nor & Kadir (2020) claim, loopholes in trust values and internal supervision can encourage the misuse of zakat funds, thereby negatively affecting institutional reputation. A human development plan should therefore incorporate checks and balances in performance measurement and an equitable reward system to keep staff on track and on the right path. According to Romli and Daud (2021), a long-term human development strategy should also include ongoing training, competency assessment, and the establishment of a work culture grounded in Islamic values.

© 2026 by MIP

Within the framework of MAIPk, the strategic human development plan must be drafted in accordance with the institution's vision to be a pioneer in the welfare and development of the ummah in the state of Perak. The emphasis is not solely on the amil's technical aptitude, but also on the strategic, innovative, and value-oriented development of human resources. This approach will ensure that MAIPk not only functions as a zakat management institution but also serves as a model of high-impact, competitive Islamic human development at the national level.

Overall, the literature highlights that strategic human development in zakat institutions should be addressed as an organisational transformation agenda rather than merely as human resource training. The elements of Islamic personality, professional competence, integrity, and innovation should be integrated into a comprehensive, continuous development framework. In the context of MAIPk, the ability to develop a knowledgeable, ethical, and strategic workforce will determine the institution's effectiveness in managing zakat efficiently and in articulating the *maqasid al-shariah* in the social reality of the Muslim community in Perak.

RESEARCH METHODOLOGY

This section discusses the study design, data collection and data analysis methods used to address the research questions and achieve the study objectives. The study adopts a qualitative approach, which is appropriate for examining complex organisational and social phenomena in depth. According to Creswell (2007), qualitative research aims to describe and understand a phenomenon inductively within a real-world context, drawing on informants' experiences and perspectives. This approach is also suitable for addressing the questions of what, how, and why, which form the basis of this study.

This study employs a qualitative case study design, with MAIPk serving as the primary unit of analysis. The case study approach enables an in-depth examination of how human development strategies are implemented within a specific institutional context. According to Yin (2014), case studies are ideally used to study contemporary phenomena in real contexts when the boundaries between phenomenon and context are not very clear.

The study data were obtained from two main sources: primary and secondary data. Primary data were collected through semi-structured interviews with two officers in the Management and Organisational Development Services Division of MAIPk. Prior to the interviews, the informants were informed about the purpose of the study and their consent was obtained in accordance with ethical research practices. The informants were selected using purposive sampling because they hold key roles directly related to organisational development, human resource planning, and strategic management within MAIPk. As such,

they possess the relevant institutional knowledge and decision-making experience necessary to provide in-depth insights into the implementation of human development strategies. Although the number of informants is limited, the study focuses on key informants whose roles are directly involved in policy and organisational development, allowing the research to obtain detailed and context-specific information. The interview findings were also supported by documentary analysis of institutional reports and policies to enhance data triangulation and strengthen the credibility of the study.

Table 1: List of Informants

No.	Name of the Informant	Division	Unit
1.	NAY01	MAIPk Management and Organizational Development Services Division	Information Technology Unit
2.	NFAJ02	MAIPk Management and Organizational Development Services Division	Service and Administration Unit

Secondary data were obtained from institutional documents and literature, including annual reports, organisational policies, academic journals, books, and the official website of MAIPk. The study also examined documents related to other zakat institutions, such as those in Kedah, Penang, and the Federal Territories, for general comparison and data triangulation. Additional institutional data were also obtained directly from MAIPk through official correspondence and on-site visits.

Data were analysed using an inductive approach through qualitative content analysis. This approach allowed patterns, categories, and themes to emerge from interview transcripts and institutional documents. According to Hsieh et al. (2006), content analysis is a research technique used to identify meanings, patterns, and themes in narrative data. In this research, content analysis was used as the primary method to analyse primary data (interview transcripts) and secondary data (institutional documents) to identify the most prominent themes related to human development strategies in MAIPk.

The analysis followed three stages based on the framework suggested by Krippendorff (2004) and White and Marsh (2006). First, interview transcripts and institutional documents were coded using initial categories related to the research objectives. Second, the coded data were reviewed to identify key themes representing strategic dimensions of human development, including competence development, leadership grounded in Islamic values, and the integration of professional and spiritual development. Third, these themes were interpreted by linking interview findings with documentary evidence to generate a

© 2026 by MIP

comprehensive understanding of strategic human development practices within MAIPk.

The inductive analysis allowed the researcher to interpret the data without imposing predetermined hypotheses. The results of the analysis were then presented in tables and diagrams to provide a clearer, more structured picture. The use of multiple data sources, including interviews and institutional documents, enabled data triangulation and enhanced the credibility of the findings.

FINDINGS

The data collected and analysed are described in this section, in line with the study's objective of identifying strategic human development among staff. The research was conducted specifically at the Perak State Zakat Institution (MAIPk).

Human Development Among Staff at Perak State Zakat Institutions

The human resources department is responsible for staff recruitment and the implementation of human capital development programmes. As a key organisational unit, it plays an important role in strengthening institutional capacity and operational effectiveness. In general, high-quality human capital contributes to improved organisational performance and management efficiency. Based on the study results, MAIPk demonstrates strong zakat distribution performance, reflecting the effectiveness of its institutional management practices. While many zakat institutions emphasise operational efficiency and digital collection mechanisms, the MAIPk approach highlights the integration of strategic human development, organisational governance, and digital management systems as complementary drivers of institutional effectiveness. At the initial stage, human capital development begins with the recruitment of officers and staff by the Human Resources Unit, which is then managed by the special human capital unit within the Management Services Division.

Naturally, matters related to the organisation's staff or officers are handled by the human resources department. Specifically, the appointment process of officers and staff is managed by the Human Resources Unit in accordance with the guidelines issued by the state government. As MAIPk is a government body, all appointment processes are subject to government acts governing the appointment and posting of civil servants. Eligibility to hold positions in MAIPk remains subject to government guidelines, which vary by grade and position classification. This can be proven in the statement of the NFAJ02 informant:

> "For recruitment, we have rules, regulations, and circulars that we have to follow. It is indeed obligatory for us to follow the government's act for appointments and promotions for the civil service." (NFAJ02, Face-to-Face Interview)

In the appointment process, MAIPK's human resources will first analyse vacancies before aligning them with the organisation's planned budget. These vacancies will then be advertised on various platforms, typically for a period of three weeks. After the advertisement is made, the list of applicants is roughly screened by the human resources department before it is proposed to the Appointment Committee meeting. This is in line with the statement given by the NFAJ02 informant:

> "…we need a plan at least a year in advance, given that we prepare the budget a year in advance. Usually, our advertisement lasts for three weeks. We have an interview section, and the selection process follows. It is enough to put all the requirements before it goes to the committee." (NFAJ02, Face-to-Face Interview)

Human capital is managed by a special unit under the management services unit, namely the Training and Performance Unit. The unit's function is to identify and evaluate the performance of each officer and staff member at MAIPk, and to analyse the need for them to attend courses or workshops to improve their skills. As stated by the NFAJ02 informant:

> "We have a dedicated unit to conduct training and performance; it is a unit under management services that will do performance evaluations. The training section will determine which positions and trainees are suitable and meet their requirements. If there is sufficient budget and other relevant resources, then you can do it. However, if you follow the government regulations, everyone must have at least three days of coursework." (NFAJ02, Face-to-Face Interview)

Skills courses and workshops also depend on the budget allocated; they will be implemented according to budgetary suitability. According to government regulations, MAIPk must complete courses for at least 3 days per year, with the schedule planned a year in advance. This is because the design for the next year's program must be based on the previous year's budget. Typically, each division under MAIPk will conduct at least two training sessions. Workshops and courses conducted include financial workshops, Microsoft 365 workshops, and lecture

© 2026 by MIP

courses. The example of this workshop or course is in line with the statement given by the NFAJ02 informant, namely:

> "Usually, we will do a finance workshop, then the training. As in last year, we conducted a Microsoft 365 workshop. Now that we are more on social media, we need to be strong in that part." (NFAJ02, Face-to-Face Interview)

Human capital development also considers skills in Information and Communication Technology (ICT). This is because the ICT system can benefit the organisation by improving management efficiency. One of the dimensions of human capital is the number of individuals skilled in ICT. Previous findings indicate that MAIPk has one of the highest zakat distribution rates, thereby illustrating the efficiency of its staff management. The ICT system will be updated to align with current needs and technological developments. The zakat management system used by MAIPk is known as the *i-Syura* system. This system is used in the Zakat Distribution Division to carry out the zakat application process and application approval. This agrees with the statement by informant NAY01 (2024):

> "We have zakat distribution management here. This means that there is a system that processes. But if we call it the '*i-Syura'* system". (NAY01, Face-to-Face Interview)

The process of approval of zakat applications starts from the receipt of the application form. Next, the data from the form will be registered and recorded in the system before further investigation is carried out. After the investigation, the officer will give a comment, and the decision will be made through a meeting or decided by the officer himself. If the zakat approval process is brought to the meeting, then the Baitulmal Committee, such as the Supreme Baitulmal, Middle, Executive, and District Baitulmal Committee, will be involved. As stated by informant NAY01:

> "Applicants submit the application form, which is then registered and recorded in the system by the staff. The application will be investigated and reviewed before a decision is made either by the responsible officer or through a committee meeting. If the decision goes to the meeting level, it may involve several Baitulmal committees, including the Supreme, Central, Executive, and District Baitulmal Committees" (NAY01, Face-to-Face Interview)

Informant NAY01 also stated:

> "If the application is approved, the system will generate a sub-voucher and an approval letter. The entire process is managed through the *i-Syura* system. We also have an online zakat assistance application system that offers three schemes: domestic bursary assistance, overseas bursary, and general education assistance." (NAY01, Face-to-Face Interview)

This means that after the application is approved, the system will issue a sub-voucher along with an approval letter, and then payment will be made to the recipient. MAIPk also offers an education assistance scheme, which can be applied for through the online zakat application system. Among the types of schemes offered are domestic bursary schemes, overseas bursaries, and general education aid. With this system, manual work is less used, and the data obtained is more accessible, which ultimately accelerates the affairs of zakat distribution. MAIPk also provides a zakat deduction system called e-pzb, a Scheduled Zakat Deduction System through salary deduction, which can be applied for online. In a statement given by informant NAY01:

> "or zakat income collection, we use the e-PZB system, which allows the public to apply for salary deductions online. The application is registered at the district level and then processed by the headquarters, which determines the deduction amount and notifies the employer." (NAY01, Face-to-Face Interview)

This application requires approval from the employer before the amount of deduction notified to the MAIPk can be passed. The counter collection system at MAIPk is also implemented, as there are still people who are not ICT literate, especially the elderly. In fact, digital media can be considered as an alternative that can create and increase public confidence in the abilities and transparency of zakat institutions.

Based on the analysis conducted previously, MAIPk has the second-highest percentage of zakat distribution at 93.3%. This high percentage of zakat distribution is driven by the factors of the zakat management system, namely *i-Syura* and human capital development carried out by MAIPk. Through a special unit under the management services unit, such as the Training and Performance Unit, it indirectly has a positive impact on the efficiency of zakat distribution in the state of Perak.

© 2026 by MIP

ANALYSIS AND DISCUSSION

Theme 1: Structured Human Resource Structure and Management

The human resources division at MAIPk plays an important role in the recruitment and development process of officers and staff. As a religious agency under the state government, the appointment process at MAIPk is subject to public service regulations and circulars, including qualification, promotion, and promotion guidelines. The implementation based on this system ensures fairness, transparency, and integrity in the selection process.

As stated by the NFAJ02 informant, all appointments must comply with government acts as well as go through a screening process by the Appointments Committee after three weeks of advertising. This shows that MAIPk emphasises the principles of governance based on Islamic values such as trustworthiness and justice, according to the dimension of *maqasid al-Shariah* in preserving the wealth and welfare of the organisation.

This approach illustrates how strategic people development is not just focused on training and skills but starts with a fair and systematic process of recruitment. This is in consonance with the views of Garavan (1991) in the theory of Strategic Human Resource Development (SHRD), which emphasises the importance of the alignment between organisational goals and human resource development strategies.

According to Hasan et al. (2019), the process of recruiting at the zakat institutions from the shariah perspective must be carried out legally through offering the applicants accurate information about the job vacancies, such as duties and responsibilities in the positions, compensation, and other benefits that are available to the employees. This will help them assess whether the requirements of the job match their skills, talents, and interests.

Theme 2: Training, Competency Development, and Professional–Spiritual Values

MAIPk also established a Training and Performance Unit under the Management Services Division with the same purpose of training and assessing the performance of the staff. This unit is responsible for determining the type of annual training programs conducted in the organisation, evaluating the individual performance based on task requirements and targets of the organisation. The implementation of this exercise is planned for a year to ensure that it is in line with the annual budget planning.

According to the NFAJ02 informant, all members of staff must attend at least three days of courses per year, in accordance with government guidelines. Some of the courses conducted are financial workshops, Microsoft 365 workshops, and digital communication courses. MAIPk also reassessed the

dominance of the traditional version of talks and the use of more practical interactive training to replace it.

Aside from the technical workshops, the training framework of MAIPk includes spiritual and ethical magnetism through *tazkiyah al-nafs* (self-purification) and *adab al-'amal* (work ethics). These elements are included in the leadership retreats and professional seminars organised to strengthen the moral compass of the employees and enhance their managerial and operational ability. This holistic approach ensures human development at MAIPk goes beyond skills acquisition and includes values-based leadership, in line with the principles of Islamic governance.

This model matches the strategic dimension of human development, the dimension in which professional competencies are developed, such as communication, management, and decision-making, along with spiritual maturity. Through constant training and reinforcement by virtue of ethics, MAIPk develops a strong workforce that can adapt to an organisation's transformation with the requisite religious integrity. Such a balance is of vital importance in the handling of zakat, which both requires administrative precision and moral consciousness.

The implementation of this development program not only improves technical competence but also strengthens the ethical and spiritual values in work. According to Syahid et al. (2024), human capital, technology, and employee empowerment are important in improving the performance of the organisation. This is in keeping with the concept of *Insan Kamil*, which involves the balanced development of humans from the intellectual, moral, and spiritual aspects. Therefore, strategic human development in MAIPk can be considered as the road of building Islamic professional character, which is not only the road of competence, but also of blessings and social responsibility. In essence, the strategy adopted by MAIPk reflects the fusion between professional development and spiritual and ethical reinforcement, which is a dual strategy aimed at increasing institutional credibility and consolidating the trust of the public in the management of zakats.

Theme 3: Theme 3: Digital Transformation and Efficiency of Zakat Management

One of MAIPk's main successes is the implementation of the *i-Syura* digital system in the management and distribution of zakats, and e-PZB (Scheduled Zakat Deduction) in the collection of zakat on income. The *i-Syura* system enables the whole process of application, i.e., from registering the application to approving it, to be carried out online and is supervised by the Baitulmal Committee on different levels. According to informant NAY01, this system

© 2026 by MIP

provides ease for monitoring, facilitates the administration process of approving issues, and brings transparency to the distribution process of zakat.

In addition, the e-PZB system enables the zakat payers to apply for the salary deductions online, thus reducing the workload of manual work. The effectiveness of this system illustrates the efficiency of MAIPk staff in adapting to ICT technologies, although continuous training and adaptation are required to ensure that all personnel remain capable of managing evolving digital systems. The development of ICT competencies is an important matter in the concept of modern strategic human development, where technological skills and innovative thinking are the keys to the efficiency of zakat institutions (Muyassarah et al, 2025). This demonstrates that strategic human development and digital transformation are executed and complement each other to create a competitive, transparent, and trustworthy organisation.

Overall, the findings demonstrate that MAIPk's human development strategy integrates competency development, leadership strengthening, ethical and spiritual values, and digital capability within a holistic institutional framework. This integrated approach illustrates how strategic human development, organisational governance, and digital management systems function collectively to enhance institutional efficiency and strengthen public trust in zakat administration. The MAIPk experience, therefore, highlights the importance of aligning professional competence with Islamic ethical values in sustaining effective and accountable zakat management.

CONCLUSION

This study found that the effectiveness of zakat management in MAIPk is greatly influenced by human development strategies that are implemented in a planned and continuous manner. A clear organisational structure, systematic training programmes, as well as the use of digital systems such as *i-Syura* and e-PZB have strengthened the efficiency of zakat distribution in the state of Perak. However, in order to maintain the sustainability of the performance of zakat institutions, some improvements are recommended. First, MAIPk and other zakat institutions are advised to expand Islamic competency-based training programs that emphasise the integration of professionalism and spiritual values. Second, the development of digital systems needs to be enhanced by introducing more user-friendly designs, especially for the less tech-savvy. Third, human resource management policies need to be reviewed regularly to align with current challenges and societal needs. Overall, the study highlights that strategic human development is a key driver of institutional excellence in zakat administration. Integrating technical competence, ethical leadership, and digital capabilities can strengthen institutional resilience and enhance public trust in zakat governance. Future research may further explore comparative studies across zakat institutions

or examine the impact of digital transformation and human resource development on institutional performance in Islamic social finance organisations.

ACKNOWLEDGEMENT

This research and publication were supported by the Geran Inisiatif Penyelidikan (GIP) under grant code EP-2024-039 and the Faculty of Economics and Management, Universiti Kebangsaan Malaysia. The authors gratefully acknowledge this financial support.

REFERENCE

Creswell, J. W. 2007. *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, C, Sage Publications, Inc.

Daud, M. Z., Noh, M. S. M., Fidhayanti, D., Hussin, M. N. M. (2025). Empowering the future: Unveiling zakat's vital role in economic development and legal framework in Malaysia. *Jurisdictie: Jurnal Hukum dan Syariah, 16*(1): 235–274. http://dx.doi.org/10.18860/j.v16i1.31424

Garavan, T. N. (1991). Strategic Human Resource Development. *Journal of European Industrial Training, 15*(1), 17-30. https://doi.org/10.1108/EUM0000000000219

Hasan, A., Hassan, R., Ali, E. R. A. E., Ali, E. M. T. E., Abduh, M., & Noordin, N. H. (2019). A proposed human resource management model for zakat institutions in Malaysia. *ISRA International Journal of Islamic Finance, 11* (1): 98–109. https://doi.org/10.1108/IJIF-10-2017-0036

Hsieh, H. F., Shannon, S. E., & Curtis, J. R. (2006). Contradictions and communication strategies during end-of-life decision making in the intensive care unit. *Journal of Critical Care, 21*(4), 294–304. https://doi.org/10.1016/j.jcrc.2006.06.003

Ikhwandha, M.F., & Hudayati, A. (2019). The influence of accountability, transparency, affective and cognitive trust toward the interest in paying zakat. *Jurnal Akuantasi & Auditing Indonesia*, *23*(1), 39–51. https://doi.org/10.20885/jaai.vol23.iss1.art5

Jaria, A., Soraya, Z., & Abdullah, I. (2025). Implementasi manajemen sumber daya manusia dalam pengumpulan dana zakat di badan amil zakat nasional kabupaten Enrekang. *Journal of Innovative and Creativity*, *5* (2), 8721–8734. https://doi.org/10.31004/joecy.v5i2.1388

Krippendorff, K. (2004). *Content analysis: An introduction to its methodology*, 2nd edn. Thousand Oaks, CA: Sage.

Kusumaningtyas, E. A., Asegaf, M. M., & Dikuraisin, B. (2021). Human capital sebagai strategi pengembangan sumber daya profesional di Lembaga Zakat Nurul Hayat. *Jurnal Manajemen zakat dan wakaf*, *2*(2): 155–174. https://doi.org/10.22515/finalmazawa.v2i2.4847

Lateff, E. E. A., Palil, M. R., & Hassan, M. S. (2014). Prestasi kecekapan agihan kewangan dan bukan kewangan di kalangan institusi zakat di Malaysia. *Jurnal Ekonomi Malaysia, 48* (2), 51-60.

Mansor, F., & Kasim, T. S. A. T. (2008). Pembangunan modal insan dari perspektif pengurusan Islam. *Journal of Al-Tamaddun*, *3*(1), 85–109. https://doi.org/10.22452/JAT.vol3no1.5

© 2026 by MIP

Muyassarah, M., Mawadah, S., Saadah, N., Faizah, F. N., Nurlaily, L. (2025). Revised zakat distribution: Perspectives on digital transformation for poverty alleviation. *Journal of Islamic Thought and Civilisation, 15*(1): 19–215 https://doi.org/10.32350/jitc.152.11

Noor, A. H. M., Rasool, M. S. A., Yusof, R. M., Ali, S. M., Rahman, R. A. (2015). Efficiency of Islamic Institutions: Empirical Evidence of Zakat Organizations' Performance in Malaysia, *Journal of Economics, Business and Management*, *3*(2): 282–286. https://doi.org.10.7763/JOEBM.2015.V3.195

Nor, M. N. M., & Kadir, D. A. (2020). Cabaran fraud di institusi zakat: Jenis, punca dan mekanisme pencegahan. *International Journal of Zakat and Islamic Philanthropy*, *2*(1), 11–21.

Paizin, M. N., & Sarif, S. (2021). Peranan pengkorporatan pentadbiran zakat terhadap pengurusan sumber manusia: Kajian di Malaysia. *Journal of Islamic Social Sciences and Humanities*, *25*(1), 264–280. https://doi.org/10.33102/abqari.vol24no2.310

Rashid, K. A., Hasan, S. F., Fauzi, P. N. F. N. M., Aripin, S., & Sarkawi, AA. (2019). Zakat and wakaf-funded housing for the poor and needy – An analysis of the Zakat and Wakaf authorities' roles from the authorities' perspectives. *Planning Malaysia: Journal of the Malaysian Institute Planners*, *17*(1), 70-81. https://doi.org/10.21837/pmjournal.v17.i9.587

Romli, A. B., & Daud, M. N. (2021). Peningkatan kemahiran dan kualiti kerja amil melalui pembangunan model kompetensi amil zakat. *International Journal of Islamic Economic, Business and Entrepreneurship*, 1(1), 1–17.

Romli, A. B., & Daud, M. N. (2023). Konsep kompetensi keperibadian amil zakat. *AZKA International Journal of Zakat & Social Finance*, *4*(1), 57–65. https://doi.org/10.51377/azjaf.vol4no1.130

Syahid, A. M. A., Mujitaba, M. A., Rameli, N., Zukri, T. M. Z., & Razali, N. A. (2024). Entrepreneurial human capital on the empowerment of asnaf entrepreneurs planning in the state of Selangor. *Planning Malaysia: Journal of the Malaysian Institute Planners*, *22*(1), 296-308. https://doi.org/10.21837/pm.v22i30.1441.

Wahid, H., & Noor, M. A. M. (2019). *Pengurusan zakat di Malaysia: Pemerkasaan dan pengukuhan tadbir urus institusi.* Bangi: Penerbit Ekonis UKM.

White, M. D., & Marsh, E. (2006). Content Analysis: A flexible methodology. *Library Trends, 55*(1), 22-45.

Yin, R. K. (2014). Case study research design and methods (5th ed.). Thousand Oaks, CA: Sage.

Zaid, S. H. M., & Hashim, S. N. A. (2022). Peningkatan kualiti modal insan untuk keusahawanan sosial Islam di Malaysia. *AZKA International Journal of Zakat & Social Finance*, 3(3), 53–66. https://doi.org/10.51377/azjaf.vol3no3.136

Zakiy, F. S, Falikhatun, F., Fauziah, N. N. (2025). Sharia governance and organizational performance in zakat management organization: Evidence from Indonesia. *Journal of Islamic Accounting and Business Research*, 16(6): 1034–1057 https://doi.org/10.1108/JIABR-06-2023-0188

Received: 28th October 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 63 – 79

MADANI PLANNING IN THE ERA OF AI: STRATEGIES FOR BALANCING TECHNOLOGICAL INNOVATION AND COMMUNITY WELL-BEING

Abdul Hanis Embong [1], Wan Mohd Khairul Firdaus Wan Khairuldin [2], Shahir Akram Hassan[3], Asyraf Hj Ab. Rahman[4], Najihah Abdul Mutalib[5], Ismar Liza Mahani Ismail[6]

[1,4,5,6] *Centre for Fundamental and Continuing Education*,
UNIVERSITI MALAYSIA TERENGGANU,
21300 KUALA NERUS, TERENGGANU
[2] *Faculty of Islamic Contemporary Studies,*
Research Institute of Islamic Product and Malay Civilization (INSPIRE),
[3] *Faculty of Islamic Contemporary Studies,*
UNIVERSITI SULTAN ZAINAL ABIDIN
[3] *Centre for Islamic Development Management Studies (ISDEV),*
UNIVERSITI SAINS MALAYSIA

Abstract

This paper explores the intersection of artificial intelligence (AI) and Malaysia Madani, a governance framework that prioritizes sustainability, prosperity, innovation, respect, trust, and compassion. The study employs a qualitative, exploratory design using inductive thematic document analysis of recent Malaysia Madani policy frameworks, official government reports, and comparative academic literature. Three core strategies are identified for balancing technological innovation with community well-being: the development of multidimensional well-being indicators, the adoption of community-based approaches in AI governance, and the design of ethical interventions that safeguard dignity and social cohesion. Definitions of Malaysia Madani planning, well-being, and AI are outlined, followed by an assessment of threats and opportunities posed by AI to social equity, cultural diversity, and democratic trust, with specific attention to marginalized communities in Malaysia. The findings suggest that embedding Malaysia Madani values into AI governance offers a unique model for aligning innovation with normative commitments to justice, inclusivity, and resilience. The paper concludes by calling for interdisciplinary, transdisciplinary, and systems-based approaches to ensure that AI becomes a tool for collective flourishing rather than a source of fragmentation.

Keywords: Artificial Intelligence (AI), Malaysia Madani Values, Sustainable Urban Planning, Digital Governance, Policy Frameworks

[1] Corresponding author. Email: hanis.embong@umt.edu.my

INTRODUCTION

The convergence of artificial intelligence (AI) with societal planning represents both a profound opportunity and a pressing challenge for contemporary governance (Gharaibeh et al., 2025). Scholars widely agree that AI is reshaping not only economic sectors and institutional functions but also the fundamental dynamics of communities and social well-being (Awashreh, 2025). While some portray AI as an enabler of progress in healthcare, education, and urban management, others highlight its potential risks ranging from job displacement and data exploitation to the erosion of civic trust (Cowls & Floridi, 2018; Goodman & Powles, 2019). In this context, the quest for frameworks that harmonise technological advancement with human-centred values has become indispensable (Lartey & Law, 2025).

Malaysia's Malaysia Madani framework offers a timely response to this dilemma. As a governance philosophy, Malaysia Madani emphasizes balance (wasatiyyah), compassion (rahmah), and inclusivity in public policy (Shuid & Mohd Zamin, 2018), seeking to align development with ethical and communal responsibilities (Balaraman et al., 2024). By embedding moral and social principles into socio-economic planning, Malaysia Madani thinking underscores that true progress is measured not only in material prosperity but also in social cohesion, justice, and dignity (Nasir et al., 2024). The intersection of AI and Malaysia Madani planning thus provides fertile ground to explore how emerging technologies can be leveraged without undermining community well-being (Setiawan, 2020).

Globally, comparable governance frameworks have emerged that share philosophical similarities with Malaysia Madani. Singapore's Smart Nation initiative incorporates ethics and inclusivity into digital transformation policy (GovTech Singapore, 2023), while the European Union's AI Act establishes a risk-based regulatory framework designed to protect fundamental rights and democratic values (European Commission, 2024). In the Global South, countries such as Indonesia and Bangladesh have begun integrating Islamic governance principles into digital policy discourse, reflecting a broader trend of aligning technological governance with culturally embedded moral frameworks (Setiawan, 2020). These international precedents affirm that Malaysia Madani's approach is not an isolated experiment but part of a growing global movement to ensure that AI serves human and community well-being.

Malaysia Madani planning refers to a governance paradigm rooted in the principles of rahmah (compassion), wasatiyyah (balance), and inclusivity (Sualman, 2025). Unlike conventional development models that prioritize economic growth as the central indicator of progress, Malaysia Madani planning emphasizes justice, ethical stewardship, and social cohesion (Zakaria & Long, 2024). It views communities not simply as economic units but as moral and

cultural collectives, where well-being is measured holistically through material, spiritual, and social dimensions (Yap, 2025). In the context of AI, Malaysia Madani planning provides a normative compass, guiding technological integration toward outcomes that protect human dignity, reinforce social solidarity, and ensure equitable participation in innovation processes.

Following the Organisation for Economic Co-operation and Development (2019), well-being may be understood as encompassing both present living conditions and future sustainability, including natural, economic, human, and social capital. McGregor (2007) further highlights that well-being emerges within "social collectivity," underscoring its embeddedness in societal structures. Building on this, community well-being is defined as multidimensional, spanning culture, economy, education, governance, health, environment, and subjective life satisfaction (Phillips & Wong, 2017). In the Malaysia Madani paradigm, well-being is not an individual pursuit but a collective achievement, demanding balanced attention to material sufficiency, spiritual growth, and community resilience.

AI, coined by McCarthy in 1956, is broadly understood as the science and engineering of creating machines capable of tasks that mimic human intelligence (Wang, 2012; Pan, 2016). Within the current discourse, AI can be categorized as narrow AI (task-specific algorithms such as image recognition and predictive analytics), general AI (hypothetical systems capable of flexible reasoning), and superintelligence (self-aware systems surpassing human cognition) (Kaplan & Haelein, 2018). In community contexts, AI manifests in robotics, big data, cross-media integration, and human–machine augmented systems (Pan, 2016). From a Malaysia Madani perspective, the deployment of AI must be critically assessed not merely in terms of efficiency or profitability but in its capacity to enhance justice, solidarity, and collective welfare (Samsurijan et al., 2024).

Global debates already reflect the dual potential of AI. On one hand, AI-enabled systems can contribute to sustainable development goals, such as reducing inequality, enhancing disaster preparedness, and improving access to healthcare (Bushuyev et al., 2025). On the other, unregulated or profit-driven applications of AI may intensify disparities, marginalize vulnerable populations, and deepen the divide between those with and without digital capital (Nizamani et al., 2025). These tensions resonate with the Malaysia Madani paradigm, which calls for technological innovation to be evaluated not merely by efficiency or profitability (Wan Mokhtar et al., 2025), but by its capacity to preserve human dignity and foster collective well-being (Iskandah et al., 2025a).

This article therefore seeks to investigate strategies for balancing technological innovation with the ethical imperatives of Malaysia Madani planning. Specifically, it proposes that sustainable adoption of AI in governance requires

© 2026 by MIP

three interlinked strategies: (1) the integration of well-being indicators to monitor the societal effects of AI; (2) the embedding of community-based approaches in AI development and governance; and (3) the design of interventions that safeguard cultural values while enabling technological progress (Musikanski et al., 2020). By situating Malaysia Madani planning within the global discourse on AI and community well-being, the paper argues for an interdisciplinary and systems-based approach that bridges technological innovation with normative visions of justice, balance, and inclusivity.

RESEARCH METHODS

This study adopts a qualitative and exploratory research design aimed at examining the intersection of artificial intelligence (AI) and the Malaysia Madani framework of governance (Tornero-Costa et al., 2023). The exploratory orientation is appropriate given that both AI and Malaysia Madani planning represent evolving phenomena whose integration has not yet been extensively theorized in the scholarly literature (Van Der Maden et al., 2023). The objective of this method is not to test hypotheses but to provide conceptual clarity and generate insights into potential strategies for balancing technological innovation and community well-being.

The primary data for this research are drawn from policy documents, government reports, and official speeches outlining the vision and implementation of Malaysia Madani. These include policy papers released by the Prime Minister's Office and the Ministry of Economy, as well as public addresses by the Prime Minister in 2023 and 2024 that articulate the six core values of the Malaysia Madani framework: Sustainability (Kelestarian), Prosperity (Kemakmuran), Innovation (Daya Cipta), Respect (Ihsan), Trust (Amanah), and Compassion (Rahmah). Secondary data are supplemented from academic literature, international policy reports, and comparative studies on AI and community well-being (Organisation for Economic Co-operation and Development, 2019; Musikanski et al., 2020).

Data were collected through systematic document analysis, focusing on the most recent iterations of Malaysia Madani policy frameworks and associated implementation strategies. The analysis employed an inductive thematic coding approach, whereby documents were systematically reviewed and coded to identify recurring themes related to: (1) the role of innovation in governance; (2) ethical principles in development planning; and (3) strategies for promoting social well-being in the context of technological adoption. Initial codes were generated directly from the text of each document and subsequently grouped into broader thematic categories through iterative comparison. This coding process was conducted manually, without the use of qualitative data analysis software,

given the focused scope of the document corpus. Reliability was enhanced through reflexive review, in which coded themes were revisited across multiple readings to ensure consistency and interpretive accuracy.

The coded themes were then cross-referenced with scholarly debates on AI and community well-being in order to highlight both convergences and tensions between Malaysia Madani values and emerging international AI governance frameworks. It is important to acknowledge the limitations of this methodological approach. As a document-based analysis, the findings are shaped by the framing and scope of official government documents, which reflect institutional positions rather than the full diversity of community perspectives. Additionally, the qualitative and interpretive nature of thematic analysis means that findings are not statistically generalizable. These limitations are mitigated by triangulating document analysis with comparative international literature and by clearly distinguishing between empirical observations derived from the data and conceptual propositions offered by the authors.

RESULTS AND DISCUSSION

The findings of this exploratory study highlight the critical role of Malaysia Madani planning as a normative compass for navigating the dual potentials of artificial intelligence (AI). Through thematic analysis of Malaysia Madani policy documents, three major themes emerged: (1) the need for robust well-being indicators to assess the societal impact of AI; (2) the importance of community-based approaches in AI development and governance; and (3) the design of ethical interventions that align technological innovation with collective values of justice, compassion, and inclusivity. These findings resonate with existing international debates on AI and community well-being (Tong & Li, 2024), but they also extend the discourse by situating it within the distinctly Malaysian philosophical framework of Malaysia Madani, which foregrounds balance (wasatiyyah) and dignity (maruah).

In discussing these results, it is evident that AI adoption in Malaysia cannot be understood solely through the lens of efficiency or competitiveness (Lai et al., 2025). Rather, the Malaysia Madani paradigm requires that innovation be evaluated in relation to its broader socio-cultural implications and its contribution to long-term community resilience (Hamzah et al., 2025). This section therefore synthesizes empirical insights from policy analysis with conceptual reflections from global scholarship, illustrating how Malaysia Madani planning provides both opportunities and challenges for embedding AI within sustainable and ethical governance systems.

© 2026 by MIP

Threats and Opportunities in the Era of AI: A Malaysia Madani Perspective

While AI holds immense promise for societal advancement, several threats emerge when technological adoption is pursued without ethical safeguards (Palakurti, 2024). Scholars warn that AI may exacerbate inequalities, undermine human autonomy, and erode civic trust if driven solely by profit-maximizing imperatives (Roy, 2021). In Malaysia, this challenge is particularly acute across three dimensions. First, the rural-urban digital divide remains a structural barrier: communities in Sabah, Sarawak, and remote peninsular areas have significantly lower broadband penetration and digital literacy rates than urban centres, meaning that AI-driven services in finance, education, and public administration risk excluding precisely those communities most in need of equitable development (Mahusin et al., 2024).

Second, low-income households and marginalized communities, including Orang Asli populations, face compounded disadvantages as AI hiring algorithms and automated credit scoring systems may embed historical biases, perpetuating cycles of exclusion rather than alleviating them. Third, senior citizens and persons with disabilities risk being structurally excluded from AI-mediated public services if accessibility and inclusive design principles are not mandated from the outset.

Moreover, the governance of AI raises significant concerns over privacy, data security, and surveillance (G. Kumar et al., 2025). Incidents in other jurisdictions demonstrate that poorly regulated AI in smart city projects can weaken public trust and provoke civic resistance (Sanchez et al., 2025). Such dynamics, if replicated in Malaysia, would conflict with the Malaysia Madani vision of respect (ihsan) and trust (amanah) as foundational principles of governance. The Malaysia Madani framework underscores that technological adoption must not undermine human dignity or compromise the moral contract between government and citizenry (Anwar, 2023).

Opportunities for Malaysia Madani Planning

Despite these risks, AI also presents substantial opportunities for strengthening the Malaysia Madani agenda. Properly integrated, AI can support sustainable development goals such as equitable healthcare, improved education access, and efficient disaster preparedness (Panteli et al., 2025). Several concrete examples from Malaysia and comparable countries illustrate this potential. Malaysia's MyHEALTH portal and the Ministry of Health's integration of AI-driven clinical decision support systems represent early steps toward leveraging AI for equitable healthcare delivery, consistent with Malaysia Madani's emphasis on compassion (rahmah). AI-driven predictive analytics could further assist Malaysia in mitigating climate change risks, consistent with Malaysia Madani's emphasis on sustainability (kelestarian). Similarly, adaptive learning platforms powered by

AI, aligned with objectives under the Malaysia Education Blueprint 2013–2025, can help address disparities in education quality, a direct contribution to the Malaysia Madani goal of inclusivity and shared prosperity (kemakmuran) (Jogarao et al., 2024).

From a governance perspective, AI-enabled participatory platforms can enhance citizen engagement, enabling communities to play an active role in shaping policy decisions (Yan & Qi, 2024). This aligns with the Malaysia Madani value of trust (amanah) and participatory governance, reinforcing democratic legitimacy. Internationally, Estonia's AI-assisted public service delivery and South Korea's smart governance platforms offer instructive benchmarks for how AI can be deployed transparently and accountably, providing Malaysia with actionable models for responsible adoption. Furthermore, AI applications in healthcare diagnostics and social welfare targeting could strengthen compassion (rahmah) within public service delivery, ensuring that vulnerable groups are not left behind in the transition to a digital economy (Iskandah et al., 2025b).

The Malaysia Madani vision highlights that innovation must be tempered with ethical reflection and social responsibility. Achieving this balance requires deliberate policy design, investment in inclusive digital infrastructure, and the integration of well-being indicators that measure not only technological efficiency but also social cohesion, equity, and dignity (Mohd Nafi et al., 2021).

Strategy 1: Well-Being Indicators Aligned with Malaysia Madani Pillars

A key finding of this study is that the integration of well-being indicators into AI governance must be explicitly aligned with the six pillars of Malaysia Madani. Unlike conventional performance metrics that focus primarily on efficiency and economic output, Malaysia Madani planning positions societal values as the foundation of sustainable progress (Anwar, 2023). Embedding these values into assessment tools allows Malaysia to operationalize its national philosophy in ways that guide and constrain technological innovation. The following sub-sections elaborate how each pillar translates into concrete evaluative dimensions for AI governance.

Sustainability (Kelestarian)

AI adoption must be measured by its ecological footprint and contribution to intergenerational justice (Cardoso & Rodrigues, 2025). Indicators should track how AI-driven systems impact energy consumption, waste reduction, and environmental stewardship, ensuring that technological progress does not undermine the Malaysia Madani commitment to ecological balance.

© 2026 by MIP

Prosperity (Kemakmuran)
Beyond GDP growth, AI governance should evaluate whether innovation enhances equitable prosperity. Indicators should assess job creation, inclusivity of marginalized groups, and fair distribution of digital resources, reflecting Malaysia Madani's aim of shared wealth and social justice.

Innovation (Daya Cipta)
While AI inherently represents technological innovation, Malaysia Madani planning calls for innovation that is ethical and socially responsive. Indicators should measure not only the scale of adoption but also the creativity with which AI addresses national priorities, such as healthcare access, food security, and educational equity.

Respect (Ihsan)
AI governance must safeguard cultural and human dignity. Indicators here include respect for linguistic diversity, religious sensitivity in algorithmic design, and the avoidance of technologies that marginalize or stereotype vulnerable groups.

Trust (Amanah)
Public trust is indispensable for AI integration. Indicators should measure transparency of algorithms, accountability mechanisms, and the degree of citizen involvement in shaping AI policies. This reflects the Malaysia Madani value of governance built upon integrity and responsibility.

Compassion (Rahmah)
AI must be evaluated for its contribution to compassion and care within society. Indicators should assess whether AI systems support vulnerable populations, enhance healthcare and welfare delivery, and uphold the ethical principle of serving humanity rather than exploiting it.

By incorporating these six pillars as evaluative dimensions, Malaysia can establish a Malaysia Madani AI Impact Framework that redefines success not only in terms of efficiency or profitability but also in alignment with moral and social imperatives. This approach transforms well-being indicators into instruments of value-based governance, ensuring that AI adoption strengthens the nation's collective identity and resilience rather than eroding them.

Strategy 2: Community-Based Approaches in AI Development
The second major theme that emerged from this study is the significance of community-based approaches in shaping AI governance within the framework of Malaysia Madani. Rather than imposing technology from the top down, Malaysia

Madani planning emphasizes the participation of citizens, communities, and civil society as co-creators of innovation (d'Elia et al., 2022). This orientation ensures that AI is not only technically efficient but also socially legitimate and ethically grounded (Mahusin et al., 2024).

Within the Malaysia Madani vision, kelestarian or sustainability requires that communities play an active role in safeguarding ecological and social balance when AI is deployed in fields such as agriculture, climate monitoring, and urban planning. Kemakmuran or prosperity is best realized when AI-driven opportunities such as digital entrepreneurship, micro-finance platforms, or smart cooperative models are distributed equitably, allowing local communities to share in the benefits of innovation. The principle of daya cipta or innovation is given meaning when communities are involved in designing technologies that address their own lived realities, such as rural education needs, public health monitoring, or cultural preservation initiatives (Agarwal & Nene, 2025).

By embedding ihsan or respect, AI governance becomes sensitive to Malaysia's pluralistic context, ensuring that systems do not reproduce cultural or religious biases but instead honor diversity and human dignity. Trust, or amanah, is strengthened when AI policies are transparent and participatory, with mechanisms for oversight that involve citizen input and safeguard accountability. Finally, the value of rahmah or compassion anchors community-based AI development in a moral commitment to uplift the marginalized, whether through targeted welfare distribution, healthcare access, or disaster relief systems that prioritize human lives. By weaving these six pillars into participatory governance, community-based approaches transform AI development into a collaborative process that reflects both technological sophistication and moral responsibility, operationalizing the Malaysia Madani vision in ways that strengthen rather than fragment the social fabric.

Strategy 3: Ethical Interventions for Safeguarding Community Well-Being

The third theme emerging from this study is the necessity of designing ethical interventions that ensure AI contributes positively to collective welfare (Avila-Robinson et al., 2025). While technological innovation often promises efficiency and growth, it simultaneously raises complex questions regarding fairness, privacy, accountability, and human dignity (D. Kumar & Suthar, 2025). In Malaysia, these concerns must be addressed within the moral architecture of Malaysia Madani planning, which calls for governance anchored in values rather than solely in technical capacity.

Three concrete ethical frameworks offer practical guidance for Malaysia Madani-aligned AI governance. First, the OECD Principles on AI (Organisation for Economic Co-operation and Development, 2019) provide a

© 2026 by MIP

globally recognized baseline, emphasizing inclusiveness, transparency, accountability, security, and safety, principles that map directly onto the Malaysia Madani values of amanah, ihsan, and rahmah. Second, the European Union's AI Act (European Commission, 2024) introduces a risk-tiered regulatory model that prohibits high-risk AI applications threatening fundamental rights, a model Malaysia could adapt to protect marginalized communities from biased automated decision-making in welfare, employment, and public administration. Third, UNESCO's Recommendation on the Ethics of AI (2021) explicitly calls for culturally sensitive governance of AI, recognizing that diverse societies require context-specific ethical frameworks, a principle wholly consistent with Malaysia Madani's emphasis on respect (ihsan) and balance (wasatiyyah). Drawing on these frameworks, Malaysia could develop a National Malaysia Madani AI Ethics Charter that mandates algorithmic transparency, community impact assessments, and independent oversight bodies for high-stakes AI applications.

Ethical interventions extend beyond regulatory compliance to embedding kelestarian or sustainability in long-term digital policies, ensuring that environmental and social consequences of AI adoption are fully anticipated and mitigated. Kemakmuran or prosperity requires that AI be harnessed to reduce inequality rather than exacerbate it, with ethical frameworks guiding resource allocation, access to digital infrastructure, and protection of vulnerable communities. The Malaysia Madani emphasis on daya cipta or innovation reinforces that ethical responsibility should not stifle creativity but instead inspire solutions that are socially responsive and morally grounded. Taken together, these ethical interventions illustrate how Malaysia Madani values can be translated into a practical normative framework for AI governance that safeguards community well-being while enabling innovation.

Table 1: Synthesis of Results and Malaysia Madani Values in AI Governance

Theme	Focus	Integration with Malaysia Madani Values
Well-Being Indicators	Developing multidimensional tools to measure AI's societal impact on communities	Sustainability: Measure environmental footprint of AI adoption. Prosperity: Assess equitable distribution of economic benefits. Innovation: Track socially relevant technological contributions. Respect: Safeguard cultural and religious diversity in evaluation. Trust: Ensure transparency and accountability in measurement.

Theme	Focus	Integration with Malaysia Madani Values
		Compassion: Include indicators on welfare, healthcare, and social protection.
Community-Based Approaches	Engaging citizens and communities in AI design, development, and governance	Sustainability: Foster local roles in environmental monitoring and smart agriculture. Prosperity: Promote digital cooperatives and inclusive entrepreneurship. Innovation: Co-create solutions for education, health, and cultural preservation. Respect: Protect diversity through participatory design. Trust: Build oversight mechanisms with citizen input. Compassion: Design AI for healthcare, welfare, and disaster relief.
Ethical Interventions	Embedding moral values into regulatory and governance frameworks	Sustainability: Align AI policy with long-term ecological and social goals. Prosperity: Use AI to reduce inequality, not widen gaps. Innovation: Encourage creative yet ethically grounded AI applications. Respect: Prevent algorithmic bias against cultural and religious identities. Trust: Strengthen transparency, accountability, and integrity in governance. Compassion: Prioritize public good, welfare services, and inclusive protection.

CONCLUSION

This study has examined the integration of artificial intelligence (AI) into governance through the normative framework of Malaysia Madani. By focusing on well-being indicators, community-based approaches, and ethical interventions, the analysis demonstrates that technological innovation cannot be meaningfully pursued without anchoring it in values that safeguard human dignity and collective resilience. The six pillars of Malaysia Madani, namely sustainability (kelestarian), prosperity (kemakmuran), innovation (daya cipta), respect (ihsan), trust (amanah), and compassion (rahmah), provide both conceptual clarity and practical guidance for evaluating AI's societal impact.

© 2026 by MIP

Together, they offer a framework that moves beyond efficiency and competitiveness, situating AI within a broader moral and cultural horizon.

The findings underscore that Malaysia is uniquely positioned to pioneer a value-driven model of AI governance, one that balances technological advancement with the preservation of social cohesion and ethical responsibility. In this sense, Malaysia Madani planning in the era of AI is not only a national strategy but also a potential contribution to global debates on how to align innovation with the pursuit of human and community well-being.

Several directions for future research emerge from this study. First, empirical research employing mixed-methods designs, combining community surveys, policy evaluations, and longitudinal data, would help validate and refine the Malaysia Madani AI Impact Framework proposed here. Second, comparative studies examining how other Muslim-majority nations integrate faith-based governance principles into digital policy could illuminate both the universality and contextual specificity of the Malaysia Madani approach. Third, participatory action research engaging marginalized communities, including rural populations, the urban poor, and persons with disabilities, would ground future frameworks in lived experience rather than policy discourse alone. Finally, the development of standardized, measurable well-being indicators aligned with the six Malaysia Madani pillars represents a pressing practical priority for researchers, planners, and policymakers working at the intersection of AI governance and sustainable development.

ACKNOWLEDGEMENT

The author expresses sincere thanks to the Research Interest Group (RIG): Centre for Fundamental and Continuing Education, Universiti Malaysia Terengganu, Malaysia

REFERENCES

Agarwal, A., & Nene, M. J. (2025). A five-layer framework for AI governance: Integrating regulation, standards, and certification. *Transforming Government: People, Process and Policy, 19*(3), 535–555. https://doi.org/10.1108/TG-03-2025-0065

Ávila-Robinson, A., Miyashita, S., & Sengoku, S. (2025). Ethical and social issues in research and technology development. In O. J. Montiel Méndez, L. D. C. Álvarez-Castañón, & J. Jasso (Eds.), *Technology and innovation in Latin America* (pp. 133–154). Emerald Publishing Limited. https://doi.org/10.1108/978-1-83797-747-520251008

Awashreh, R. (2025). AI for urban innovation in developing cities. In M. A. Abdelmottlep (Ed.), *Advances in computational intelligence and robotics* (pp. 263–290). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3373-0245-4.ch011

Balaraman, R. A., Mukhiar, S. N. S., & Rahman, N. A. A. (2024). Citizen environmental communication. In M. S. M. Saleh, S. A. A. Kasuma, & H. Miao (Eds.), *Multi-stakeholder contribution in Asian environmental communication* (1st ed., pp. 173–186). Routledge. https://doi.org/10.4324/9781032670508-18

Bono Rossello, N., Simonofski, A., & Castiaux, A. (2025). Artificial intelligence for digital citizen participation: Design principles for a collective intelligence architecture. *Government Information Quarterly, 42*(2), 102020. https://doi.org/10.1016/j.giq.2025.102020

Bushuyev, S., Chumachenko, I., Galkin, A., Bushuiev, D., & Dotsenko, N. (2025). Sustainable development projects implementing in BANI environment based on AI tools. *Sustainability, 17*(6), 2607. https://doi.org/10.3390/su17062607

Cardoso, P. J. S., & Rodrigues, J. M. F. (2025). Human-centered AI in placemaking: A review of technologies, practices, and impacts. *Applied Sciences, 15*(17), 9245. https://doi.org/10.3390/app15179245

Cowls, J., & Floridi, L. (2018). Prolegomena to a white paper on an ethical framework for a good AI society. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3198583

d'Elia, A., Gabbay, M., Rodgers, S., Kierans, C., Jones, E., Durrani, I., Thomas, A., & Frith, L. (2022). Artificial intelligence and health inequities in primary care: A systematic scoping review and framework. *Family Medicine and Community Health, 10*(Suppl 1), e001670. https://doi.org/10.1136/fmch-2022-001670

Embong, A. H., Ghazaly, M. M., Yasin, M. F. M., & Rahman, B. A. (2023). Covid-19 pandemic implications on Quran subjects at primary school in Malaysia: A new solution based on 3T Quranic basic module. *Journal of Higher Education Theory and Practice, 23*(3), 99–110. https://doi.org/10.33423/jhetp.v23i3.5842

Embong, A. H., Rahman, A. H. A., Kadir, F. K. A., Khairuldin, W. M. K. F. W., Shahrani, S. S., & Karim, M. R. A. (2022). A research design based on the framework of tafseer al-fiqhiy (Quranic juristic commentary). *Academic Journal of Interdisciplinary Studies, 11*(2), 391–412. https://doi.org/10.36941/ajis-2022-0060

Embong, A. H., Rahman, A. H. A., Kadir, F. K. A., Salamun, H., Mutalib, N. A., & Mokhtar, W. K. A. W. (2024). Contemporary employment jurisprudence: An analysis on the aspects of belief, sharia, and morality. *Revista Juridica, 2*(78), 495–511. https://doi.org/10.26668/revistajur.2316-753X.v2i78.6868

European Commission. (2024). *Artificial intelligence act*. Official Journal of the European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401689

Gharaibeh, A. A., Al-Rabee', M. S., & Obeidat, R. (2025). Integrating artificial neural networks and neighborhood analysis for enhanced urban growth prediction. *Journal of Urban Management*. https://doi.org/10.1016/j.jum.2025.04.010

Gharibi, M., Zachariah, A., & Rao, P. (2020). FoodKG: A tool to enrich knowledge graphs using machine learning techniques. *Frontiers in Big Data, 3*, 12. https://doi.org/10.3389/fdata.2020.00012

Goodman, E. P., & Powles, J. (2019). Urbanism under Google: Lessons from Sidewalk Toronto. *Fordham Law Review, 88*, 457.

© 2026 by MIP

GovTech Singapore. (2023). *National AI strategy 2.0*. Government Technology Agency of Singapore. https://www.smartnation.gov.sg/nais/

Hamzah, M. H. I., Othman, M. F., Mohd Zin, N. A., Sahid, M. Z., Ab. Aziz, M. F., & Abd Ishak, S. (2025). A conceptual model for sustainable intelligent systems in Malaysian MSMEs. *International Journal of Basic and Applied Sciences, 14*(2), 288–295. https://doi.org/10.14419/7qbx1p19

Husain, R., Wahab, N. A., & De Gracious, M. S. (2022). A literature review of the available artificial intelligence (AI) technology to assist in greening the Malaysian automotive industry. *020008*. https://doi.org/10.1063/5.0120583

Iskandah, M. F. B., Kamrin, R. S. H. R., Abdullah, I. H. T., Mohamad, W. M. F. W., & Ahmad, M. M. A. (2025a). Balancing human ideals in developing ihsan of Malaysia Madani. In E. AlDhaen, A. Braganza, A. Hamdan, & W. Chen (Eds.), *Business sustainability with artificial intelligence (AI): Challenges and opportunities* (Vol. 568, pp. 579–586). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-71526-6_50

Iskandah, M. F. B., Kamrin, R. S. H. R., Abdullah, I. H. T., Mohamad, W. M. F. W., & Ahmad, M. M. A. (2025b). Balancing human ideals in developing ihsan of Malaysia Madani. In E. AlDhaen, A. Braganza, A. Hamdan, & W. Chen (Eds.), *Business sustainability with artificial intelligence (AI): Challenges and opportunities* (Vol. 568, pp. 579–586). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-71526-6_50

Jogarao, M., Lakshmanna, B. C., & Naidu, S. T. (2024). AI-enabled circular economy management for sustainable smart cities. In V. Kandpal, E. D. Santibanez-Gonzalez, P. Chatterjee, & M. K. Nallapaneni (Eds.), *Smart cities and circular economy* (pp. 83–96). Emerald Publishing Limited. https://doi.org/10.1108/978-1-83797-957-820241008

Kaplan, A., & Haelein, M. (2018). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons, 62*(1), 15–25. https://doi.org/10.1016/j.bushor.2018.08.004

Khairuldin, W. M. K. F. W., Anas, W. N. I. W. N., Embong, A. H., Hassan, S. A., Hanapi, M. S., & Ismail, D. (2019). Ethics of mufti in the declaration of fatwa according to Islam. *Journal of Legal, Ethical and Regulatory Issues, 22*(5), 1–6. https://www.abacademies.org/articles/ethics-of-mufti-in-the-declaration-of-fatwa-according-to-islam-8706.html

Khairuldin, W. M. K. F. W., Anas, W. N. I. W. N., Mohamad, M. Z., Embong, A. H., & Mokhtar, W. K. A. W. (2021). The role of Prophet Muhammad S.A.W in educating children and its applications to prevent gadget addiction among children. *International Journal of Early Childhood Special Education, 13*(2), 718–722. https://doi.org/10.9756/INT-JECSE/V13I2.211112

Kumar, D., & Suthar, N. (2025). Balancing innovation and regulation: Ethical frameworks for AI policy and governance. In A. Youssef & A. Arslan (Eds.), *Advances in computational intelligence and robotics* (pp. 171–200). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3373-1210-1.ch007

Kumar, G., Vyas, S., Sharma, S. N., & Dehalwar, K. (2025). Urban growth prediction using CA-ANN model and spatial analysis for planning policy in Indore city, India. *GeoJournal, 90*(3), 139. https://doi.org/10.1007/s10708-025-11393-7

Lai, M. K., May, A. Y. C., Tay, L. C., & Lim, K. G. (2025). Re-examining AI adoption antecedents and its potential effect on AI sustained use in small and medium enterprises (SMEs). *PaperASIA, 41*(1b), 292–305. https://doi.org/10.59953/paperasia.v41i1b.337

Lartey, D., & Law, K. M. Y. (2025). Artificial intelligence adoption in urban planning governance: A systematic review of advancements in decision-making, and policy making. *Landscape and Urban Planning, 258*, 105337. https://doi.org/10.1016/j.landurbplan.2025.105337

Mahusin, N., Sallehudin, H., & Satar, N. S. M. (2024). Malaysia public sector challenges of implementation of artificial intelligence (AI). *IEEE Access, 12*, 121035–121051. https://doi.org/10.1109/ACCESS.2024.3448311

Makridakis, S. (2017). The forthcoming artificial intelligence (AI) revolution: Its impact on society and firms. *Futures, 90*, 46–60. https://doi.org/10.1016/j.futures.2017.03.006

Matlamat Pembangunan Mampan (SDGS) dalam Kerangka Malaysia Madani dan Prinsip Maqasid. (2024). *International Journal of Islamic Thought, 25*. https://doi.org/10.24035/ijit.25.2024.294

McGregor, J. A. (2007). Researching wellbeing: From concepts to methodology. In I. Gough & J. A. McGregor (Eds.), *Wellbeing in developing countries: From theory to research* (pp. 316–350). Cambridge University Press.

Mohd Nafi, S. N., Jaganathan, M., & Zainol Abidin, M. A. (2021). Public–private partnership and social innovation in Malaysia. In B. S. Sergi & A. R. Jaaffar (Eds.), *Modeling economic growth in contemporary Malaysia* (pp. 177–189). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80043-806-420211014

Musikanski, L., Bhatt, C., Rakova, B., Sobel, P., Hollander, M., & Sherwood, J. (2020). Artificial intelligence and community well-being: A proposal for an emerging area of research. *Informatics, 7*(1), 10. https://doi.org/10.3390/informatics7010010

Nasir, K., Zaman, R. K., & Ahmad, K. A. (2024). Gagasan Malaysia Madani: Analisis korelasi enam nilai teras ketamadunan daripada kisah Nabi Sulayman (as) dalam surah al-Naml. *Al-Bayan: Journal of Qur'an and Hadith Studies, 22*(2), 291–317. https://doi.org/10.1163/22321969-20240154

Nizamani, M. M., Qureshi, S., Tarashkar, M., Zhang, H.-L., Zhou, Q., & Lai, Z. (2025). Ethical AI: Human-centered approaches for adaptive and sustainable urban planning and policy. *Land Use Policy, 157*, 107650. https://doi.org/10.1016/j.landusepol.2025.107650

Organisation for Economic Co-operation and Development. (2019). *OECD framework for measuring well-being and progress*. OECD Publishing. https://doi.org/10.1787/9789264307292-en

Palakurti, N. R. (2024). Obstacles and resolutions. In P. Whig, P. Sharma, N. Aneja, A. A. Elngar, & N. Silva (Eds.), *Artificial intelligence and machine learning for sustainable development* (1st ed., pp. 1–18). CRC Press. https://doi.org/10.1201/9781003497189-1

© 2026 by MIP

Pan, Y. (2016). Heading toward artificial intelligence 2.0. *Engineering, 2*(4), 409–413. https://doi.org/10.1016/J.ENG.2016.04.018

Panteli, D., Adib, K., Buttigieg, S., Goiana-da-Silva, F., Ladewig, K., Azzopardi-Muscat, N., Figueras, J., Novillo-Ortiz, D., & McKee, M. (2025). Artificial intelligence in public health: Promises, challenges, and an agenda for policy makers and public health institutions. *The Lancet Public Health, 10*(5), e428–e432. https://doi.org/10.1016/S2468-2667(25)00036-2

Phillips, R., & Wong, C. (Eds.). (2017). *Handbook of community well-being research*. Springer.

Roy, A. (2021). The responsible innovation framework: A framework for integrating trust and delight into technology innovation. *Hawaii International Conference on System Sciences*. https://doi.org/10.24251/HICSS.2021.126

Samsurijan, M. S., Ebekozien, A., Nor Azazi, N. A., Shaed, M. M., & Radin Badaruddin, R. F. (2024). Artificial intelligence in urban services in Malaysia: A review. *PSU Research Review, 8*(2), 321–340. https://doi.org/10.1108/PRR-07-2021-0034

Sanchez, T. W., Brenman, M., & Ye, X. (2025). The ethical concerns of artificial intelligence in urban planning. *Journal of the American Planning Association, 91*(2), 294–307. https://doi.org/10.1080/01944363.2024.2355305

Setiawan, A. D. (2020). The influence of national culture on responsible innovation: A case of CO2 utilisation in Indonesia. *Technology in Society, 62*, 101306. https://doi.org/10.1016/j.techsoc.2020.101306

Shuid, S., & Mohd Zamin, M. F. (2018). Maqasid al-syariah & human well-being: A study on Melaka's public housing. *Planning Malaysia, 16*. https://doi.org/10.21837/pm.v16i6.478

Sualman, I. (2025). The perception and understanding of Malaysia Madani's core values. In E. AlDhaen, A. Braganza, A. Hamdan, & W. Chen (Eds.), *Business sustainability with artificial intelligence (AI): Challenges and opportunities* (Vol. 568, pp. 417–426). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-71526-6_36

Tong, S., & Li, S. (2024). Explainable artificial intelligence for urban planning: Challenges, solutions, and future trends from a new perspective. *International Journal of Advanced Computer Science and Applications, 15*(7). https://doi.org/10.14569/IJACSA.2024.0150777

Tornero-Costa, R., Martinez-Millana, A., Azzopardi-Muscat, N., Lazeri, L., Traver, V., & Novillo-Ortiz, D. (2023). Methodological and quality flaws in the use of artificial intelligence in mental health research: Systematic review. *JMIR Mental Health, 10*, e42045. https://doi.org/10.2196/42045

UNESCO. (2021). *Recommendation on the ethics of artificial intelligence*. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000380455

Van Der Maden, W., Lomas, D., & Hekkert, P. (2023). A framework for designing AI systems that support community wellbeing. *Frontiers in Psychology, 13*, 1011883. https://doi.org/10.3389/fpsyg.2022.1011883

Wan Mokhtar, W. K. A., Ibrahim, M. N. A., Jubba, H., Qudsy, S. Z., & Embong, A. H. (2025). Developing Malaysia Madani: The impact of gender and student origin

(urban vs. rural) on leadership, citizenship, and democratization in Malaysian universities. *Planning Malaysia, 23*. https://doi.org/10.21837/pm.v23i36.1736

Wang, F.-Y. (2012). A big-bang for intelligence and a new axial age. *IEEE Intelligent Systems, 27*(6), 2–4. https://doi.org/10.1109/MIS.2012.115

Yan, F., & Qi, X. (2024). Application and prospect of artificial intelligence technology in low-carbon cities. *Land, 13*(11), 1834. https://doi.org/10.3390/land13111834

Yap, S. N. (2025). AI governance for sustainable development: Lessons for Malaysia from the EU AI act. In F. Ghazali & S. F. A. Shukor (Eds.), *Integrating legal compliance with sustainable development goals* (pp. 327–354). IGI Global. https://doi.org/10.4018/979-8-3373-1792-2.ch011

Zakaria, N., & Long, A. S. (2024). Malaysia Madani dan agenda pembangunan nasional: Satu analisis wacana. *Jurnal Pengajian Melayu, 35*(1), 1–22.

Received: 28th October 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 80 – 95

WAQF-BACKED URBAN REGENERATION IN KUALA TERENGGANU, MALAYSIA: A *TAYYIB* APPROACH TO HOUSING AND COMMUNITY WELL-BEING

Nadhirah Nordin[1,2], Muhammad Ridhwan Ab. Aziz[3], Azhar Alam[4], Ririn Tri Ratnasari[5], Aam Slamet Rusydiana[6]

[1]*Islamic Social Finance Research Centre (ISF),*
[2]*Faculty of Islamic Contemporary Studies,*
UNIVERSITI SULTAN ZAINAL ABIDIN
[3]*Faculty of Economics and Muamalat,*
UNIVERSITI SAINS ISLAM MALAYSIA
[4]*Department of Islamic Economic Laws,*
UNIVERSITAS MUHAMMADIYAH SURAKARTA
[5]*Faculty of Economics and Business,*
UNIVERSITAS AIRLANGGA
[6]*Faculty of Political Sciences,*
SAKARYA UNIVERSITY

Abstract

The chronic lack of affordable housing and the poor utilisation of waqf land in Malaysia are the reasons why a holistic and more ethical view on sustainable urban regeneration is needed. In terms of Islam, financing and development can be guaranteed to be free of such aspects as riba (usury), gharar (excessive uncertainty), and haram activities. Nevertheless, tayyib is not only associated with legal adherence but also with justice, fairness, ecological purity, safety, and the welfare of the populace. This paper will formulate and operationalise a tayyib-based framework of waqf-based urban regeneration in Kuala Terengganu through the creation of the Tayyib Urban Indicator Set (TUIS) as an indicator of affordability, environmental quality, safety, and social well-being. The study also suggests design protocols to be used in housing and community facilities design, ethical financing systems to be used, which refer to cash waqf and waqf-linked sukuk, through a qualitative exploratory method that incorporates a document analysis with expert interviews. The results show that the implementation of tayyib values encourages inclusivity, equity, and sustainability by integrating urban regeneration with the spiritual and moral purpose of the maqasid al-shariah. Moreover, the hybrid financing option increases affordability and perpetually protects waqf resources under open governance. The example of the application of the TUIS in Kuala Terengganu shows that tayyib-oriented regeneration does not only correspond to shariah-compliant standards but also to the promotion of social justice, ecological balance, and the well-being of citizens in the long term.

Keywords: waqf, urban regeneration, tayyib, housing, maqasid al-shariah

[1] Corresponding author. Email: nadhirahnordin@unisza.edu.my

INTRODUCTION

Malaysia has also been struggling to offer affordable and sustainable housing, especially in urban areas like Kuala Terengganu, where land is scarce and socio-economic inequalities exacerbate the pressures of development (Roslan, Gohain, Mustafa, Ismail, & Kumaran, 2025). Increased housing prices have greatly exceeded the rate of income increase, and now most households live in financial insecurity. In this framework, the concept of *waqf* land as an everlasting endowment will provide a tactical tool to minimize expenditures and enhance equity since the land value will no longer be associated with housing costs. Recent reports suggest that *waqf*-supported housing would make housing more affordable and more resilient due to the inclusion of shared facilities and social infrastructure (Rochani, Yuliastuti, and Sudarwanto, 2022; Priyadi, Achiria, Imron, and Zandi, 2022).

Urban regeneration in this study refers to the revitalisation of underutilised areas to make them liveable, equitable, and sustainable. From an Islamic perspective, ḥalal ensures that financing and contracts avoid riba (usury), *gharar* (excessive uncertainty), and ḥaram activities, while *tayyib* extends this framework by emphasising justice, fairness, ecological purity, safety, and social welfare. A project may therefore be technically halal, but it only becomes *ṭayyib* when it ensures fair pricing, adequate green spaces, and long-term community well-being. In this study, *ṭayyib* refers to the ethical dimension of development that emphasises goodness, wholesomeness, and societal benefit, while *maqasid al-shariah* represents the higher objectives of Islamic law aimed at safeguarding religion, life, intellect, lineage, and wealth (Nordin et al., 2024).

Nevertheless, the potential of the *waqf* housing initiatives is impeded by the conventional financing and planning models (Rahim, Rathore, Rabbani, & Alam, 2024). This study proposes a ṭayyib-based framework for *waqf*-backed urban regeneration in Kuala Terengganu through the development of the Tayyib Urban Indicator Set (TUIS). The framework integrates affordability, environmental quality, safety, and social well-being indicators with ethical financing mechanisms such as cash *waqf* and *waqf*-linked sukuk to align urban development with *maqasid al-shariah* objectives.

LITERATURE REVIEW

Conceptual Foundations of Urban Regeneration

Urban regeneration is, therefore, a multidimensional process that seeks to resolve economic, physical, social, and environmental issues through an integrated approach. Basic theoretical models, such as the four-element model, which consists of government, market, society, and spatial reproduction, emphasise the significance of co-governance and interdisciplinary approaches to urban regeneration (Liu, 2022). The circular economy, which is based on reusing

© 2026 by MIP

heritage sites and brownfields, is an underlying principle that seeks to promote sustainability and improve the resilience of cities.

The scope of urban regeneration has also changed over time, moving away from the mere redevelopment of cities and focusing more on improving the quality of life, with particular emphasis on the conservation of heritage sites, ensuring social inclusion, and encouraging community participation (Cerreta & La Rocca, 2021). Thus, the theme of participatory governance and sustainability, with the aim of improving accessibility, reducing energy poverty, and increasing environmental sustainability, is still predominant, and this is in line with the principles of sustainable regeneration, which is a multidimensional concept involving the regeneration of the physical, economic, and social infrastructures of cities, with particular emphasis on the development of community indicators (Nik Hashim et al., 2023). This underpins the need for an operative perspective, to ensure the application of principles to planning standards.

Waqf and Its Role in Urban Development and Housing

Waqf has been instrumental in maintaining community infrastructure, ranging from cash *waqf* in Ottoman times, which funded educational and health institutions, to current forms in Indonesia that promote community ownership and productivity (Korkut, 2024; Rochani, Yuliastuti, & Sudarwanto, 2022). In Malaysia, housing projects such as Taman Salehuddin Telok Chengai have proven the financial viability of *waqf*-based housing for developers, local authorities, and the community at large (Baharudin et al., 2025). *Waqf* management is, therefore, crucial for fully exploiting its potential. The integration of modern financial systems, such as FinTech and green infrastructure, into *waqf* is likely to improve its efficiency and sustainability (Mohamed & Akande, 2025). *Waqf* is important for meeting basic needs, fighting poverty, and preserving cultural heritage, which makes it an important tool for equitable and sustainable development. This is supported by current research, which indicates that affordable *waqf*-based housing requires innovative governance and social integration to meet current demands for development (Nor Azizan Che Embi et al., 2021; Hassan et al., 2021). This potential, however, can be fully harnessed by improving transparency in governance, finance, and performance, which must be grounded in practice. In Malaysia, this is further complicated by institutional arrangements between State Islamic Religious Councils, local authorities, and developers, as well as regulatory procedures for *waqf* land administration and development approvals.

The *Tayyib* Framework and *Maqasid al-shariah* in the Built Environment

While ḥalal sets legal boundaries, *tayyib* extends to qualitative values of goodness, purity, and wholesomeness, making it relevant to housing and

community design. In line with *maqasid al-shariah*, (favoring religion, life, intellect, lineage, and property), the *tayyib* offers an ethical basis of sustainable planning (Jaiyeoba et al., 2025). *Maqasid*-based liveability indices, eco-*maqasid* strategies of climate change, and innovative projects such as the Islamic Energy Garden can be used (Idris et al., 2025). Irrespective of these developments, there are gaps in creating standard approaches and empirical verification, particularly on long-term effects on well-being and environmental sustainability. It is natural to conclude that it is necessary to convert the ethical precepts into signs that can be tested and reproduced within any situation to accomplish the logical transition of principle to practice.

Ethical and Innovative Financing Mechanisms for *Waqf* Projects

To solve the liquidity problems of the development of *waqf* it is necessary to adopt new financing tools like crowdfunding cash *waqf*, *waqf*-based sukuk, cooperative housing models (WCHF), and Islamic Real Estate Investment Trusts (I-REITs) (Ismail et al., 2024; Khan et al., 2023). These instruments draw on under-utilised *waqf* resources, create more transparency, lessen reliance on government resources, and prompt job creation and access to affordable housing. The issues of ethics continue to take center stage, and the strict follow-up of shariah principles and the focus on accountability are observed (Abidah et al., 2025). The models, such as CWLS and I-REITs, illustrate the way in which the waqf may be in harmony with SDGs through funding inclusive and sustainable projects. Nevertheless, the issue of governance and people's participation is a continuous problem, which needs more institutional structures to achieve its full potential (Qadri et al., 2024). Finally, the effectiveness of implementing these mechanisms depends on institutional capacity and developing the image of public legitimacy, which are discussed more in the analysis.

Housing, Community Amenities and Social Well-Being

Affordable housing contributes to social stability, community cohesion, and quality of life. Empirical studies also demonstrate that access to green spaces, neighbourhood facilities, and social infrastructure significantly influences residents' well-being and social inclusion (Gallent, 2023; Liu et al., 2019; Williams et al., 2020). These findings highlight the importance of integrating housing provision with place-based indicators that link the built environment with broader social outcomes.

Research Gaps in *Waqf-Backed* Urban Regeneration

Existing studies highlight limited exploration of *waqf* applications in green infrastructure and sustainable building, as well as insufficient performance metrics for digital *waqf* platforms (Mohamed & Akande, 2025). Similarly, design

© 2026 by MIP

frameworks such as WCHF show potential but lack generalizability across different contexts (Khan et al., 2023). Innovations, such as blockchain and CWLS, have enhanced the transparency on the financing side, but still, there are gaps in governance and participation (Jafar et al., 2025). The additional multidisciplinary studies are necessary to improve the ability of *waqf* as a value-based model in accordance with SDGs, integrating sustainable finance, digital innovation, and urban planning to develop more comprehensive regeneration strategies (Budalamah et al., 2019). It is against this context that the current research opts to use a qualitative case study design in coming up with and testing *tayyib*-compliant indicators and financing procedures on *waqf*-supported urban regeneration.

RESEARCH METHODOLOGY

This part gives the design, sampling, data collection, data coding, and credibility checks. The paper uses a qualitative and exploratory design (Creswell, 2014) to create and operationalise a *tayyib*-oriented approach to *waqf*-supported city regeneration in Kuala Terengganu, Malaysia. The *waqf* land at Kampung Banggol Peradong was chosen because it was a legally clear case with a scale and zoning as residential land by the Department of Town and Country Planning (JPBD), which is in line with the argument of the case study research to investigate contextual complexities (Yin, 2018). The location, which consists of 74 endowed lots of which 37 are already developed into terrace houses, places the *Tayyib* Urban Indicator Set (TUIS) in the real-world situation and offers a testbed to determine spatial equity and financial well-being.

Primary data were collected through document analysis and semi-structured interviews. Document analysis included classical and contemporary works on maqasid al-shariah, *waqf* development, urban regeneration, planning policies, and ethical financing. Two purposively selected interviewees contributed practical insights: a senior officer from the Terengganu State Islamic Religious Council (MAIDAM), responsible for *waqf* governance, and an academic expert in Islamic finance specialising in *waqf*-linked instruments. The participants were sampled using criterion-based purposive sampling, ensuring that both the perspectives of regulators and instrument designers were included. The limited number of interview participants reflects a purposive strategy designed to capture institutional governance and financial-instrument perspectives rather than statistical representation, which is consistent with exploratory qualitative case-study research.

The interviews were conducted online and transcribed verbatim for analysis with the documents. The transcripts were subject to participant verification, and discrepancies were managed using adjudication, as recommended, with an audit trail recorded. Secondary statistical data for the

location of Kuala Terengganu were consulted as context for the issues of affordability and accessibility of services. The coding involved both open and axial coding to identify themes, with iterative comparison and categorisation as recommended by Miles, Huberman, and Saldaña (2014) for improved reliability.

The results were clustered into three categories: waqf asset maps and utilisation, TUIS development, and ethical finance and housing protocol development. The limitations of the study include the small number of interviewees and the single case study, which may impact generalizability and representativeness, although this was managed by using triangulation with document analysis and connecting the results with theoretical frameworks as recommended by Creswell (2014) and Yin (2018).

ANALYSIS AND DISCUSSION

Operationalising *Tayyib* through the TUIS Framework

The concept of *tayyib* is operationalised in this study through the *Tayyib* Urban Indicator Set (TUIS), which establishes measurable indicators for evaluating urban regeneration outcomes. The framework translates Islamic ethical principles into planning standards covering affordability, environmental quality, safety, and social well-being, while aligning these indicators with the objectives of *maqasid al-shariah*. By linking ethical values with quantifiable planning metrics, TUIS provides a practical evaluative tool for policymakers, planners, and waqf administrators.

All dimensions of the TUIS scale are pegged on quantifiable proxies that convert the values into tangible planning norms. The concept of affordability is evaluated based on the housing price-to-income ratio, which makes it fair and equally accessible to housing (Dali et al., 2018). Environmental quality is measured using such indicators as minimum threshold of green space and rainwater harvesting, which strengthen the ecological equilibrium and the health of the population (Azmin Shompa et al., 2025). Safety is associated with access to healthcare and safe walking, which guarantees the safeguarding of life. Social well-being covers family unity, cognitive development, and spirituality, which are described by levels of satisfaction, schools, and mosques.

The National Property Information Centre (NAPIC, 2023) also reports that the urgency of the implementation of the TUIS framework is especially high in Kuala Terengganu, where the housing price to income ratio is 5.1, which is much higher than the affordability level of 3.0. Ratios above 5.0 are generally classified as severely unaffordable in international housing affordability benchmarks, highlighting the structural housing pressure faced by urban households. The interviews with experts in Islamic finance revealed that the regeneration based on *tayyib* needs financial honesty and spiritual responsibility. He also stressed that the religious security (*hifz al-din*) should be given priority

© 2026 by MIP

over material benefits in the development of housing (Ishak, 2025). On the same note, an official of the MAIDAM emphasised that just as stipulated in the Terengganu *Waqf* Enactment 2016, it is important to carry out transparent mapping and valuation of *waqf* assets to maintain justice and the community trust (Mohamad, 2025). All these revelations underline the fact that integrity and transparency are at the heart of seeing that *waqf*-based residential developments reflect both moral and social goals desired by the *tayyib* concept.

Table 1: Alignment of TUIS Indicators with *Tayyib* Values, Measurement Metrics, and *Maqasid* Outcomes

Urban Indicator (TUIS)	***Tayyib* Value**	**Measurement/Proxy**	***Maqasid* Outcome**
Affordability	Fairness & equity in economic access	Housing cost-to-income ratio	*Hifz al-Mal* (Preservation of Wealth)
Environmental Quality	Ecological purity & sustainability	≥10 m² green space per capita; Rainwater systems	*Hifz al-Nafs* (Preservation of Life)
Safety	Secure and healthy living	Access to clinics; Safe pedestrian pathways	*Hifz al-Nafs* (Preservation of Life)
Social Well-being (Family)	Social integrity & cohesion	Community satisfaction index	*Hifz al-Nasl* (Preservation of Lineage)
Social Well-being (Intellect)	Wholesomeness in knowledge	Access to schools, libraries, cultural centers	*Hifz al-ʿAql* (Preservation of Intellect)
Social Well-being (Spiritual)	Ethical-spiritual enrichment	Access to mosques and religious facilities	*Hifz al-din* (Preservation of Religion)

Source: Author's synthesis based on maqāṣid al-sharīʿah dimensions and tayyib principles adapted from Dali et al. (2018), Nordin et al. (2024), and interviews (2025).

Table 1 presents the practicality of the Islamic ethical principles in the field of urban planning. This framework offers the possibility of a strict instrument of balancing between the ethical demands and the practicality of the field by transforming the abstract values of justice, environmental purity, and spiritual integrity into quantifiable measures such as expense rates, green spaces, or the provision of religious facilities. This presents the possibility of TUIS rebranding the concept of urban regeneration in a more useful scale, instead of technical efficiency, to an economically viable concept that is also socially equitable, environmentally responsible, and spiritually complete.

Translating *Tayyib* Values into Housing and Community Design

The introduction of *ṭayyib* values into the design protocols ensures that the housing projects will not simply comply with the shariah but also provide a quality of life. Unlike the ḥalal compliance, which focuses on escaping the impermissible elements, including riba and *gharar*, a design framework that pays attention to *ṭayyib* considers fair pricing, environmental custodianship, social unity, and holistic well-being (Nordin et al., 2024). Housing that is poorly planned and is profit-driven tends to overlook these dimensions. A *tayyib*-based approach, in contrast, is a conscious incorporation of human-centred and ecological values, which is found in the human-housing and eco-housing orientations observed in the international settings (UN-Habitat, 2022).

These values are converted into design standards in the form of concrete protocols. Sensible plans, e.g., cross-ventilation, minimise energy reliance and enhance health within the building. The solar panels and harvesting of rainwater can guarantee equitable availability of cheap utilities, and the reduction of flooding and wastage, respectively (Haupt, 2019). Pocket parks and shared spaces, which promote cohesion (Zhao et al., 2025), schools and cultural centres, which contribute to intellectual development (Chong, 2024), and mosques, which run on renewable energy, contribute to community well-being. These actions are a combination of ecological and human-focused principles, which boost *maqasid* objectives in housing design.

Even though it has potential opportunities, issues like rising construction costs and insufficient funding are major concerns to implement *ṭayyib* principles within *waqf* housing (Mohamad, 2025). The existing practices are more inclined towards technical and economic issues than social sustainability. Addressing this requires multi-level collaboration: MAIDAM, local authorities, and private developers must integrate *ṭayyib* protocols within statutory planning frameworks such as the Town and Country Planning Act 1976 and the Uniform Building By-Laws 1984. Only through integrated governance can housing projects uphold justice, safety, and sustainability across their life cycle (Mohamad, 2025).

Table 2: *Tayyib*-Based Design Protocols for Housing and Community Facilities

TUIS Indicator	**Design Element**	**Benefits / Rationale**
Affordability (Fairness & Equity)	Solar panels	Reduces energy costs; ensures fair access
Environmental Quality	Rainwater harvesting; pocket parks	Conserves water; mitigates floods; supports ecology
Safety	Cross-ventilated layouts; safe walkways	Improves air quality; enhances physical health
Social Well-being (Family)	Pocket parks; communal facilities	Strengthens cohesion; fosters interaction

© 2026 by MIP

TUIS Indicator	Design Element	Benefits / Rationale
Social Well-being (Intellect)	Schools, libraries, cultural centres	Supports learning and innovation
Social Well-being (Spiritual)	Mosques with renewable energy systems	Combines sustainability with spiritual values

Source: Author's formulation from TUIS framework integrating UN-Habitat (2022), and interviews (2025).

As shown in Table 2, *tayyib*-based design protocols extend the evaluative role of TUIS by embedding ethical values into the physical configuration of housing and community facilities. Each design element, ranging from renewable energy systems and rainwater harvesting to communal parks and mosques serves not only functional and technical purposes but also delivers normative outcomes linked to *maqasid al-shariah*. This integration underscores that ethical housing provision is inseparable from ecological stewardship, social cohesion, and spiritual enrichment, thereby repositioning design practice as an instrument for holistic well-being rather than mere infrastructure delivery. These protocols can be codified as statutory notes and performance conditions to ensure *maqasid* outcomes are delivered in practice rather than deferred, while standard detail libraries, such as cross-ventilation modules and rainwater systems, facilitate replication with local adaptation.

Financing Architecture for *Tayyib*-Based Urban Regeneration

Investing is critical towards putting *tayyib* principles into action. A suitable way out is to create a hybrid model of cash *waqf* coupled with *waqf-linked* sukuk. Cash *waqf* is the seed capital of small-scale facilities like solar panels or parks, whereas sukuk is the capital of larger business investments, like housing. The benefits obtained through rental income and utility savings are used to pay sukuk owners without affecting the ownership of *waqf* assets (Abidah et al., 2025).

The measure of effectiveness cannot be conducted solely on a financial basis, but also on social and environmental KPIs. These consist of the green space per capita, the carbon emission reduction, household bill savings, as well as community satisfaction (Pignatelli et al., 2023). Incorporation of these measures would guarantee that financing models are simple, responsible, and consistent with *maqasid* results. Through this, the ethical financing will avoid riba, *gharar*, and *maysir* and enhance confidence in the Islamic financing mechanisms.

However, as much as these models have great opportunities, the implementation of these models is not without challenges. Such factors as regulatory barriers, stakeholder opposition, and lack of awareness among the general population might limit uptake. The solution to these barriers must be through coordinated efforts, as evidenced by more institutional backing, more consistent regulatory conditions, and more case-specific awareness efforts to create confidence in the community and investor turnout.

There are still difficulties in social perception and adoption. The case of Cash *Waqf* Linked Sukuk (CWLS) in Indonesia shows that the model is viable but also limited because its adoption was sluggish due to low levels of public awareness (Hosen et al., 2022). Digital tools and fintech platforms are also being suggested to widen the participation and enhance transparency (Qadri et al., 2024). In the case of Kuala Terengganu, a hybrid pilot may prove viable through combining cash *waqf*-financed communal facilities with sukuk-financed housing. The case of the Penang Wakaf Seetee Aisah housing project teaches the importance of open governance in achieving social good and yet being financially viable (Mohamad, 2025). This financing structure allocates cash *waqf* to early-stage liquidity and social buy-in and sukuk to construction risks and repayment risks on asset-backed cashflows. In addition to this, covenants can have a KPI dashboard, including green space, carbon offset, affordability, and social return, to ensure that covenants are managed in tandem with results.

Table 3: Ethical Financing Mechanisms for *Waqf* -Backed Urban Regeneration

Financing Mechanism	Application	Benefits / Outcomes
Cash *Waqf*	Funds small-scale amenities	Inclusive, voluntary, risk-buffer capital
Waqf -Linked Sukuk	Finances large-scale housing	Mobilises investment; ensures perpetual asset ownership
Hybrid Cash *Waqf* -Sukuk	Combines both instruments	Balances risk, scale, and sustainability
KPI Monitoring Framework	Green space, carbon reduction, SROI and community well-being	Ensures accountability; aligns with *maqasid* and SDGs

Source: Author's compilation based on ethical financing models from Ismail et al. (2024), Abidah et al. (2025), and interviews (2025).

As summarised in Table 3, the integration of ethical financing mechanisms illustrates how classical Islamic instruments can be reconfigured through contemporary innovation to support sustainable urban regeneration. The hybridisation of cash *waqf* and *waqf*-related sukuk not only leverages various sources of capital but also ensures that transparency, inclusiveness, and sustainability are embedded in the process of financial governance. The KPI and impact monitoring framework, in addition to these tools, ensures that project outcomes comply with the principles of *maqasid al-shariah* and sustainability through environmental and social KPIs such as the provision of green spaces, carbon footprint reduction, and community well-being. This is where the distinction of the proposed financing model, based on the concept of *tayyib*, is evident, as it seeks to strike a balance between the two. The recognition of the

© 2026 by MIP

regulatory, institutional, or societal limitations is evident in the proposed model as a way forward.

Case Illustration: The Banggol Peradong *Waqf* Housing Project in Kuala Terengganu

The Banggol Peradong project is an empirical anchor that is critical in assessing the *tayyib* framework. The land, which comprises 74 lots, was endowed to MAIDAM by Konsortium Perumahan Rakyat Terengganu Sdn. Bhd. with a 99-year leasehold and residential zoning in accordance with Section 200 of the National Land Code. Out of the total, 37 units of terrace houses are built to accommodate the poorest of the poor (*asnaf*) households, while the remaining are kept in reserve for the next phases of development (Mohamad, 2025). This is an example of the clarity in institutional arrangements that are shariah-compliant in perpetuity with corporate *waqf* contributions.

The project implements the main concepts of TUIS. It makes housing affordable with mid-cost housing to reduce risks (*hifz al-mal*). It enhances the well-being of the people by providing clustered housing, which ensures that families are kept together and have access to education, promoting family and mind (*ḥifẓ al-nasl, hifz al-aql*). It also enhances the quality of the environment through the provision of small parks and rainwater harvesting, promoting life (*ḥifẓ al-nafs*). Furthermore, the *waqf* management ensures that the management is based on Shariah principles, promoting the protection of religion (*hifz al-din*) (Mohamad, 2025).

Apart from the strategies, the project also focuses on community integration. According to an Islamic finance expert, waqf housing should not only target the *asnaf* but also integrate with other communities. Integration ensures that the stigma of welfare housing is eliminated, and people from different economic backgrounds can interact with each other, promoting a stronger community. In this regard, the discussion on inclusive housing in the United Kingdom is essential, promoting upward movement while maintaining the dignity and solidarity of disadvantaged groups (Ishak, 2025). Planning regulations on integration would ensure that the *waqf* renewal projects are just and promote social cohesion, in addition to affordability.

Table 4: Alignment of Banggol Peradong Project with TUIS and *Maqasid* Outcomes

TUIS Indicator	Application in Banggol Peradong	***Maqasid* Outcome**
Affordability	Medium-cost homes for *asnaf* households	*Ḥifẓ al-Mal*
Environmental Quality	Integration of pocket parks; rainwater harvesting	*Ḥifẓ al-Nafs*

TUIS Indicator	Application in Banggol Peradong	*Maqasid* Outcome
Safety	Planned pedestrian pathways; access to clinics	*Ḥifẓ al-Nafs*
Social Well-being (Family)	Clustered housing fostering cohesion and resilience	*Ḥifẓ al-Nasl*
Social Well-being (Intellect)	Access to schools and community learning facilities	*Ḥifẓ al-Aql*
Social Well-being (Spiritual)	Governance under perpetual *waqf* and mosque access	*Hifz al-din*

Source: Author's field synthesis from the Banggol Peradong case study (MAIDAM data, 2025) and TUIS framework developed in this study.

As shown in Table 4, the Banggol Peradong project presents empirical evidence of the TUIS framework in action. This project shows the possibility of advancing affordability, environmental quality, safety, and social well-being simultaneously under a waqf governance structure that is perpetually shariah compliant. The application of mixed community principles in the context of the Banggol Peradong project presents a progressive blueprint for sustainable communities. This case exemplifies the possibility of executing *waqf*-backed regeneration as a scalable model for sustainable urban development.

CONCLUSION

This study aims to explore the possibilities for waqf-based urban regeneration in Kuala Terengganu through the application of a *tayyib* approach. *Tayyib* Urban Indicator Set (TUIS) provides tools for measuring affordability, environmental quality, safety, and social well-being, which are then correlated with quantifiable measures and moral imperatives under *maqasid al-shariah*. Design protocols also provide tools for demonstrating how renewable energy, green spaces, and community facilities can be integrated into housing development to support sustainability, inclusivity, and social cohesion. The study reveals that existing conventional *waqf* assets and financial instruments have established basic foundations, but they have limitations in terms of scale and sustainability. New hybrid models of ethical finance, which integrate cash *waqf* and *waqf*-based sukuk, have stronger prospects for sustainability by ensuring perpetual ownership and aligning with *maqasid al-shariah* imperatives.

The Banggol Peradong case is a good example of how a corporate waqf endowment is being converted for the purpose of providing affordable housing with shariah governance, thus validating the applicability of the proposed framework. The incorporation of ethical values with *maqasid* principles and planning protocols enables the development of a useful tool for planning evaluation and assessment. The TUIS framework also has the potential for replication and application in other cities in Malaysia, particularly with *waqf* land

© 2026 by MIP

for housing and community development purposes. Future research should be conducted on the application of the TUIS framework in other cities, *waqf* land, and the application of KPIs for sukuk covenants, as well as the distributional impact of mixed-income integration, which will further enrich the development of cities in Malaysia and the global debate on ethical and value-based approaches to urban development and planning.

REFERENCES

Abidah, A., Asnawi, N., Suprayitno, E., & Zuhriah, E. (2025). The applicability of cash waqf linked sukuk (CWLS) through the Tafriqus Sufqah Al-Khatib Al-Sharbini theory: An approach to Sharia compliance and financial innovation. *Samarah: Jurnal Hukum Keluarga dan Hukum Islam, 9*(2), 1201–1219.

Baharudin, M. H., Yusoff, R. M., Tarmudi, S. M., & Saringat, S. M. (2025). Financial feasibility study of housing development on *waqf* land: A case study of Taman Salahuddin Telok Chengai Alor Star. In *Lecture Notes in Networks and Systems* (pp. 311–324). Springer.

Budalamah, L. H., El-Kholei, A. O., & Al-Jayyousi, O. R. (2019). Harnessing value-based financing for achieving SDGs: Social innovation model for Arab municipalities. *Arab Gulf Journal of Scientific Research, 37*(2), 112–128.

Cerreta, M., & La Rocca, L. (2021). Urban regeneration processes and social impact: A literature review to explore the role of evaluation. In *Lecture Notes in Computer Science* (pp. 143–155). Springer.

Che Embi, N. A., Kassim, S., Ramlee, R., & Wan Husain, W. R. (2021). A proposal for affordable waqf housing projects in Malaysia: Public perception of house characteristics. *Planning Malaysia, 19*(17), 261–269.

Chong, K. H. (2024). *Data-driven smart community design: Strategies for fostering inclusive and resilient neighbourhoods*. Springer.

Cottino, P., Domante, D., & Franchina, A. (2022). Urban regeneration: An "incremental circularity" perspective. In *GeoJournal Library* (pp. 189–207). Springer.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approach* (4th ed.). Sage.

Dali, N. M., Abdullah, A., & Islam, R. (2018). Prioritization of the indicators and sub-indicators of *maqasid al-shariah* in measuring liveability of cities. *International Journal of the Analytic Hierarchy Process, 10*(3), 348–368.

El Basyoni, M. (2011). Revitalization of the role of *waqf* in the field of architecture: Activation of *waqf* to improve the function of public buildings. *WIT Transactions on the Built Environment, 118*, 265–272.

Gallent, N. (2023). The contribution of affordable housing to quality of life in rural England. In *Rural Quality of Life* (pp. 55–73). Springer.

Hassan, M. A. M., Alias, A., Mahamood, S. M., & De, F. (2021). Waqf land development approaches and practices in the State Islamic Religious Councils. *Planning Malaysia: Journal of the Malaysian Institute of Planners, 19*(3), 317–325.

Haupt, P. (2019). Energy-water-food synergy possibilities in housing environment. *IOP Conference Series: Materials Science and Engineering, 609*, 042081.

Hosen, M. N., Maulana, A., Farhand, M. Z., & Fudhail Rahman, M. (2022). Evaluating

the fundraising process of the world's first Cash *Waqf*-Linked Sukuk in Indonesia. *Qudus International Journal of Islamic Studies, 10*(1), 175–214.

Idris, M. M., Husini, E. M., Rahman, A. Ab., & Sharkawi, N. (2025). The Islamic Energy Garden (IEG) framework for sustainable living in Malaysian university campuses based on *maqasid shariah*. *International Journal of Islamic Thought, 27*(June), 125–136.

Ishak, M. S. I. (2025). *Interview on the role of maqasid al-shariah and tayyib principles in Islamic urban regeneration*. Kuala Terengganu.

Ismail, M. A. M., Muneeza, A., & Mohsin, M. I. A. (2024). A framework for *waqf*-linked sukuk to develop idle *waqf* land in Malaysia. *Manchester Journal of Transnational Islamic Law and Practice, 20*(2), 77–92.

Jafar, A., Ibrahim, H., & Malik, R. (2025). *Waqf*: From classical charitable system to modern financial tool. *International Journal of Ethics and Systems, 41*(2), 233–250.

Jaiyeoba, H. B., Jamaludin, M. A., Busari, S. A., & Amuda, Y. J. (2025). The implications of *maqasid al-shari'ah* for integrated sustainability practices among businesses: A qualitative inquiry. *Qualitative Research in Financial Markets, 17*(3), 511–531.

Khan, M. K., Abdul Rasid, S. Z., Bardai, B., & Saruchi, S. A. (2023). Framework of affordable cooperative housing through an innovative *waqf-based* source of finance in Karachi. *Journal of Islamic Accounting and Business Research, 14*(6), 881–899.

Khairuldin, W. M. K. F. B. W., Embong, A. H., Hassan, S. A., Yasin, M. F. M., & Anas, W. N. I. W. N. (2019). Strategic management in fatwa-making process. *Academy of Strategic Management Journal, 18*(4), 1–6.

Khairuldin, W. M. K. F. W., Hassan, S. A., Anas, W. N. I. W. N., Mokhtar, W. K. A. W., & Embong, A. H. (2020). Al-Takyif Al-Fiqhi and its application in Islamic research methodology. *Journal of Critical Reviews, 7*(7), 462–467. https://doi.org/10.31838/jcr.07.07.80

Korkut, C. (2024). Effects of cash *waqf* on sustainable economic development in the Balkans during the early modern period. In *Islamic financial institutions from the early modern period to the 20th century*. Routledge.

Liu, Y. (2022). Space reproduction in urban China: Toward a theoretical framework of urban regeneration. *Land, 11*(12), 2341.

Liu, Y., Pan, Z., Feng, J., & Liu, Y. (2019). Factors influencing residents' emotional well-being in the affordable housing communities of China's big city: A case study of Guangzhou. *Tropical Geography, 39*(1), 65–76.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage.

Mohamad, M. R. (2025). *Interview on MAIDAM's governance and challenges in waqf-based urban development*. Kuala Terengganu.

Mohamad, M. Z., Mujani, W. K., Rozali, E. A., Omar, S. H. S., Othman, M. S., Syed Ab. Rahman, S. M. A., Ali, M. S., Ali, E. M. T. E., Yusoff, K., & Hashim, J. (2014). The negative impact of religious pluralism on the Islamic society in Malaysia. *Social Sciences (Pakistan), 9*(3), 153–156. https://doi.org/10.3923/sscience.2014.153.156

Mohamad, M. Z., Noh, N. C., Junid, H. M. L., Khairuldin, W. M. K. F. W., Yusof, S.,

© 2026 by MIP

Idris, M. F. H. M., Latif, F. A., & Anuar, A. (2024a). The importance of Nursi's thought in empowering Muslim identity. *Pakistan Journal of Life and Social Sciences, 22*(2), 518–524. https://doi.org/10.57239/PJLSS-2024-22.1.0037

Mohamad, M. Z., Yusoff, K., Sulaiman, A. A., Ismail, D., Omar, L., Ismail, M. Z., Abdullah, W. I. W., Yaacob, A., Omar, M. C., & Bakar, M. A. (2014). Nursi's unity model and its importance in the context of racial unity in Malaysia. *Mediterranean Journal of Social Sciences, 5*(29), 87–92. https://doi.org/10.5901/mjss.2014.v5n29p87

Mohamed, A., & Akande, A. E. (2025). *Waqf*-led buildings and green infrastructure role in environmental sustainability: Understanding critical gaps in current research landscape. *Management and Sustainability, 13*(2), 45–63.

Mohd Yasin, M. F., Embong, A. H., Khairuldin, W. M. K. F. W., Rahim, A., Sulaiman, R., Dollah, A., Said, S., & Mutalib, N. A. (2018). Contributions of technology towards development of Qur'anic Tajweed knowledge. *International Journal of Civil Engineering and Technology, 9*(6), 1340–1352. Scopus.

Mokhtar, W. K. A. W., Ibrahim, A., Khairuldin, W. M. K. F. W., Embong, A. H., Ali, A. W. M., & Saud, M. (2024). Modeling the student leadership, citizenship, and democratisation in Islamic university in Malaysia. *International Research Journal of Multidisciplinary Scope, 5*(2), 549–563. https://doi.org/10.47857/irjms.2024.v05i02.0572

NAPIC. (2023). *Property market report 2022/2023*. Valuation and Property Services Department, Ministry of Finance Malaysia.

Nik Hashim, N. H., Md. Dali, M., & Alias, A. (2023). Developing sustainable urban regeneration (SUR) evaluation method for the Malaysian context. *Planning Malaysia, 21*(6), 100–115.

Nordin, N., Zaid, A. Z. M., Astutik, A. P., Rashid, N. K. A., Zahari, Z., Ifwat, M. S., Khairuldin, W. M. K. F. W., & Embong, R. (2024). Integrating *tayyib* principles in halal health products and services: A holistic consumerism approach. *Global Journal Al-Thaqafah, 14*(2), 228–239.

Pignatelli, M., Torabi Moghadam, S., Genta, C., & Lombardi, P. (2023). Spatial decision support system for low-carbon sustainable cities development: An interactive storytelling dashboard for the city of Turin. *Sustainable Cities and Society, 89*, 104310.

Priyadi, U., Achiria, S., Imron, M. A., & Zandi, G. R. (2022). *Waqf* management and accountability: *Waqf* land financing models for economic wellbeing. *Asian Economic and Financial Review, 13*(1), 74–84.

Qadri, R. A., Pratama, R. H., Khabibi, A., & Pratama, R. S. (2024). Refining the cash-*waqf* blended finance model for infrastructure development. *Management and Accounting Review, 23*(1), 77–95.

Rahim, R., Rathore, H. S., Rabbani, M. R., & Alam, M. N. (2024). *Maqasid al-shariah* and green finance: A theoretical framework on Islamic finance with Sustainable Development Goals for a greener future. In *2024 International Conference on Sustainable Islamic Business and Finance (SIBF)* (pp. 255–261).

Rochani, A., Yuliastuti, N., & Sudarwanto, B. (2022). Sustainable urban communities: Territoriality of *waqf*-based communal place in Kampong Cities. *IOP Conference Series: Earth and Environmental Science, 1098*(1), 012073.

Roslan, S. N. M., Gohain, K., Mustafa, A. M. A. A., Ismail, M. M., & Kumaran, V. V. (2025). Designing affordable urban ecosystems: A quantitative model to enhance the quality of life for the urban poor in Malaysia through employment, housing, and digital access. *Challenges in Sustainability, 13*(1), 18–34.

UN-Habitat. (2022). *World cities report 2022: Envisaging the future of cities*. UN-Habitat.

Williams, A. J., Maguire, K., Morrissey, K., & Wyatt, K. (2020). Social cohesion, mental well-being and health-related quality of life among a cohort of social housing residents in Cornwall: A cross-sectional study. *BMC Public Health, 20*(1), 1706.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage.

Zhao, Q., Zhang, L., & Hou, J. (2025). Developing a cultural sustainability assessment framework for environmental facilities in urban communities. *npj Heritage Science, 11*(23), 1–12.

Received: 28th October 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 96 – 111

OMAN'S FOREIGN POLICY DURING THE YA'ARUBA DYNASTY THROUGH THE BOOK MANHAJ AL-TALIBIN WA BALAGH AL-RAGHIBIN BY SHEIKH KHAMIS BIN SAEED AL-SHAQSI

Habib Marhoon Al Hadi[1], Mohd Syakir Mohd Rosdi[2*], & Faiz Marhoon Al Hadi[3]

[1,2,3] *Centre for Islamic Development Management Studies (ISDEV),*
UNIVERSITI SAINS MALAYSIA (USM)

Abstract

Oman possesses a profound legacy of Islamic scholarship, distinguished by encyclopaedic works that delve into diverse aspects of Islamic law, governance, and the humanities. These writings frequently document political and civilizational relations through the correspondence of imams, scholars, governors, and rulers, as well as through the issuance of legal fatwas. Among the most prominent legal encyclopaedias produced in Oman during the early Ya'aruba period is Manhaj al-Ṭālibīn wa Balāgh al-Rāghibīn, authored by the distinguished scholar Sheikh Khamis bin Saeed al-Shaqsi. Despite the numerous references within these encyclopaedic works to political relations and civilizational exchanges between Oman and various regional and international powers, these dimensions have received limited scholarly attention. This study seeks to uncover and analyze these overlooked aspects, emphasizing their contemporary and future relevance in understanding Oman's historical position as a significant regional power during the Ya'aruba era. Accordingly, the research is guided by the following objectives. Firstly, to identify the political role of Sheikh Khamis bin Saeed al-Shaqsi, the author of Manhaj al-Ṭālibīn wa Balāgh al-Rāghibīn. Secondly, to analyze the major events and dynamics of Oman's foreign relations during the early Ya'aruba period as reflected in the encyclopaedia. Methodologically, this study adopts a descriptive-analytical approach, examining the content of the encyclopaedia with particular attention to its political dimensions. The research is structured into two main chapters. The first introduces the author and his legal encyclopaedia, while the subsequent chapters explore Oman's foreign relations during the reigns of Imam Nasser bin Murshid and Imam Sultan bin Saif respectively.

Keywords: Oman's Foreign Policy, Ya'aruba Dynasty, Manhaj Al-Talibin wa Balagh Al-Raghibin, Sheikh Khamis bin Saeed Al-Shaqsi

[2] Corresponding author. Email: mohdsyakir@usm.my

INTRODUCTION

By the end of the 9th century AH (15th century CE) and the dawn of the 10th century AH (16th century CE), Oman confronted one of the most critical turning points in its history with the arrival of European colonial powers in the eastern Islamic world. The Spaniards and the Portuguese were the first European nations to embark on overseas expeditions in search of dominance and territorial expansion beyond the European continent. Their main objective was to control maritime trade routes and the lands from which valuable goods originated. Under the pretext of geographical exploration, they pursued broader political and economic ambitions.

Religious motives also underpinned these ventures. The papacy extended full support to both kingdoms, which had long been under Muslim rule for nearly eight centuries a period during which al-Andalus stood as one of the most prominent centers of Islamic civilization. The European expansion was, therefore, not merely economic but also ideological, reflecting the continuation of the centuries-long struggle between Christendom and Islam.

Oman endured profound consequences from this wave of invasion. Its coastal regions fell under Portuguese control from 1507 to 1650 CE. Being primarily a maritime power, the Portuguese confined their presence to coastal strongholds, unable to penetrate inland due to their limited manpower. Nevertheless, their domination of the ports had devastating effects. Since the coasts served as the arteries of Omani commerce, the occupation crippled trade networks and disrupted internal economic activity. By monopolizing trade across the Indian Ocean and controlling Oman's key ports, the Portuguese imposed a system of economic dependency that led to a prolonged era of weakness and subjugation lasting nearly a century and a half.

Portuguese domination was particularly concentrated in several strategic coastal cities, including Muscat, Sohar, Julfar, Sur, and Qurayyat, which functioned as major maritime and commercial gateways linking Oman to the wider Indian Ocean trade network. Control over these ports enabled the Portuguese to regulate regional trade routes and impose restrictions on Omani merchants navigating between the Arabian Peninsula, India, East Africa, and the Persian Gulf. Consequently, the occupation not only weakened Oman's maritime economy but also disrupted long-standing diplomatic and commercial relations with neighbouring regions.

In addition to economic consequences, Portuguese military fortifications and naval patrols in these coastal areas intensified political fragmentation within Oman and limited the authority of local rulers over maritime territories. Several confrontations occurred between Portuguese forces and emerging Omani resistance movements, particularly during the early seventeenth century, when local scholars and tribal leaders began mobilizing

© 2026 by MIP

efforts to restore political unity and expel foreign domination. These developments formed the geopolitical background against which the Ya'aruba Imamate emerged and within which Sheikh Khamis bin Saeed al-Shaqsi played a significant intellectual, political, and diplomatic role.

Relief and transformation eventually arose from within Omani society itself. A circle of scholars in Rustaq, led by the distinguished jurist and intellectual Sheikh Khamis bin Sa'id al-Shaqsi, took decisive initiative. As recorded by the historian al-Azkawi (2012), Sheikh al-Shaqsi corresponded extensively with scholars in Rustaq and Nizwa: *"There was communication and correspondence between them... and their word became unified."*

The history of the Ibadi school and indeed, the broader Islamic intellectual tradition demonstrates that when scholars assume their moral and social responsibilities, remarkable transformations can occur. Through knowledge, unity, and guidance, they can steer the nation from fragmentation and despair towards cohesion and renewal.

Amidst this climate of occupation, oppression, and falsehood imposed by Christian powers, the Omani people yearned for liberation and justice. Their aspirations materialized in 1034 AH / 1624 CE, when the *Ahl al-Ḥall wa'l-'Aqd* (Council of Decision-Makers) convened in Rustaq under the leadership of Sheikh Khamis bin Sa'id al-Shaqsi both a scholar and a capable military leader. This pivotal assembly marked the emergence of collective resistance and the beginning of Omani unification. Reflecting on that dark period, al-Barashdi (2013) wrote: *"The Muslims were weakened and felt like those holding hot coals unable to conceal heresy, nor to manifest the law of Islam."*

This event signalled not only the end of Omani fragmentation but also the resurgence of Islamic governance grounded in knowledge, faith, and unity. It paved the way for the establishment of the Ya'aruba Imamate, which later became a cornerstone of Omani political and civilizational revival.

RESEARCH BACKGROUND

Introduction to Sheikh Khamis bin Sa'id al-Shaqsi, Author of the Encyclopedia *Manhaj al-Ṭālibīn wa Balāgh al-Rāghibīn*

Sheikh Khamis bin Sa'id bin 'Ali bin Sa'ud bin 'Abdullah bin Ziyad al-Shaqsi al-Rustaqi belonged to the distinguished Shaqsi tribe, whose lineage traces back to Banu Ziyad descendants of Samah bin Lu'ayy from the Quraysh tribe of Adnanite origin. Among the tribes sharing this noble lineage in Oman are the Banu al-Bu Sa'id, al-Sulaymani, and Banu Nafi', who settled in central Oman, particularly in Nizwa, during the early Islamic period. Historical records indicate their presence in the events of 140 AH, establishing Nizwa and Bahla as the ancestral homelands of the Shaqsi tribe.

Although originally from Nizwa, Sheikh Khamis later became associated with Rustaq, earning the appellation *al-Shaqsi al-Rustaqi*. This suggests that his ancestors eventually migrated there. Some sources, such as al-Batashi (2016), indicate that he was born in Nizwa before relocating with his family to Rustaq.

The exact dates of his birth and death remain uncertain due to the tumultuous period in which he lived. However, it is likely that he was born towards the end of the 10th century AH and passed away before 1080 AH. The last recorded event in his life was his will, written in 1070 AH. Sheikh Nasser al-Sab'i estimated his death between 1070 AH and 1079 AH, noting, *"It seems to me that he did not live long after writing his will. The oldest manuscript I found for the thirteenth volume of his book al-Manhaj bears the transcription date of 1079 AH and contains supplications for al-Shaqsi."*

In his introduction to *Manhaj al-Ṭālibīn wa Balāgh al-Rāghibīn*, Sheikh Salim bin Hamad al-Harthi described al-Shaqsi as *"the scholar of his time and the unique figure of his era... He took the reins in Oman at the beginning of the 11th century, being distinguished by both sword and pen—a man of high resolve and great ambitions, a vast ocean of knowledge, of whom it was said: 'How little did the predecessors leave for the successors.'"* His contemporary, Ibn Qaisar, also praised him as *"Qadi Khamis bin Sa'id, a man of piety and fatwa, steadfast in his adherence to God's strongest cause."* Ibn Qaisar further highlighted his close relationship with Imam Nasser bin Murshid, writing that *"He was one of his kin, a prominent figure in his circle, and a beacon of his intimate fellowship."* (al-Sab'i, 2003)

According to al-Harthi, Sheikh Khamis bin Sa'id al-Shaqsi's influence extended beyond Oman's borders, reaching various intellectual and political centers abroad. He was a pivotal figure in the establishment of the early Ya'aruba state, particularly in shaping Omani foreign policy. Al-Harthi remarks: *"He exerted his utmost efforts sincerely for the sake of God, wielding both his sword and pen in God's path. With his sword, the Ya'aruba state arose, subduing India and Africa, striking fear in Europe, extending its reach to Sindh, and safeguarding Iraq and its environs."* This account reflects the far-reaching impact of al-Shaqsi's political and intellectual contributions to Oman's emergence as an independent and sovereign Islamic state prior to the mid-17th century.

Scholar Omar bin al-Qasim al-Fadli further emphasized his stature, stating: *"The kingdom of Oman was fragmented among chiefs and tyrants, plunged into misery, and knowledge and its people had vanished until God sent His servant, the virtuous scholar Sheikh Khamis bin Sa'id al-Shaqsi al-Rustaqi may God have mercy on him who endeavored to restore the Imamate. God then guided him to a pure and ascetic man, the distinguished Sayyid Nasser bin*

© 2026 by MIP

Murshid al-Ya'arubi, who was pledged allegiance to and established justice." (Ibn Qaisar, 1983)

Sheikh al-Shaqsi's writings reflect his deep political insight and awareness of the necessity of leadership for national unity. In *Manhaj al-Ṭālibīn wa Balāgh al-Rāghibīn*, he wrote:

> *"A nation must have a leader under whom their judgments are enforced, to whom their opinions converge, who upholds their unity and gathers their efforts, to whom they turn in crises, and who repels every falsehood."*

Although he lived during the rule of Malik bin Abi al-'Arab al-Ya'arubi the grandfather of Imam Nasser bin Murshid disputes over leadership eventually arose. Recognizing the political vacuum in Rustaq, Sheikh al-Shaqsi initiated correspondence with scholars across Oman, ultimately guiding the community toward pledging allegiance to Imam Nasser. His vision was to restore the Imamate as a system of governance based on justice, unity, and faith. Sheikh al-Khurasini later described Imam Nasser's leadership: *"God provided us with a righteous successor who upheld justice, eradicated oppression, and feared no reproach for God's sake. He manifested God's word, and tyrants obeyed him humbly; kings submitted to him willingly or unwillingly. After we had been defeated, we became dominant and exalted"* (al-Siyar, 2018).

Sheikh Khamis bin Sa'id al-Shaqsi served as Oman's Foreign Minister during the reigns of the just Imams Nasser bin Murshid and Sultan bin Saif. He played significant roles in diplomacy, negotiations, and military affairs, particularly in engagements with the Portuguese and Persian occupiers. Historical accounts record that he led the army of Imam Nasser against the Portuguese in Muscat: *"He first encamped in Bawshar, then marched to Mutrah, where negotiations took place regarding their surrender of some fortifications, agreeing at that time for a perceived benefit in 1043 AH."*

His influence was not limited to local politics. Sheikh al-Shaqsi maintained intellectual and religious correspondence with Ibadis across North Africa, particularly in the Nafusa Mountains (Libya), Djerba Island (Tunisia), and the M'zab Valley (Algeria). His son, Sheikh Sa'id bin Khamis al-Shaqsi, even visited Djerba, strengthening ties with the wider Ibadi world. In *Luqṭu al-Athar*, a jurisprudential response he received discussed issues related to external relations and the conflicts involving Portuguese Christians (Franks) and Turks in Oman. The text notes: *"For those asking about those taken by the Zanj (Franks) when Umayr bin Humayr captured Sohar, and those taken by the Turks when they marched into Oman are their statuses considered absent or missing? Clarify this for us, may God have mercy on you."*

Sheikh al-Salmi corroborates the presence of these external forces before the election of Imam Nasser bin Murshid, stating: *"The Christians were in Muscat, Sohar, Julfar, Sur, and Qurayyat. Oman deteriorated after justice and security, and tyrants ravaged it."* (al-Ghailani, 2009)

As a jurist, administrator, and statesman, Sheikh al-Shaqsi served as the central legal and political authority for governors and judges throughout Oman. In 1056 AH / 1646 CE, Sheikh Khalaf bin Ahmad al-Raqishi, the governor of Imam Nasser bin Murshid in the province of Sir, sought his legal opinion on governance further attesting to his enduring influence and scholarly authority within the Ya'aruba state.

Introduction to the Book *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn*

The encyclopaedia *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* is considered one of the most important Omani works in the field of Islamic jurisprudence (*fiqh*). In his critical edition, Sheikh Salim bin Hamad al-Harthi describes it as a work of profound scholarly value, noting that it is "of immense stature, encompassing the principles and branches of jurisprudence and religion." The author, Sheikh Khamis bin Sa'īd al-Shaqsi, structured the encyclopaedia into twenty volumes, each containing multiple chapters, diverse topics, and detailed discussions. It stands as a monumental encyclopaedia of Islamic jurisprudence.

Sheikh al-Shaqsi composed this work to address a perceived intellectual decline and to revive scholarly engagement with religious sciences. He explained his motivation as follows:

> *"When I observed the dwindling number of its seekers, the reluctance of most people towards it, the slackening of resolve in attaining the positions of the righteous predecessors, and the inability to reach the objectives of the forerunners, I employed my mind in composing a concise work to gather the landmarks of Sharia, to organize the scattered elements of jurisprudence, to elucidate its principles and branches, and to present its issues clearly, coherently, and consecutively" (Al-Shaqsi, 1993).*

Regarding its title, al-Shaqsi stated: *"I named it the Book of Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn".* The work is characterized by its moderate length neither too lengthy nor overly concise. Al-Shaqsi emphasized that his book "suffices in place of both the abridged and the extensive works, as it comprehensively covers most topics with concise wording".

Although primarily a compendium of *Shariah* sciences, the encyclopaedia extends beyond jurisprudence to address a range of intellectual, social, economic, educational, political, and environmental issues. Al-Shaqsi himself highlighted its comprehensive nature, describing it as encompassing

© 2026 by MIP

"various fields of Sharia sciences and diverse branches of knowledge." In doing so, he anticipated what contemporary scholars term *fiqh al-wāqi'* (jurisprudence of reality) or *nawāzil* (jurisprudence of contemporary issues).

Importantly, *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* documents numerous political events and provides a vivid picture of Omani society during a turbulent period marked by foreign interventions—especially the Portuguese occupation of the Omani coasts. This occupation choked the lifelines of trade and communication between Oman's interior and the outside world. Internally, the region was beset by conflicts among tribal factions, city rulers, and competing Imams who lacked the unity needed to stabilize the state. The encyclopaedia poignantly captures this condition:

> *"Oman reverted to the worst conditions and the most damaging outcomes wealth plundered, men killed, rivers dried, homes destroyed, books burned, and traces obliterated" (Al-Kharasini, 1995).*

Composed during the 11th century AH, scholars differ regarding the precise period of authorship. Some suggest that al-Shaqsi wrote it after the death of Imam Nasser bin Murshid (between 1060–1070 AH), dedicating himself to scholarship after the country's unification and the expulsion of the Portuguese. Others propose that he began writing during Imam Nasser's reign, or even before his Imamate.

In essence, the encyclopaedia represents a revival of the Omani tradition of *Shariah* encyclopedias, which flourished particularly during the 6th century AH within the Ibadi school of jurisprudence. *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* serves as a comprehensive synthesis of Ibadi jurisprudence in Oman across ten centuries. It gained notable recognition among Maghrebi Ibadi scholars, who studied and adapted it for educational use. Sheikh Abdulaziz al-Thamini, for example, produced an abridged version titled *Al-Tāj al-Manzūm min Durar al-Minhāj al-Ma'lūm* ("The Crown Adorned with the Gems of the Known Methodology") for use in study circles. The work also received high praise from Sheikh al-Salmi and Imam al-Khalili (Al-Salmi, 2017).

Historian John Wilkinson underscores the encyclopedia's significance, describing it as a major work that revitalized the religious spirit of the Ibadi community and laid the *Shariah* foundations of Ibadi doctrine. He noted that "scholars engaged with it due to its clarity of expression and excellent organization." Wilkinson further emphasized its unifying role in reconciling two long-standing intellectual traditions within Oman the Rustaqi and Nizwani schools which had been divided for nearly seven centuries. The consensus among scholars from both currents on the Imamate of Nasser bin Murshid al-Ya'arubi marked a crucial turning point in Omani history.

Several factors contributed to this consensus:

1. Presence of a Prominent Scholar – Sheikh Khamis bin Sa‘id al-Shaqsi was widely accepted by scholars from both intellectual schools as a spiritual leader.
2. Shared Belief in the Necessity of Change – There was a collective understanding that unity and reform could only be achieved through scholarly and political cooperation.
3. Imam Nasser bin Murshid’s Lineage – His noble Rustaqi lineage strengthened his legitimacy and acceptance among scholars and tribal leaders.
4. External Threats – Foreign incursions by the Portuguese, Persians, and al-Jabur reinforced the urgency for national unity and resistance.
5. Prolonged Political Vacuum – The absence of effective leadership created a compelling need for stable governance.
6. Al-Shaqsi’s Leadership Qualities – As a jurist, administrator, and military leader, Sheikh al-Shaqsi possessed the intellectual and practical capacities necessary for guidance and reform.

Observations on the Encyclopedia *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn*

An examination of the volumes of *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* reveals, as the author himself indicates, that the encyclopaedia primarily compiles and synthesizes the opinions of earlier Ibadi scholars, along with references to other juristic traditions. The work offers limited engagement with the contemporary legal and social challenges of the author’s own period. Consequently, references to political events of al-Shaqsi’s era appear infrequently throughout the text.

This omission is particularly striking given that Sheikh Khamis bin Sa‘īd al-Shaqsi personally witnessed and actively participated in pivotal political and military developments that shaped Oman’s history during the early Ya‘arubi Imamate. He played a central role in state-building efforts, foreign relations, and the resistance against European colonial powers most notably the Portuguese, who had occupied extensive parts of the Omani coastline. Despite his intimate involvement in these affairs, al-Shaqsi chose not to record or elaborate upon such events within his encyclopaedia.

This selective omission suggests a deliberate methodological choice. If an author so deeply engaged in political and military leadership refrained from documenting contemporary political realities, it would be unsurprising that other scholars particularly those without direct involvement in such affairs also avoided extensive discussion of political or diplomatic matters in their own legal writings. This silence reflects a broader tendency among classical jurists to separate

© 2026 by MIP

jurisprudential discourse from temporal political narratives, focusing instead on establishing enduring legal principles and doctrinal clarity.

Nevertheless, the global impact and scholarly legacy of *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* remain substantial. The encyclopaedia has been widely studied across Ibadi communities beyond Oman, including those in Jabal Nafusa (Libya), the island of Djerba and the region of al-Jarīd (Tunisia), the M'zab Valley in the Algerian Sahara, and throughout East Africa. Within these intellectual centers, the work continues to serve as a foundational reference for Ibadi jurisprudence, legal reasoning, and theological discourse, reflecting its far-reaching influence in shaping the legal consciousness of the Ibadi world.

RESEARCH METHODOLOGY

This study employs a historical-analytical approach, providing both a comprehensive description and a theoretical interpretation of Omani efforts in shaping foreign policy and resisting foreign occupation. Through this approach, the research seeks to highlight key historical texts and political events that unfolded during the period under study, offering important indicators for understanding, analyzing, and interpreting the political and civilizational dynamics of that era.

Given the nature of the study, a content analysis method was selected as the principal research tool. This method allows for an objective and systematic examination of the historical texts contained within the encyclopaedia, *Manhaj al-Ṭālibīn wa Balāgh al-Rāghibīn*. By analyzing these texts, the study identifies and interprets the political themes, events, and discourses that reflect Oman's engagement with regional and international powers during the early Ya'aruba period.

The combination of historical description and content analysis ensures both depth and accuracy in examining the intellectual and political contributions of Sheikh Khamis bin Saeed al-Shaqsi and his contemporaries. This integrated methodology provides a balanced framework for uncovering the historical realities and the underlying political thought that shaped Oman's resistance and diplomatic strategies during this formative stage of its history.

ANALYSIS AND DISCUSSION

The encyclopedia *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* provides profound insights into the governance system of Oman from as early as 132 AH (750 CE), particularly in relation to the Ibāḍī Imamate as envisioned within Ibāḍī political thought. This system was revitalized in Oman under the leadership of Sheikh Khamīs bin Saʿīd al-Shaqṣī, the author of the encyclopedia, during the establishment of the Yaʿārubah Imamate with the inauguration of Imam Nāṣir bin Murshid in 1034 AH (1624 CE).

The first volume of *Manhaj al-Ṭālibīn* elaborates on the principles of the Imamate, a central theme in Islamic political theory. It notes:

> *"The people of Oman had not unanimously agreed upon the legitimacy of any of their Imams since the days of Imam Saʿīd bin ʿAbdullah bin Muḥammad bin Maḥbūb may God be pleased with them all until Imam Nāṣir bin Murshid, upon whom the scholars of Oman unanimously agreed and whose authority was established." (Ghabash, 1997)*

Table 1: Analysis of Political Elements in the Encyclopedia

Political Aspect	Brief Description	Analytical Finding	Reference
Imamate (Leadership)	Explained as the foundational structure of Islamic governance in Oman	Discussed in principle without explicit reference to historical events	Al-Shaksi (1993); Al-Sab'i (2003)
Jihad and Warfare	Discussed in terms of its legal principles and conditions	Not directly connected to wars against the Portuguese	Al-Toubi (2017); Al-Ghailani (2009)
Foreign Relations (Siyasah Dauliyyah)	Addressed through jurisprudential discussions	Minimal references to Oman's actual foreign relations	Al-Siyar (2018); Ghabash (1997)
Administrative System	Discussed theoretically as part of Islamic governance	Lacks historical narrative on implementation by Imam Nasser or Imam Sultan bin Saif	Al-Barashdi (2019); Al-Sab'i (2003)

This statement highlights the historical continuity between the consensus achieved during the Imamate of Saʿīd bin ʿAbdullah around 280 AH (893 CE) and the renewed unanimity under Imam Nāṣir bin Murshid. Sheikh al-Shaqṣī's success in uniting the scholars and notables under a single leadership represented a milestone in Omani history, marking the restoration of national unity and the reassertion of collective resolve after a period of fragmentation.

The encyclopedia's seventh volume offers deeper exploration of the Ibāḍī theory of governance, which may be viewed as a distinct political philosophy within Islamic civilization. Ibāḍī jurists conceptualized political authority in contrast to the hereditary monarchies of the Umayyad and ʿAbbāsid dynasties, emphasizing instead an elective system based on piety, justice, and communal consent. The Ibāḍī school thus evolved as both a political movement and a legal-theological tradition. Within this intellectual framework, Sheikh al-

© 2026 by MIP

Shaqṣī stands out as one of the foremost theorists and practitioners of the Imamate system in Oman.

In *Manhaj al-Ṭālibīn*, al-Shaqṣī asserts the obligatory nature of the Imamate:

> *"It is definitively established that the Imamate is a divine duty, mandated by the Qur'an, the Sunnah, and the consensus."*

Despite facing internal dissension among local rulers and external threats from the Portuguese and other powers competing for control of Omani ports, Sheikh al-Shaqṣī viewed the reestablishment of the Imamate as the only viable path toward stability and justice. He emphasized the moral imperative of electing qualified leadership, declaring:

> *"Fearing for the survival of the state and the well-being of the people, it is permissible for Muslims to elect a man with strength, vision, piety, and caution" (Al-Shaybānī, 2015).*

Sheikh al-Shaqṣī's political foresight and leadership culminated in the foundation of the first modern Omani Imamate through his mentorship of Imam Nāṣir bin Murshid al-Yaʿārubī. His efforts were instrumental in transforming Oman into a cohesive state capable of expelling European colonizers and restoring sovereignty during a period when much of the Arab world remained under foreign rule. This achievement symbolized a profound shift in the Gulf region's conception of statehood—from tribal autonomy to structured political governance.

It is noteworthy that Oman had already established itself as an independent polity based on elective leadership nearly nine centuries earlier, when Imam al-Julandā bin Masʿūd was chosen as Imam in 132 AH (750 CE). Omani history is thus deeply interwoven with the evolution of the Ibāḍī Imamate, which consistently sought to actualize a model of governance rooted in justice, consultation (shūrā), and public accountability, in accordance with the Ibāḍī understanding of the Islamic state (Al-Shaybānī, 2015).

Sheikh al-Shaqṣī underscores the sacredness of the Imamate by invoking the Qur'anic verse:

> *"I am going to make you an Imam to the people" (al-Baqarah 2:124).*

Affirming that legitimate leadership is divinely sanctioned and essential for maintaining order and justice.

He further articulates the political and administrative principles governing the Imamate in Oman, noting:

> *"There cannot be two Imams in one city unless there is an intervening unjust ruler. It is as though one Imam governs the interior and another in Ḥafīt, while Ṣuḥār remains under the control of an unjust ruler. If Ṣuḥār is under neither of the two Imams, both retain their leadership. However, if the unjust ruler's control ceases and their jurisdictions connect, their leadership becomes null, as I have explained" (Al-Shaqṣī, 1993).*

This passage exemplifies Sheikh al-Shaqṣī's systematic approach to defining the limits of political authority and the conditions of legitimacy within the Ibāḍī Imamate. His political thought demonstrates a sophisticated understanding of state structure, unity, and the moral foundations of governance.

In sum, *Manhaj al-Ṭālibīn wa-Balāgh al-Rāghibīn* represents not only a legal compendium but also a monumental intellectual effort to revive and codify the principles of Ibāḍī political theory in early modern Oman. Through his leadership and scholarship, Sheikh Khamīs bin Saʿīd al-Shaqṣī laid the groundwork for the reemergence of the Omani state as a regional power and a model of Islamic governance founded upon justice, unity, and religious legitimacy.

Table 2: Factors Explaining the Limited Political Content

Factor	Explanation	Supporting References
1. Purpose of the Work	Sheikh al-Shaqsi explicitly stated that his work aimed to focus on legal discussions rather than political history	Al-Shaksi (1993, 2006)
2. Political Sensitivity of the Era	The ongoing internal conflicts may have required cautious treatment of political matters	Al-Siyar (2018); Al-Salmi (2017)
3. Classical Fiqh Tradition	Classical jurisprudential works were typically normative rather than descriptive of historical events	Al-Barashdi (2013); Al-Kharousi (2015)
4. Scholarly Orientation	The author was primarily a jurist (faqih) rather than a historian	Al-Barashdi (2019); Al-Sabʻi (2003)

Imam Sultan bin Saif bin Malik al-Yaʻarubi ascended to the Imamate immediately following the death of Imam Nasser bin Murshid in 1059 AH / 1649 CE, in accordance with Imam Nasser's testament, which had been endorsed by the scholars of Oman, including Sheikh Khamis bin Saʻid al-Shaqsi the author of *Minhaj al-Talibin wa Balagh al-Raghibin*. Imam Sultan faithfully implemented

© 2026 by MIP

his predecessor's directives, continuing the mission to consolidate internal unity and resist foreign domination.

Historian al-Salmi records Imam Nasser's message to his cousin and military commander, Sultan bin Saif:

> *"Today, you are my wing through which I uphold the pure faith and my successor, a pillar for this doctrine."*

True to these words, Imam Sultan continued the struggle initiated by Imam Nasser against Portuguese colonial control over Oman's coasts and maritime routes. Al-Salmi narrates:

> *"He waged war against the remaining Christians in Muscat, personally leading the campaign until God granted him victory over them. He continued to fight them wherever he found them on land and sea, capturing many of their territories, destroying many of their ships, and seizing much of their wealth".*

The *Minhaj al-Talibin* contains several indirect references to Oman's maritime adversaries, presented within the framework of legal and moral discussions rather than as historical narratives. Nevertheless, these references provide significant insight into the geopolitical realities of Imam Sultan bin Saif's era. The text mentions:

> *"Those who block the way from the coast of Oman in earlier times in the sea from Indian ships, ignorant men from Mahra, or other sinners up to the coast of Aden on the landward side of Oman if it is not certain that they are from the Indian polytheists, are considered as rebels among the people of prayer."*

Such passages reflect the author's deep awareness of maritime challenges and his sophisticated understanding of the geopolitical environment surrounding Oman. They also echo the persistent hostilities that characterized the Indian Ocean trade routes during the 16th and 17th centuries.

Table 3: Implications for the Study of Omani Fiqh and Politics

Aspect	Scholarly Implication	Suggested Further Study
Fiqh al-Nawazil (Jurisprudence of Contemporary Issues)	The absence of direct references suggests fiqh in this era remained theoretical, not yet contextualized for political realities	Comparative study of contemporary Omani jurisprudential works addressing practical governance
Siyasah Shar'iyyah (Islamic Political Governance)	Political thought in Omani context appears moral–legal rather than historical–narrative	Comparative analysis between al-Shaqsi's text and works of al-Salmi or other Omani scholars
Contribution to Omani History	Despite limited historical content, the encyclopedia demonstrates the centrality of scholars in shaping Omani Islamic political thought	Further research into related works by contemporaries such as al-Barashdi and al-Siyabi

Prior to the composition of the *Minhaj*, similar incidents had occurred such as pirate attacks targeting Omani merchant and pilgrim vessels en route to the Ka'bah. These aggressions occasionally reached Omani shores. For instance, during the reign of Imam Ghassan bin Abdullah, pirates from India attacked the Omani coastline, prompting the Imam to dispatch special naval units *shadha* and *ghuruf* vessels from the port of Dama (modern-day Seeb). This location served as a strategic naval base for monitoring and intercepting hostile fleets approaching the Omani coast.

During Imam Sultan bin Saif's rule, the Omani navy expanded significantly, transforming into a formidable maritime force. By the lifetime of Sheikh al-Shaqsi, the Omani fleet had extended its reach to the coasts of Persia, the eastern Arabian Peninsula, India, Sindh, Yemen, the Red Sea, and East Africa. Consequently, Oman's naval power dominated the Indian Ocean, ensuring safe navigation and trade between East and West while establishing Oman as a regional maritime power.

One of the most significant engagements of this period was the Battle of Diu, in which the Omani fleet dealt a decisive blow to the Portuguese. The victory yielded substantial spoils, which were reportedly used to construct the renowned Nizwa Fort an enduring symbol of Omani sovereignty and resilience. Under Imam Sultan bin Saif's leadership, Oman successfully liberated the coasts of the Arabian Peninsula from Portuguese control, ushering in a period of political stability, economic prosperity, and maritime supremacy that endured throughout his reign and beyond.

© 2026 by MIP

CONCLUSION

A close examination of the encyclopedia *Minhaj al-Ṭālibīn wa Balāgh al-Rāghibīn* shows that it was written during a critical period in Omani history marked by political transformation and the consolidation of national unity. Its author, Sheikh Khamis bin Saʿid al-Shaqsi, was an influential figure in Omani political, administrative, and religious life and played an important role in the movement that contributed to the liberation of Omani coastal cities from Portuguese occupation.

Although the encyclopedia primarily functions as a comprehensive jurisprudential work covering a wide range of legal issues, it also reflects the political realities of its time, particularly during the Imamate of Imam Nasser bin Murshid and Imam Sultan bin Saif. Notably, al-Shaqsi devoted the entire eighth volume to the themes of Imamate and jihad, highlighting their importance in the political and religious discourse of the Yaʿaruba period. Nevertheless, direct references to contemporary political events remain relatively limited, likely because the author's primary objective was to address legal and doctrinal issues rather than to document historical developments.

From a broader perspective, the political and maritime developments of the Yaʿaruba period laid important foundations for Oman's later diplomatic traditions. The consolidation of maritime power and regional engagement across the Indian Ocean contributed to the formation of Oman's outward-looking foreign relations. In this context, the intellectual and political contributions of Sheikh al-Shaqsi reflect an early articulation of Islamic governance principles that influenced the historical foundations of Omani foreign relations.

REFERENCES

Al-Barashdi, M. bin S. (2019). *Al-dawr al-siyasi li 'ulama' Oman* [The political role of Omani scholars] (1st ed.). Omani Writers and Literati Association.

Al-Barashdi, M. bin S. (2013). *Al-hayat al-'ilmiyyah bi Oman fi 'ahd al-Ya'aribah* [Scientific life in Oman during the Ya'ariba period] (1st ed.). The Cultural Club.

Al-Batashi, S. bin H. (2016). *Ithaf al-a'yan fi tarikh ba'd 'ulama' Oman* [Honoring the distinguished: The history of some Omani scholars] (4th ed.). Office of the Special Advisor to His Majesty the Sultan for Religious and Historical Affairs.

Al-Ghailani, Y. bin A. (2009). The role and contributions of Sheikh Khamis bin Said al-Shaksi in the establishment of the Ya'ariba State 1624–1749. *Yarmouk Research Journal: Humanities and Social Sciences Series*, Yarmouk University, 661–676.

Al-Kharasini, A. bin M. (1995). *Fawa'kih al-'ulum fi ta'at al-hay al-qayyum* [The fruits of sciences in the obedience of the Ever-Living Sustainer] (M. Saleh & M. al-Tawajini, Trans.; 1st ed.). Muscat.

Al-Kharousi, M. bin K. (2015). *Al-nujoom al-zahirah fi al-aflaq al-da'irah* [The shining stars in the revolving orbits] (2nd ed.). Office of the Special Advisor to His Majesty the Sultan for Cultural and Historical Affairs.

Al-Sab'i, N. bin S. (2003). *Al-'Allamah Khamis bin Said al-Shaksi: Hayatuhu wa madrastuhu al-fikriyyah* [Sheikh Khamis bin Said al-Shaksi: His life and intellectual school]. In *Proceedings of the Seminar "Readings in the Thought of al-Shaksi"* (May 11–12, 2002) (1st ed.). The Literary Forum.

Al-Salmi, A. bin H. (2017). *Tuhfat al-a'yan bi sirat ahl Oman* [The gift of the distinguished: The history of the people of Oman]. Muscat Library.

Al-Shaksi, K. bin S. (1993). *Minhaj al-talibin wa balagh al-raghibin* [The path of seekers and the success of aspirants] (2nd ed.). Ministry of National Heritage and Culture. http://www.waleman.com

Al-Shaksi, K. bin S. (2006). *Minhaj al-talibin wa balagh al-raghibin* [The path of seekers and the success of aspirants] (1st ed.). Muscat Library.

Al-Shaybani, S. bin M. (2015). *Al-iidah fi ma awda'ahu Allah min al-hikmah fi al-nujoom wa al-riyah* [The clarification of what God has endowed in the wisdom of stars and winds] (1st ed.). Memory of Oman.

Al-Siyabi, S. bin M. (2018). *Al-'Umaniyun wa al-'ulum al-tajribiya: al-tibb wa al-handasa wa al-falak wa al-milaha al-bahriyya* [Omanis and the experimental sciences: Medicine, engineering, astronomy, and marine navigation] (1st ed.). Fatimah al-Zahra Library.

Al-Siyar, A. (2018). *Dawlat al-Ya'aribah* [The Ya'ariba State] (1st ed.). Kuttab Publishing and Distribution.

Al-Toubi, A. bin H. (2017). *Al-muqawamah al-'Umaniyyah lil wujud al-Burtughali fi al-Khaleej al-'Arabi wa al-Muhit al-Hindi* [Omani resistance to the Portuguese presence in the Arabian Gulf and the Indian Ocean] (1st ed.). Bait al-Ghasham.

Azkawi, S. bin S. (2012). *Kashf al-ghummah al-jami' li akhbar al-ummah* (M. H. Saleh & M. bin M. al-Sulaimi, Trans.; 1st ed.). Sultanate of Oman.

Ghabash, H. O. G. (1997). *Oman: Islamic democracy – The tradition of Imamate and modern political history (1500–1970)* (A. Hamzi, Trans.; 1st ed.). Dar al-Jadid.

Ibn Qaisar, A. bin K. (1983). *Sirat al-Imam Nasser bin Murshid* (A. al-Qaisi, Trans.; 2nd ed.). Ministry of National Heritage and Culture.

Rosdi, M. S. M., & Ithnan, K. A. (2019). The ultimate objective of islamic political actors: A conceptual analysis based on selected hadith. *International Journal of Islamic Thought, 15*, 84–92.

Rosdi, M. S. M., & Jackson, R. (2020). The meaning of political economy: Revisiting a definition toward the meaning of the new political economy. *International Journal of Innovation Creativity and Change, 10*(10), 44–60.

Tahrim, S. N. C., Muhammad, M. Z., Rosdi, M. S. M., Musa, A., & Din, N. M. (2019). The revival of mudharabah contract: A proposed framework. *Research in World Economy, 10*(2 Special Issue), 70–73.

Received: 28th October 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 112 – 124

FROM WORSHIP TO COMMUNITY HUB: EXPLORING HOW MOSQUE-BASED INITIATIVES INSPIRE TOURISM ENGAGEMENT

Murni Yusoff[1]

[1]*Centre for Islamic Development Management Studies,*
UNIVERSITI SAINS MALAYSIA

Abstract

Mosques have increasingly evolved from being spaces of worship into active community hubs that integrate education, culture, and social engagement. Despite the growing recognition of mosque tourism as part of cultural heritage tourism, the visibility of mosques as attractive destinations remains limited. Less attention has been given to how mosque internal practices contributes to tourism appeal. This paper explores how mosque-based initiatives inspire tourism engagement through the application of internal marketing in enhancing mosque visibility. Using a qualitative approach and document analysis, the study examines literature related. The analysis reveals that internal marketing dimensions, namely internal communication, volunteer empowerment, motivation, and service orientation serve as strategic drivers that strengthen both internal cohesion and external appeal. Mosques that effectively manage their internal stakeholders and foster shared values are better positioned to deliver meaningful community programs that attract visitors seeking authentic cultural and spiritual experiences. The study argues that mosque visibility and tourism engagement are outcomes of internal organizational strength rather than external promotion alone. By integrating internal marketing practices within mosque management, religious institutions can project themselves as inclusive and sustainable cultural heritage sites. The findings contribute to the broader discourse on cultural heritage tourism by linking internal organizational dynamics with visitor engagement, offering valuable insights for mosque management committee and policymakers in advancing Islamic tourism in Malaysia.

Keywords: Mosques Tourism, Community Programs, Internal Marketing, Cultural Heritage Tourism, Malaysia.

[1] Corresponding author. Email: murniyusoff@usm.my

INTRODUCTION

Tourism has long been recognized as a significant contributor to Malaysia's socio-economic development, particularly through the expansion of cultural and heritage tourism. Malaysia has recorded substantial growth of domestic tourism sector in year 2024, with total expenditure by domestic visitors reaching RM106.7 billion, an increase of 25.6 per cent from RM84.9 billion in 2023. This trend has continued to rise by 22.1% increase in the first quarter of year 2025 (Department of Statistic Malaysia, 2025).

In the context of Islamic tourism, the objective of mosque tourism is to present Malaysia's diverse culture, historical background, and Islamic identity through an appreciation for the architectural designs of mosques and their role in our society in a well-managed, innovative, and informative way. Mosque Tourism presents a strategic opportunity for local authorities to collaborate with mosque administrators, nearby attractions, local communities, and hospitality service providers such as hotels, cafés, and restaurants in promoting local tourism development. Strengthening these partnerships enables the showcasing of the surrounding area's cultural and social assets, thereby enhancing visitor engagement (Islamic Tourism Centre, 2021).

To further advance the development of the mosque tourism sector, it is essential to understand the roles of various stakeholders and the strategies they employ to attract both local and international visitors. Recognizing the factors that influence tourists' visitation intentions provides valuable insights into their preferences and expectations regarding mosque tourism experiences. Such understanding not only clarifies the needs and wants of potential visitors but also helps identify strategic approaches that should be prioritized by local authorities and industry players. By aligning stakeholder initiatives with tourists' motivations, the mosque tourism segment can strengthen its contribution to Malaysia's economic growth alongside other emerging niche tourism sectors. Therefore, there is a clear need to examine the role of stakeholders in fostering the sustainable development of the mosque tourism industry in Malaysia (Mansur et.al., 2024).

While heritage mosques have traditionally received significant attention as key attractions within cultural and heritage tourism (Sutrisno et.al, 2024; Mat Isa et.al., 2024; Mohamad Zaidi & Saad, 2018) this emphasis often narrows the understanding of what makes a mosque appealing to visitors. The appeal of a mosque does not necessarily depend on its historical designation or architectural prominence alone. Rather, its visibility within the community reflecting active engagement, social interaction, and public presence can also play a crucial role in generating tourism interest. However, in other perspective, how internal stakeholders (mosque management committees and volunteers) could play their roles in strengthening the mosque visibility to inspire tourism interest?

© 2026 by MIP

Therefore, this paper aims to explore how mosque-based initiatives inspire tourism engagement through the application of the internal marketing concept. Specifically, it examines how internal marketing practices within mosque management influence the visibility and attractiveness of mosques as tourism destinations.

LITERATURE REVIEW

Mosque Tourism as Cultural Heritage Tourism

The growing segment of Muslim travellers, coupled with the rapid advancement of virtual reality (VR) technologies, is transforming the landscape of global tourism. Md Sawari et.al. (2024) indicate a significant interrelationship between authentic experiences, cognitive and affective responses, and the travel intentions of Generation Y towards mosque visitation. Mohammad et.al (2025) propose a comprehensive approach for positioning mosque tourism through digitalisation, covering mosque structure and management, program and attraction development, provision of visitor facilities, and the integration of digital technologies.

Mansur et.al (2024) investigate the role of stakeholders in fostering mosque tourism successfully identified several key elements essential in attracting tourists to Malaysia. Their findings reveal that effective mosque management and infrastructure development, collaborative partnerships among stakeholders, educational initiatives, cultural preservation, and active community engagement each play a pivotal role in supporting the government's strategy to promote mosque tourism as a niche segment within the Malaysian tourism industry.

Raja Othman et. al (2025) found that effective interpretive signage, particularly when multilingual and digitally enhanced, plays a critical role in improving visitor understanding and engagement in mosque tourism. However, limited digital adoption and accessibility barriers can constrain the effectiveness of these interpretive tools, especially for non-Muslim visitors.

Amir et. al (2020) highlight that awareness, security and privacy concerns, and implementation limitations are key challenges affecting the adoption of smart tourism in Malaysia. These findings underscore the need for a comprehensive framework to enhance the effectiveness of smart tourism initiatives.

All these studies suggest that mosque tourism operates at the intersection of spiritual, cultural, and technological dimensions of heritage tourism. Digital innovation, stakeholder collaboration, and community-based initiatives converge to strengthen the positioning of mosques as living heritage sites spaces that embody both sacred meaning and socio-cultural value. This synthesis illustrates a shifting paradigm in cultural heritage tourism, where the

mosque functions not only as a site of worship but as a medium for cultural continuity, learning, and intercultural dialogue.

Mosque-Based Community Programs

Mosques have long been involved in community activities such as education, charity, and social welfare. In recent years, these initiatives have evolved into organized programs that engage both residents and visitors. Community-driven activities such as cultural exhibitions, heritage talks, and volunteering programs can strengthen the mosque's social role and visibility. The integration of such programs within tourism planning highlights the mosque as a living heritage site rather than a static monument. This transformation underscores the potential of mosques to serve as dynamic spaces of cultural exchange.

Karimullah (2023) highlights that mosques have evolved beyond their traditional role as places of worship to become dynamic centres for community empowerment in contemporary Islamic societies. The study identified innovative and best practices that enhance mosques' educational, social, and spiritual functions. The educational dimension fosters religious literacy, ethical awareness, and practical life skills; the social role promotes solidarity and collective responsibility; and the spiritual function nurtures personal faith, communal identity, and motivation for positive societal transformation.

Auwal Salisu and Rufa'I Sulaiman Abubakar (2024) have emphasized on the success of specific mosque in fostering spiritual growth, promoting knowledge acquisition, enhancing social well-being, and empowering the Muslim community. The study explores the potential for replicating such multi-functional mosque models in other settings, particularly in the Nigerian context.

Internal Marketing and Organizational Engagement

Internal marketing refers to the management philosophy of treating internal stakeholders comprise of employees, volunteers, and community members as internal customers who must be motivated and informed to deliver service excellence.

Rafiq & Ahmad (2000) has defined internal marketing as a planned effort using a marketing-like approach to overcome organizational resistance to change and to align, motivate and inter-functionally co-ordinate and integrate employees towards the effective implementation of corporate and functional strategies to deliver customer satisfaction through a process of creating motivated and customer orientated employees.

Internal marketing plays an important role in supporting such organizational transformation. However, internal marketing remains a complex and context-dependent concept that is often difficult to operationalize. As a holistic managerial approach, internal marketing emphasizes the coordination

© 2026 by MIP

and integration of organizational functions to enhance internal alignment and organizational effectiveness. By fostering collaboration and shared understanding among stakeholders, internal marketing enables managers to integrate diverse perspectives and strengthen the overall functioning of the organization (Ahmed & Rafiq, 2003).

Internal marketing fosters a positive attitude among employees toward serving and engaging with customers, thereby enhancing value creation and enabling organizations to sustain a stronger competitive advantage (Brown et.al, 2025)

Internal Marketing Practices in Non-Religious Tourism

Internal marketing is also highly relevant in non-profit and volunteer-driven organisations where service outcomes rely heavily on stakeholder commitment rather than financial incentives. Bennett and Barkensjo (2005) argue that internal marketing activities significantly enhance volunteers' organizational commitment and job satisfaction in charitable organizations. However, negative client-contact experiences may weaken these effects, although higher satisfaction and commitment remain strongly linked to volunteers' dedication to delivering high-quality services.

Ramya et.al (2025) indicate that internal marketing practices within Human Resource Management, such as training, performance management, recognition, and effective internal communication, play a significant role in enhancing employee engagement. Increased engagement subsequently strengthens employee commitment and job satisfaction, while also improving customer-focused performance and customer satisfaction, positioning engaged employees as key drivers of organizational value.

Despite the growing body of literature on mosque tourism and cultural heritage tourism, existing studies have largely focused on aspects such as architectural heritage, digital promotion, and stakeholder collaboration in attracting visitors. While these studies provide valuable insights into the external factors that influence mosque tourism, limited attention has been given to the internal organisational practices that support the implementation of mosque-based initiatives. In particular, the role of internal marketing in strengthening internal stakeholder engagement within mosque institutions remains underexplored. Considering that mosque activities are largely organized and sustained by management committees and volunteers, understanding how internal marketing practices influence mosque visibility and tourism engagement is essential. Therefore, this study seeks to address this gap by examining how mosque-based initiatives, supported by internal marketing practices, contribute to enhancing mosque visibility and inspiring tourism engagement.

RESEARCH METHODOLOGY

This study employed a basic qualitative research design to explore how mosque-based initiatives enhance tourism engagement through the lens of internal marketing. The study focused on mosques and their internal stakeholders in Malaysia. Mosques were selected because they function as both religious and socio-cultural institutions with potential to serve as tourism sites. Internal stakeholders were identified as key actors in implementing internal marketing practices that strengthen mosque visibility and community outreach.

Data were gathered through document analysis of publicly available materials, including relevant journal articles, Islamic Tourism Centre (ITC) and Penang Global Tourism publications. This method enabled systematic examination of authentic textual sources that reflect mosque activities, internal communication, and engagement strategies aimed at enhancing public and tourist interest. The documents were selected based on two criteria. First, relevance to mosque tourism, mosque management practices, or mosque-based community initiatives. Second, credibility of sources, focusing primarily on peer-reviewed journal articles, institutional reports, and publications produced by recognised organisations such as the Islamic Tourism Centre and Penang Global Tourism. These criteria ensured that the selected documents reflected both academic perspectives and institutional practices related to mosque-based tourism initiatives.

The collected documents were analysed using thematic content analysis. Ahmed et al. (2025) describe six phases that guide this analytical process. The first phase involves familiarisation with the data, where the researcher reviews the documents to gain an overall understanding of the dataset and identify preliminary ideas. The second phase consists of generating initial codes by systematically labelling meaningful segments of the text. In the third phase, related codes are grouped to identify broader patterns and develop potential themes. The fourth phase involves reviewing the themes to ensure coherence within each theme and clear distinctions between themes. The fifth phase focuses on defining and naming the themes by refining their meanings and assigning appropriate labels. Finally, the themes are presented through a coherent analytical narrative that explains how the findings emerged from the data.

In this study, the thematic analysis enabled the identification of key internal marketing dimensions that influence mosque-based initiatives. The analysis revealed four dominant themes: internal communication, volunteer empowerment, motivation, and service orientation, which collectively explain how internal stakeholder practices enhance mosque visibility and contribute to tourism engagement.

© 2026 by MIP

ANALYSIS AND DISCUSSION

The findings of this study underscore how internal marketing practices among mosque stakeholders particularly committees and volunteers which serve as strategic enablers in enhancing mosque visibility and fostering tourism engagement. four interrelated dimensions of internal marketing were identified namely internal communication, volunteer empowerment, motivation, and service orientation. Each dimension reflects how internal stakeholder practices contribute to strengthening the mosque's outward presence and attractiveness as a cultural and spiritual destination.

These internal dynamics are instrumental in enhancing mosque visibility and, consequently, stimulating tourism interest. The analysis indicates that mosques with strong internal engagement mechanisms are more likely to develop outward-facing activities that attract visitors seeking authentic cultural and religious experiences.

Several mosques in Malaysia demonstrate how internal stakeholder engagement contributes to tourism experiences. In the cases of Masjid Putra in Putrajaya and Masjid Negara (National Mosque of Malaysia) in Kuala Lumpur, guided tours and visitor programmes are supported by volunteers and mosque personnel who act as internal stakeholders responsible for communicating Islamic knowledge, mosque etiquette, and cultural heritage to visitors (Islamic Tourism Centre, n.d.: MRTKL, n.d.). These activities reflect key principles of internal marketing, particularly the engagement and alignment of internal stakeholders to deliver consistent service experiences to external audiences. Similarly, mosques in Penang such as Kapitan Keling Mosque and Acheen Street Malay Mosque illustrate how coordinated internal efforts including volunteer participation, visitor management, and informational guidance help transform religious spaces into meaningful tourism destinations (Penang Global Tourism, n.d.; Yayasan Dakwah Islamiah Malaysia, 2019). Through these practices, mosque management not only facilitates visitor engagement but also cultivates a service-oriented culture among internal stakeholders, thereby enhancing the overall tourism experience while simultaneously promoting Islamic values and heritage. In this way, internal marketing principles are operationalised within mosque institutions by aligning internal stakeholder commitment with the delivery of educational and culturally enriching visitor experiences.

This relationship can be understood as a service delivery chain in which internal marketing practices shape employee and volunteer behaviours, which subsequently influence visitor perceptions and tourism outcomes.

Internal Communication

Internal communication plays a fundamental role in building mosque visibility. The consistent and transparent communication within the mosque ensures

alignment of purpose and facilitates coordinated efforts in organizing community-based programs. When committees and volunteers share information effectively through meetings, announcements, or digital platforms, then, all activities are implemented more systematically and publicized more efficiently.

This clarity of communication enhances how mosque programs are perceived externally. It creates consistent narratives about the mosque's mission and initiatives, which improves public awareness and reinforces trust among the surrounding community and visitors. Consequently, internal communication not only strengthens organizational cohesion but also amplifies the mosque's visibility to potential tourists who view the mosque as a well-managed, active, and welcoming institution. This visibility becomes a precursor to tourism interest, as travellers are more inclined to visit spaces that project transparency, inclusivity, and vibrancy.

Effective internal communication promotes unified understanding of the mosque's vision and programs. Regular coordination, training, and dialogue sessions enhance commitment, improve service delivery, and enable consistent messaging that reaches both the congregation and external visitors. This aligns with the internal marketing proposition that internal cohesion and clarity foster organizational credibility and public appeal.

Volunteer Empowerment

Volunteer empowerments emerge as critical elements in sustaining mosque-based initiatives. When mosque management committee encourage volunteers to take initiative, lead subprograms, and participate in decision-making, they nurture a sense of belonging and accountability. Naturally, it empowers volunteers become informal ambassadors of the mosque by sharing their experiences, promoting mosque events, and engaging with visitors both physically and through online platforms.

The type of promotion enhances the mosque's visibility beyond its immediate congregation. Active volunteers help to translate the mosque's internal culture into a visible social presence, attracting interest from cultural travellers and faith-based tourists seeking authentic, community-driven experiences. In this way, volunteer empowerment becomes not merely an internal process but a strategic approach to external engagement that bridges mosque activities with broader tourism visibility.

Motivation

Motivation among internal stakeholders serves as a sustaining force for mosque-based initiatives especially when it is tied to spiritual and social rewards. The findings suggest that when committees and volunteers perceive their

© 2026 by MIP

contributions as acts of *ibadah* (worship) and community service, their motivation is intrinsically reinforced.

Highly motivated stakeholders exhibit stronger commitment to maintaining mosque cleanliness, hospitality, and program continuity, all of which contribute to the mosque's external appeal. This continuous engagement ensures that the mosque remains active, visible, and relevant within the local tourism ecosystem.

When management committee members and volunteers feel valued and included in program design and delivery, they exhibit higher levels of commitment and enthusiasm. This participatory environment not only strengthens community belonging but also projects a positive image of the mosque as an inclusive, dynamic space which portrays an image that resonates with both domestic and international tourists. Such empowerment-based practices mirror the principles of internal marketing that emphasize employee, particularly management committee and volunteer satisfaction as a precursor to service excellence.

Service Orientation

Service orientation is the behavioral expression of an organization's internal culture that determines how internal member interact with external audiences. George (1990) asserted that internal marketing is the best approach for establishing service orientation as the organizational imperative.

A strong service orientation is the most visible expression of internal marketing within mosque activities. The mosque stakeholders may prioritize hospitality, responsiveness, and the creation of meaningful visitor experiences. This includes practices such as guided tours, cultural exhibitions, or educational programs reflect how internal attitudes toward service translate into positive visitor perceptions.

When committees and volunteers internalize the value of service, they shape how tourists experience the mosque and not merely as a place of worship but as a living heritage site that embodies spiritual warmth and community inclusivity. This proactive service orientation elevates the mosque's image, enhances visitor satisfaction, and strengthens its position as a desirable tourism attraction

Based on above findings, the four dimensions of internal marketing demonstrate a clear pathway from internal stakeholder practices to mosque visibility, and ultimately to tourism engagement. Internal communication fosters organizational coherence and consistent external messaging; volunteer empowerment mobilizes community ambassadors; motivation sustains ongoing program visibility; and service orientation shapes the visitor experience that converts awareness into engagement.

These findings also highlight that mosque visibility is not merely the result of promotional efforts but the outcome of cohesive internal marketing practices embedded within mosque culture. When internal stakeholders function effectively, their practices radiate outward, projecting an image of the mosque as dynamic, inclusive, and culturally significant. This internal-external linkage is what positions mosque-based initiatives as key drivers of tourism engagement, aligning spiritual values with the broader goals of cultural and heritage tourism in Malaysia.

Further, the findings indicate that internal marketing practices contribute to tangible tourism outcomes through several mechanisms. Effective internal communication enhances coordination of mosque programs and strengthens public awareness of mosque activities. Volunteer empowerment allows internal stakeholders to act as informal ambassadors who promote mosque initiatives within the community and through social networks. Motivated stakeholders sustain the continuity of mosque programs, ensuring that the mosque remains active and visible within the local tourism landscape. The strong service orientation enhances visitor experiences by creating welcoming and informative environments for tourists. These internal practices collectively contribute to increased visitor interest, positive word-of-mouth marketing, and stronger tourism engagement.

Despite the potential benefits, implementing internal marketing practices in mosque management may face several challenges. Limited financial resources, lack of managerial training among committee members, and resistance to organisational change may hinder the adoption of structured internal management practices. Addressing these challenges requires institutional support from Islamic religious council, training programmes for mosque committees, and collaboration with tourism organisations to provide necessary resources and expertise.

CONCLUSION

This study explored how mosque-based initiatives inspire tourism engagement through the perspective of internal marketing. The analysis underscores that mosques, when functioning as community hubs, can elevate their visibility and attract visitors by fostering strong internal cohesion and shared values among their members.

Internal marketing, encompassing internal communication, volunteer empowerment, motivation, and service orientation enables mosques to deliver programs that resonate with both community members and tourists. Consequently, mosque visibility becomes not merely a function of architecture or heritage status but a reflection of active community participation and strategic internal management.

© 2026 by MIP

This conceptual exploration contributes to the discourse on cultural heritage tourism by highlighting how religious spaces can evolve into living heritage sites without compromising their sanctity. For practitioners, it suggests that mosque management committees and tourism planners should integrate internal marketing strategies into governance to enhance visibility and sustainability.

Future research could further deepen this discussion by examining how internal marketing principles can be interpreted and operationalized within an explicitly Islamic framework by incorporating Islamic values. Empirical studies could also assess how the integration of Islamic ethics into internal marketing contributes to sustainable governance and spiritual authenticity in mosque operations. This suggestion is to ensure that organizational practices support not only operational effectiveness but also the spiritual and ethical mission of the mosque. Ultimately, mosques that nurture their internal strength project outwardly as vibrant cultural and spiritual landmarks, reinforcing Malaysia's identity as a destination where faith, heritage, and community coexist harmoniously.

REFERENCES

Ahmed, S. K., Mohammed, R. A., Nashwan, A. J., Ibrahim, R. H., Abdalla, A. Q., Ameen, B. M. M., & Khdhir, R. M. (2025). Using thematic analysis in qualitative research. *Journal of Medicine, Surgery, and Public Health*, 6, 1–6.

Amir, S., Dura, N. H., Yusof, M. A., Nakamura, H., & Abu Nong, R. (2020). Challenges of smart tourism in Malaysia eco-tourism destinations. *Planning Malaysia Journal*, 18(4), 442–451.

Auwal Salisu, & Rufa'i Sulaiman Abubakar. (2024). The multifunctional role of mosques in the development of Islam: A case study of Al-Malik Khalid Mosque, Universiti Sains Malaysia, and its implications for the Nigerian context. *International Journal of Religious and Interdisciplinary Studies*, 1(2), 135–148.

Bennett, R., & Barkensjo, A. (2005). Internal marketing, negative experiences, and volunteers' commitment to providing high-quality services in a UK helping and caring charitable organization. *Voluntas: International Journal of Voluntary and Nonprofit Organizations*, 16(3), 251–274.

Brown, D. M., Pattinson, S., Sutherland, C., & Davies, M. A. P. (2025). Internal marketing and organizational performance: A systematic review and future research agenda. *Journal of Business Research*, 194, 1–14.

George, W. R. (1990). Internal marketing and organizational behavior: A partnership in developing customer-conscious employees at every level. *Journal of Business Research*, 20, 63–70.

Islamic Tourism Centre. (n.d.). *Masjid Putra Putrajaya*. https://mymuslimtrip.com/listings/masjid-putra-putrajaya/

Islamic Tourism Centre. (2021). A compelling product: Mosque tourism was thought through for Muslim tourists coming to Malaysia [Cover story]. *Islamic Tourism*

Centre Malaysia. https://itc.gov.my/wp-content/uploads/2021/09/Special-Feature-by-Islamic-Tourism-Centre-on-Mosque-Tourism-Potential-Sep-2021.pdf

Karimullah, S. S. (2023). The role of mosques as centers for education and social engagement in Islamic communities. *Jurnal Bina Ummat*, 6(2), 151–166.

Mansur, T. E. T., Sanip, M. N. A. M., Majid, N. Z., & Aziz, M. A. (2024). Investigating the role of stakeholders in fostering mosque tourism in attracting tourists to visit Malaysia. *Journal of Tourism Hospitality and Environment Management*, 9(37), 60–70.

Mat Isa, M., Ismail, N., Rosli, I. A. S., & M. Baharudin N. H. (2024). Path, portal, place: Cultural heritage site observations at Jamek Mosque Kuala Lumpur as a spiritual tourism destination. *Asian People Journal*, 7(1), 138–153.

Md Sawari, S. S., Mat Desa, S. N. H., Hussin, S. R., & Ab Talib, M. S. (2024). Mosque tourism in the digital age: Examining Generation Y's virtual reality experiences. *Planning Malaysia Journal*, 22(2), 144–156.

Metro Rail Travels Kuala Lumpur. (n.d.). *National Mosque*. https://mrtkl.com/masjid-negara

Mohamad Zaidi, A. R., & Sa'ad, M. F. (2018). The conservation works of heritage mosque in Kelantan. *3rd Undergraduate Seminar on Built Environment and Technology (USBET2018)*, 265–270.

Mohammad, A., Sutrisno, N. A., Syed Ahmad, T. S. A., Wan Hassan, W. A., & Ibrahim, S. S. (2025). Positioning of mosque tourism through digitalization: A case study of Masjid Sri Sendayan Negeri Sembilan Malaysia. *Information Management and Business Review*, 17(1), 359–370.

Mohd Ali, S. N., Arshad, H., Fauzi, N. S., Atan, N. A., & Abdullah, L. (2025). Heritage of waqf properties in Türkiye: Exploring tour guides' roles in spreading waqf appreciation among tourists. *Malaysian Journal of Social Sciences and Humanities*, 10(1), 58–71.

Penang Global Tourism. (n.d.). *Places of worship*. https://mypenang.gov.my/culture-heritage/places-of-worship/?lg=en

Rafiq, M., & Ahmed, P. K. (2000). Advances in the internal marketing concept: Definition, synthesis and extension. *Journal of Services Marketing*, 14(6), 449–462.

Rafiq, M., & Ahmed, P. K. (2003). Internal marketing issues and challenges. *European Journal of Marketing*, 37(9), 1177–1186.

Raja Othman, R. N., Ramli, R., Che Yusof, M. A., & Harun, S. N. (2025). Enhancing cultural and religious tourism through interpretive signage: A case study of Masjid Jamek Sultan Abdul Samad Kuala Lumpur. *Planning Malaysia Journal*, 23(5), 697–711.

Ramya, J., Nakkeeran, I., D, N., Batar, S., & Pandey, K. K. (2025). Internal marketing through HRM: Enhancing employee engagement for superior customer experience. *Advances in Consumer Research*, 2(5), 333–338.

Sutrisno, N. A., Kamarulzaman, M. H., Ibrahim, S. S., & Kamaruddin, M. N. (2024). Positioning heritage mosque tourism for sustainable commercialisation: A case study. *International Journal of Academic Research in Business and Social Sciences*, 14(2), 220–234.

© 2026 by MIP

Yayasan Dakwah Islamiah Malaysia. (2019). *Masjid Melayu Lebuh Acheh Pulau Pinang*. https://www.yadim.com.my/v2/masjid-melayu-lebuh-acheh-pulau-pinang/

Received: 28th October 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 125 – 137

SUSTAINABILITY IN GREEN BUILDINGS: A FAITH-BASED APPROACH

Hayati Saleh[1], Shereeza Mohamed Saniff[2]

[1] *Faculty of Education & Social Sciences,*
OPEN UNIVERSITY MALAYSIA
[2] *Centre for Islamic Development Management Studies (ISDEV),*
UNIVERSITI SAINS MALAYSIA

Abstract

The emergence of green buildings in the early 2000s marked a significant milestone in the global sustainability movement, emphasizing ecological responsibility and environmentally friendly design. While the concepts of "green" and "sustainability" are often used interchangeably to describe eco-conscious environments, there remains a notable gap in exploring these principles through the lens of faith-based approach, particularly from Islam. This study aims to identify enduring faith-based values that influence the design of green buildings. Guided by a research question, the thematic analysis reveals seven core values: worship, balance, community orientation, prevention of harm, avoidance of waste, protection of privacy, and climate consciousness. These values reflect a holistic, faith-based approach to sustainability, offering both scientific insight and practical guidance. The study contributes to the growing discourse on integrating religious principles with sustainable development, positioning faith-based values as a foundational framework for green building practices in contemporary contexts.

Keywords: Green Values, Green Buildings, Sustainability, Religion, Faith-Based Values

[2] Corresponding author. Email: shereeza@usm.my

INTRODUCTION

Green buildings, also referred to as sustainable or high-performance buildings, play a crucial role in sustainable development by reducing environmental impact (Zuo & Zhao, 2014; Bhamra & Lofthouse, 2007). Studies show that they can lower carbon emissions by up to 40% compared to conventional structures (Yudelson, 2008) and reduce energy costs by more than 55% (Lau et al., 2009), with some research reporting savings as high as 71.1% (Dwaikat & Ali, 2018). Despite these advantages, the building sector remains one of the largest global energy consumers, accounting for nearly 40% of total operational energy use (WBCSD, 2015). These figures highlight the urgent need for sustainable solutions. Research measuring the effectiveness of green buildings, including assessments of carbon dioxide emissions conducted by Suh, Tomar, Leighton and Kneifel (2014), demonstrates that such buildings not only reduce environmental impact but also function as value-added assets, enhancing both building performance and overall asset value.

The environmental and climate crisis, driven by human activities, resource mismanagement, and increasing energy demand, has pushed the global community to explore renewable energy sources such as solar, biomass, geothermal, hydroelectric, and hydrogen energy to support green building initiatives (Bhamra & Lofthouse, 2007). In response, international frameworks like Agenda 21, adopted during the 1992 Earth Summit, emphasize sustainable development through global and local collaboration (UN, 2012; Edmondson, 2007). This growing attention has also influenced the development of green buildings within faith-based contexts, including Islamic traditions, where the idea of sustainability aligns with long-standing ethical and spiritual principles (Zhao, He, Johnson & Mou, 2015).

Interest in faith-based sustainability is particularly visible in *masajid* architecture, with several mosques in countries such as Germany, Britain, Russia, Saudi Arabia, Oman, and Malaysia receiving green certification, including Masjid Al-Ikhlas in Shah Alam, Masjid Ara Damansara in Petaling Jaya, and Masjid Cyberjaya (GBI Malaysia, 2020). While religion has begun to surface within green building discussions, existing attention often focuses on the physical building rather than its philosophical or spiritual underpinnings. Given the deep historical linkage between Islam and sustainable architectural traditions, evident in enduring structures such as the *kulliye*, *imaret*, and *hamam* in Turkey (Oktay, 2014), examining sustainability in green buildings through a faith-based approach is necessary to fully understand how environmental responsibility, cultural identity, and spiritual values can be integrated into contemporary sustainable development.

This study analyses authoritative scholarly sources on green values in green buildings to identify gaps in their connection to Islamic sustainability principles Using a structured and transparent analytical approach inspired by

Higgins and Green (2011), the article organises and synthesises relevant research through clear and replicable procedures. The findings contribute to the body of knowledge by revealing overlooked intersections between Islamic sustainability concepts and green building practices, thereby offering a conceptual basis for integrating faith-based values into future sustainable building research and development.

LITERATURE REVIEW

Research on green buildings affirms their environmental and economic benefits while noting enduring gaps. Foundational reviews point to three core strands, definitions and scope, quantified benefits, and delivery approaches, yet social and ethical dimensions remain insufficiently examined despite strong evidence of energy, emissions, and cost advantages (Zuo & Zhao, 2014). Recent bibliometric analyses also show rapid growth in technologies, assessment methods, and policy tools, but stress the need for integrative frameworks that link performance metrics with cultural and value-based contexts (Li et al., 2021).

Within the faith–sustainability nexus, the Islamic worldview is increasingly recognised as a normative resource for reframing sustainability beyond technocratic approaches. Al-Jayyousi et al. (2022) show how concepts such as unity (*tawhid*), stewardship (*khilafah*), and balance (*mizan*) support a value-based sustainability discourse. Building on this, Al-Jayyousi et al. (2023) demonstrate that Islamic ethical commitments shape policymakers' climate-action narratives, indicating that faith-inspired perspectives can strengthen legitimacy, equity, and behavioural uptake in sustainability transitions. Together, these studies highlight the potential for aligning green-building strategies with Islamic ethical principles to connect environmental performance with culturally embedded motivations.

Applications within the built environment, particularly *masjid* architecture, illustrate both advancement and gaps. Malaysian cases, such as the GBI-Platinum Raja Haji Fi Sabilillah Mosque in Cyberjaya, demonstrate the feasibility of renewable energy systems, passive cooling, daylighting, and inclusive access features, while also revealing operational and climatic challenges unique to *masajid* (Ismail & Abdul Rashid, 2023). Complementary studies identify passive bioclimatic design, water stewardship, material sustainability, and community functions as key strategies, yet emphasise the need to embed spiritual–ethical intentions within performance frameworks and certification tools (Mat Sobri et al., 2021). A faith-based lens particularly that of Islam, therefore offers a meaningful contribution by connecting measurable building outcomes with ethical commitments and user practices in religious and communal settings.

© 2026 by MIP

METHODOLOGY

This study adopts a structured analytical approach informed by the general principles of the ROSES Highlights Protocol (Haddaway et al., 2018), with adaptations to suit the aims of this research. Guided by these principles, a clear research question was formulated - What are the everlasting values embedded in green building design from the sustainability concept from a faith-based approach? The research question serves as the foundation that directs the overall review and analysis process (Kitchenham & Charters, 2007). Following this, the study employed a transparent and organised procedure to gather and assess relevant literature. This procedure involved three key stages: identifying sources, applying filtering criteria, and determining eligibility, ensuring that only studies aligned with the research focus primarily on green values, green architecture, green buildings and sustainability in Islam, were included in the final analysis.

The quest for article search is also focused on the criteria that the articles consist of both theoretical studies, and empirical studies published in journals indexed in Malay and English languages acquisition limited to the year from 2000 until 2020.

ANALYSIS & DISCUSSION

Analysis of secondary data spanning 20 years shows a notable gap in the literature on integrating faith-based principles, particularly Islamic perspectives, into discussions of green buildings and sustainability. Publications addressing sustainability in green buildings from a faith-based angle remain scarce, often appearing only once per year, and key terms such as “sustainability concept” and “faith-based” are frequently absent or insufficiently emphasised.

From the analysed data, seven themes were identified, covering values such as social and environmental values. The publication pattern shows one article published in 2018 and 2020, two in 2014 and 2017, and four in 2016 and 2019.

Overall, the findings reaffirm that studies on sustainability in green buildings from faith-based perspectives are limited, with typically only one relevant article per year, and that key terms such as “sustainability concept” and “faith-based” remain underrepresented. This confirms that the topic is relatively new and insufficiently explored. Interest in the Islamic dimension of sustainability appears strongest among researchers in Muslim-majority Asian countries, specifically Malaysia, Indonesia, Iran, Iraq, Egypt, and Qatar, with limited contributions from Western or non-Muslim contexts, highlighting the need for broader and more diverse research.

Themes

Based on content analysis of the articles, the frequency of the themes that appear are tabulated in the form of Table 1. The higher the frequency of the theme

appearing indicates that the theme is very important in the green building discipline.

Table 1: Themes and Sub-themes on Green Values

AUTHOR	YEAR	LOCATION	Worship GC HC	Environment B1	Community-Oriented Ac	Preventing Damage PN	Preventing Waste C R	Privacy Protection C1 Cf	Climate Friendly EF ES
1. Oleiwi et al.	2014	Iraq			*I*		*I*		*I*
2. Raoufeh Toosi	2014	Iran				*I*	*I*	*I*	*I*
3. Nu'Man	2016	Qatar	*I*		*I*	*I*	*I*	*I*	
4. Yazdani &MahmoudiNejad	2016	Iran				*I*	*I*		
5. Adi & Puspitasari	2016	Indonesia	*I*		*I*	*I*	*I*		
6. Bakri	2016	Indonesia			*I*	*I*			
7. Ali &Abdelmaksoud	2017	Egypt					*I*	*I*	
8. Nemati et al.	2017	Iran		*I*		*I*	*I*		*I*
9. Salam &Ibrahim	2018	Malaysia	*I*	*I*	*I*	*I*			
10. Sedayu	2019	Indonesia			*I*				*I*
11. Eleza &Sediadi	2019	Egypt						*I*	*I*
12. Ramadhan et al.	2019	Indonesia	*I*	*I*	*I*	*I*	*I*		
13. Muchlis et al.	2019	Indonesia	*I*	*I*		*I*			
14. Muchlis et al.	2020	Indonesia	*I*	*I*	*I*	*I*			
15. Fikriarini et al.	2021	Indonesia	*I*	*I*		*I*	*I*		
16. Muchlis et al.	2024	Indonesia		*I*	*I*		*I*		

© 2026 by MIP

Key:

Ac	-	Accessible	ES	-	Escology System
Bl	-	Balance	GC	-	God centric
C	-	Conserve	HC	-	Human centric
Cf	-	Comfort	PN	-	Protecting Nature
Cl	-	Cultural	R	-	Recycle
EF	-	Environment Friendly			

Table 1 presents the seven value-related themes that have been identified and lists the frequency of those merging themes. The higher the frequency of emerging themes indicates that the theme is very important in the discipline of green building. Of these seven themes, the theme on Preventing Damage has the most frequency followed equally by two themes on Community Oriented and Preventing Waste. Next, is the theme on Spiritual Veneration. Two themes on Environment and Climate Friendly equally share the same frequency whilst the theme with the least frequency (4) is on Private Protection. These seven themes are laden with values on green buildings. Values refer to an entity which is both valuable and appreciated. It is valuable because it is liked, wanted, desired and aspired to (Gazalba, 1998). In this study, values mean religious and social values that are valuable to society.

Preventing Damage

The most prominent theme in green buildings is the prevention of environmental damage, encompassing essential natural elements such as soil, water, and plants (Fikriarini et al., 2021; Toosi, 2014; Yazdani & Mahmoudi Nejad, 2016). In Islam, sustainability promotes care for the environment and the avoidance of harm as foundational values (Muchlis et al., 2020), emphasising respect for the local environment and its natural building materials. Allah SWT commands humanity not to cause mischief on earth, and Islam teaches that environmental care arises from inner purity and sincere intention (Al-Attas, 2020).

As the primary actors in the creation and maintenance of green buildings, human behaviour is central to their success; individuals are expected to treat nature with love and respect (Salam & Ibrahim, 2018) because the natural world carries spiritual meaning. This aligns with Islam's sustainability objective of upholding harmonious relations between humans and Allah SWT, between people, and between humans and nature. Conversely, destructive attitudes toward the environment inevitably lead to ecological degradation.

Community-oriented

Green building extends beyond environmental and energy responsibilities to include social and cultural considerations essential to community well-being (Muchlis et al., 2024; Fikriarini et al., 2021; Salam & Ibrahim, 2018). It

encompasses all aspects of life both physical and spiritual while ensuring that benefits are shared equitably.

Designed to serve communities, green buildings provide accessible facilities and infrastructure that support daily needs (Nu'Man, 2016; Nemati et al., 2017; Muchlis et al., 2018). Their planning prioritises ease of circulation, movement, and connectivity within the surrounding area (Sedayu, 2019; Ramadhan et al., 2019), enabling access by walking and strengthening ties to nearby amenities such as markets, schools, and *masajid* (Adi & Puspitasari, 2016; Bakri, 2016).

Preventing wastage

Green buildings minimise wastage of energy, water, and building materials. Such wastes negatively impact the natural environment (Nu'man, 2016). They maintain harmony with nature by prioritising local materials, reused components, and durable construction that prolongs a building's lifespan and reduces long-term maintenance costs (Yazdani & Mahmoudi Nejad, 2016). Using materials that withstand time is the most effective strategy for reducing waste in terms of cost, energy, and resources, followed by reused and recycled materials. High-quality materials that resist weathering and pests also decrease the likelihood of construction waste being dumped at disposal sites (Ramadhan et al., 2019).

Wastage of building materials in the construction sector is unavoidable Each year more than three billion metric tons of raw materials are used for the construction and products sectors worldwide. For the construction sector, it is estimated to be more than double (Calkins, 2009). It is a large number. Therefore, green buildings are an attempt to reduce the negative impact on nature. Additionally, sourcing local materials helps limit air and sea pollution and conserves energy by reducing the transportation required to deliver materials to construction sites (Toosi, 2014).

Spiritual Veneration

Spiritual veneration in green buildings is rooted in the monotheistic principle of *tawhid* which shapes all aspects of their design, use, and management. Grounded in *aqidah* and the consciousness of servitude to Allah SWT, this approach embodies both God-centric and human-centric dimensions, reflecting the unity of the Creator, humanity, and creation (Salam & Ibrahim, 2018; Muchlis, Larasati & Triyadi, 2020; Nu'Man, 2016).

The God-centric dimension emphasises a deep spiritual relationship with Allah SWT, who sustains the universe in perfect harmony (*fitrah*), while the human-centric dimension highlights human responsibilities as servants and stewards (*khalifah*) tasked with nurturing harmonious relationships with others and with nature (Salam & Ibrahim, 2018). Consequently, green buildings are

© 2026 by MIP

conceived and managed in ways that honour and preserve the *fitrah*, ensuring that environmental elements function within their divinely established systems and maintain ecological balance. This orientation encourages moderation in fulfilling human needs and positions green buildings as expressions of spiritual reverence and ecological responsibility.

Environment

Equilibrium in Islam reflects a theological-centric view that places religion at the centre of human–environment relations, making green building inseparable from humanity's role as khalifah (Salam & Ibrahim, 2018). As vicegerents of Allah SWT, humans are responsible for maintaining reciprocal relationships with nature at individual, community, and global levels (Muchlis et al., 2024; Salam & Ibrahim, 2018), ensuring ecological balance, protecting ecosystems, and sustaining healthy green areas (Ramadhan, Wibowo, Soekard & Hertoety, 2019).

Providing green areas plays a crucial role in enhancing community well-being by supporting a healthy and high-quality environment, complementing the benefits of green buildings (Noorzai et al., 2026; Baskaran et al., 2025). Green area refers to an area that is covered by or with greenery such as a field, planted spaces with green trees such as parks, green roof, or water pond. With the presence of green areas, the impact of development on biodiversity balance can be reduced (Ramadhan et al., 2019) Environmental imbalance occurs when humans dominate nature for personal gain, reflecting an anthropocentric worldview that contrasts with Islam's theological-centric approach (Muchlis, Larasati & Triyadi, 2018). Accordingly, green buildings prioritise ecological sustainability throughout their life cycle by creating environments with fresh air, fertile land, and natural productivity, supported by green zones that preserve native trees, protect animal welfare, provide shelters and resources, and plant local fruit trees as community reserves. These efforts moderate temperatures, improve air quality, and elevate the status of animals and nature as creations of Allah SWT, fostering harmonious and balanced ecological interactions.

Climate Friendly

Climate-friendly (or environmentally friendly) design in green buildings emphasises harmonious integration with nature to minimise environmental impacts and adapt effectively to climatic conditions (Ali & Abdelmaksoud, 2017; Eleza & Sediadi, 2019). Such buildings utilise passive design strategies and natural renewable energy sources, including solar and wind, aligned with their environmental context (Nemati et al., 2017). Features such as inner courtyards that enhance air circulation and the use of natural local materials create efficient ecological micro-systems, as seen in Iran where wood and clay are commonly used (Oleiwi et al., 2014).

Topographic interactions and geographical interactions have the implications of optimizing energy, providing comfort and contributing to good health in the building (Rahman, 2015). This interaction also influences the lighting and air circulation in the green building. Green buildings prioritise environmental harmony by ensuring construction meets both physical and spiritual needs without overexploiting resources, considering micro-environmental factors like ventilation, lighting, temperature, and air quality. Effective site selection, climate-responsive design, and the prevention of heat island effects further enhance comfort and sustainability, while the use of local, natural, and recycled materials reduces pollution, waste, and costs, ensuring compatibility with local climatic and geographical conditions.

Privacy Protection

Privacy protection is grounded in Allah SWT's command for humans to cultivate harmonious social relations by fulfilling natural desires within clean, safe, and morally guided environments. This means preventing free intermingling between men and women and safeguarding *aurat* in accordance with Shariah (Eleza & Sediadi, 2019). Green buildings aligned with Shariah therefore incorporate features that maintain privacy, dignity, *aurat,* and resident comfort (Raoufeh, 2014), such as separating male and female spaces and preventing visual intrusion from surrounding areas (Nu'man, 2016).

As structures intended to support humans in fulfilling their duties as obedient servants of Allah SWT (Salleh, 2003), green buildings in Islam provide designated prayer spaces, correct *qiblah* orientation, and gender-segregated facilities to ensure that acts of worship, modesty, and other religious obligations are not compromised (Asiah Abdul Rahim, 2009). Beyond physical arrangements, privacy protection also extends to fostering proper etiquette in social interactions, as Islam emphasises modest behaviour, lowering the gaze, and avoiding improper mixing between non-mahram individuals, thereby reinforcing moral integrity, spiritual well-being, and alignment with Shariah within the built environment.

POLICY IMPLICATIONS

The findings of this study reveal important policy implications for advancing sustainability within the built environment. Recognising the alignment between green-building values and Islamic sustainability principles opens opportunities for policymakers, particularly in Muslim-majority contexts, to integrate ethical and spiritual considerations into national guidelines, certification tools, and community-based initiatives. Embedding values such as stewardship, balance, and responsible resource use into policy frameworks can strengthen cultural resonance, enhance public legitimacy, and encourage broader adoption of sustainable practices in both religious and non-religious settings.

© 2026 by MIP

Given the strong influence of faith-based values on environmental behaviour, policymakers are encouraged to collaborate with religious institutions, scholars, and community leaders. Supporting *masajid* and other faith facilities in implementing green design features, modelling low-carbon behaviours, and serving as hubs for environmental education can elevate public awareness and accelerate societal transitions toward sustainability.

Beyond Islam, diverse faith traditions contribute complementary ecological ethics, such as creation care, interdependence, non-harm, and Indigenous stewardship, that can enrich policy design. Recognising this diversity allows sustainability initiatives to be framed in ways that resonate with the moral foundations of different communities, enabling culturally sensitive and inclusive policymaking. Leveraging these shared ethical commitments broadens public participation, fosters ownership of sustainability agendas, and reinforces the view that environmental responsibility is not only a technical imperative but also a culturally grounded and socially meaningful endeavour.

CONCLUSION

The findings of this study identified seven key themes that reflect values aligned with a faith-based approach to sustainability. These themes include worship, balance, community orientation, prevention of harm, avoidance of waste, protection of privacy, and climate consciousness. Together, they suggest a holistic framework for integrating Islamic values into the design and development of green buildings. Sustainability in green buildings based on faith-based principles creates a balanced harmony between values, forms and functions.

These values are upheld to complement each other with the shape and function of the buildings despite different climates. Green buildings contribute not only to environmental health but also to the enhancement of socio-religious functions within local communities. The values embedded in such structures, rooted in both physical and spiritual dimensions, form a balanced and integrated framework that addresses the holistic needs of human beings. These buildings should harmonize with nature, avoiding environmental degradation, while simultaneously fostering an atmosphere of love and spiritual connection to Allah SWT, fellow human beings, and the natural world. This dual emphasis on ecological responsibility and spiritual enrichment reflects the essence of a faith-based approach to sustainable architecture.

This research provides significant implications for future sustainable development by offering a comprehensive framework that can inform policy formulation, regulatory control, and monitoring mechanisms for Muslims in the development of green buildings. It introduces an integrated conceptual foundation that aligns environmental sustainability with Islamic principles, ensuring that future developments reflect both ecological responsibility and spiritual values. The proposed framework can serve as a strategic reference for

planners, policymakers, architects, and local authorities in guiding the implementation of green design. Furthermore, it offers a coherent basis for developing green and Islamic townships in Malaysia, presenting a more holistic and systematic alternative to the existing eclectic approaches to green townships and Islamic city concepts.

ACKNOWLEDGMENT

The authors wish to express their appreciation to the Ministry of Higher Education Malaysia and Universiti Sains Malaysia for providing a research grant and permission respectively to carry out a study on Formulating the Framework for a Sustainable Islamic Development Approach (F2SIDA) in Malaysia (203.CISDEV.6711740) under Fundamental Research Grant Scheme financed by Ministry of Higher Education Malaysia (FRGS/1/2019/SSI10/USM/03/1), that has enabled the research and writing of this paper.

REFERENCES

Adi, S. M., & Puspitasari, C. (2016). Mosque as a model of learning principles of sustainable architecture. *Journal of Islamic Architecture, 4*(1), 33.

Al-Attas, S. M. N. (2020). *Islam dan sekularisme*. RZS-CASIS.

Al-Jayyousi, O., Mohamed Saniff, S., Wan Hasan, W. N., Janahi, N. A., & Yesuf, A. J. (2022). Re-thinking sustainable development within Islamic worldviews: A systematic literature review. *Sustainability, 14*, 7300. https://doi.org/10.3390/su14127300

Al-Jayyousi, O., Wan Hasan, W. N., Mohamed Saniff, S., Sever, S. D., & Tok, E. (2023). A critical discourse analysis on climate change in a globalized world: The nexus of Islam and sustainable development. *Sustainability, 15*(19), 14515. https://doi.org/10.3390/su151914515

Ali, W. H., & Abdelmaksoud, N. M. (2017). An applicable approach to green architecture in Egypt proposed measurement matrix model to assess the use of historic Islamic architectural elements and repertoire in the application of green architecture principles and concepts. *British Journal of Multidisciplinary and Advanced Studies, 1*(1), 45–69.

Bakri, M. (2016). Sustainable architecture through Islamic perspective. *Proceedings of Ar-Raniry Conference of Islamic Studies (ARICIS I), (1)*, 491–499.

Baskaran, S., Ab. Azis, S. S., Mat Salleh, K., Aziz, N., & Jaafar, M. N. (2025). Assessing green roof impact on mental health in Malaysia via questionnaire based frequency analysis. *Journal of the Malaysian Institute of Planners, 23*(6), 826–841. https://doi.org/10.21837/pm.v23i39.1944

Bhamra, T., & Lofthouse, V. (2007). *Design for sustainability: A practical approach*. Gower Publishing, Ltd.

Calkins, M. (2009). *Materials for sustainable sites: A complete guide to the evaluation, selection, and use of sustainable construction materials*. Hoboken, New Jersey: John Wiley.

Dwaikat, L. N., & Ali, K. N. (2018). The economic benefits of a green building – Evidence from Malaysia. *Journal of Building Engineering, 18*, 448–453.

© 2026 by MIP

Edmondson, S. T. (2007). *Sustainability think tank: Trends & waves defining the debate*. Retrieved from http://www.sustainability2030.com/sustainabilityclips/2007/9/24/sustainability-think-tank-trends-amp-waves-defining-the-deba.html on 21 August 2020.

Eleza, A. G., & Sediadi, E. (2019). Role of historic architectural elements in approach to green architecture in private homes and high-rise buildings in the United Arab Emirates (UAE) and Egypt. *Proceedings of the 18th International Conference on Sustainable Environment and Architecture (SENVAR 2018)*.

Fikriarini, A., Larasati, D., & S., S. T. (2021). Reaching the understanding of the green building concept in Islamic value: Thematic tafseer study. *Journal of Islamic Architecture, 6*(4), 321–330. https://doi.org/10.18860/jia.v6i4.12742

Gazalba, S. (1998). *Islam dan kesenian: Relevansi Islam dengan seni-budaya karya manusia*. Jakarta: Pustaka Alhusna.

GBI Malaysia. (2016). Retrieved from http://new.greenbuildingindex.org/how/tools on 30 August 2020.

Haddaway, N. R., Macura, B., Whaley, P., & Pullin, A. S. (2018). ROSES reporting standards for systematic evidence syntheses: Pro forma, flow-diagram and descriptive summary of the plan and conduct of environmental systematic reviews and systematic maps. *Environmental Evidence, 7*(1).

Higgins, J. P. T., & Green, S. (2011). *Cochrane handbook for systematic reviews of interventions*. Retrieved from https://handbook-5-1.cochrane.org/

Islam, M. M. (2004). Towards a green earth: An Islamic perspective. *Asian Affairs, 26*(4), 44–89.

Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. In *EBSE technical report*. Software Engineering Group, School of Computer Science and Mathematics, Keele University, Department of Computer Science, University of Durham.

Muchlis, A. F., Larasati, D., & Triyadi, S. (2019). Identifying Islamic values on green architectural concept: Quantitative approaches to content analysis. *Journal of Islamic Architecture, 5*(4), 221–228.

Muchlis, A. F., Larasati, D., & Triyadi, S. (2020). Sustainable development and architecture: A conceptual based on religious perspectives. *International Journal of Advanced Research in Engineering and Technology, 11*(4), 1–6.

Nemati, M. A., Bemanian, M. R., & Ansari, M. (2017). A framework for sustainable architecture in Iran with emphasis on the views of scholars. *Journal of Building Performance, 8*(1), 58–68.

Noorzai, M. Q., Hosni, N., & Pashton, N. (2026). Awareness to understanding of green infrastructure in Iskandar Malaysia. *Journal of the Malaysian Institute of Planners, 24*(1), 243–264. https://doi.org/10.21837/pm.v24i40.1971

Nu'man, S. (2016). A unified architectural theory for Islamic architecture. *International Journal of Architectural Research, 10*(3), 100–112.

Oktay, D. (2014). Towards human sustainable urbanism: Interrogating the contemporary approaches and the traditional Turkish (Ottoman) city. In Mira, R. G., & Dumitru, A. (Eds.), *Urban sustainability innovative spaces, vulnerabilities and opportunities: 6th international symposium on "sustainable environments in a changing global context" at A Coruña, Spain in 25-28 June 2013* (pp. 33–48).

© 2026 by MIP

Oleiwi, M. Q., Ali, A., Utaberta, N., & Surat, M. (2014). The application of principles of green building in traditional housing in Iraq. *Applied Mechanics and Materials, 747*, 7–11.

Rahman, A. M. (2015). *Ke arah melestarikan alam bina untuk generasi masa hadapan*. Pulau Pinang: Penerbit Universiti Sains Malaysia.

Ramadhan, T., Wibowo, H., Soekardi, R. R., & Hertoety, D. A. (2019). Implementation of green architecture concept in mosque design: A face and Islamic da'wah. *Indonesian Journal of Built Environment and Sustainability, 1*(1), 23–33.

Salam, H., & Ibrahim, N. L. N. (2018). Aspects of sustainable architecture: An Islamic perspective. *Alam Cipta, 11*(2), 2–11.

Salleh, M. S. (2003). *7 prinsip pembangunan berteraskan Islam*. Zebra Publications.

Sedayu, A. (2019). Factors effected the performance of green building in madrasah building components. *Proceeding of International Conference Science Engineering, 2*, 271–274.

Suh, S., Tomar, S., Leighton, M., & Kneifel, J. (2014). Environmental performance of green building code and certification systems. *Environmental Science & Technology, 48*(5), 2551–2560.

Toosi, R. (2014). An exploration on ecologic compatibility and green architecture principles in Iranian deserts. *Research Journal of Environmental and Earth Sciences, 6*(8), 424–429.

United Nations. (2012). *Review of implementation of Agenda 21: Detailed review of implementation of Agenda 21*. Retrieved from https://sustainabledevelopment.un.org/content/documents/1126SD21%20Agenda21_new.pdf on 16 September, 2020.

WBCSD. (2020). *Why it matters*. Retrieved from http://www.wbcsd.org/work-program/sector-projects/electricity-utilities.aspx on 31 August, 2020.

Whittemore, R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advance Nursing, 52*(5), 546–553.

World Commission on Environment and Development. (1987). *Our common future*. New York: Oxford University Press. Retrieved from http://www.un-documents.net/wced-ocf.htm on 2 September 2014.

WorldGBC. (2015). *About us*. Retrieved from http://www.worldgbc.org/about-us on 4 July 2015.

Xiao, Y., & Watson, M. (2017). Guidance on conducting a systematic review. *Journal of Planning Education and Research*, 1–20.

Yazdani, & MahmoudiNejad. (2016). The green future: Architecture + sustainability; Green architecture and impacts of it on urban planning and urban design. *Journal of Urban Management, 15*(43), 337–352.

Yudelson, J. (2008). *The green building revolution*. Washington: Island Press.

Zhao, D., He, B., Johnson, C., & Mou, B. (2015). Social problems of green buildings: From the humanistic needs to social acceptance. *Renewable and Sustainable Energy Reviews, 51*, 1594–1609. https://doi.org/10.1016/j.rser.2015.07.072

Zuo, J., & Zhao, Z. Y. (2014). Green building research–current status and future agenda: A review. *Renewable and Sustainable Energy Reviews, 30*, 271–28

Received: 28th October 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 138 – 152

PLANNING FOR URBAN POVERTY TRANSFORMATION: LIVELIHOOD TYPOLOGIES AND COMMUNITY RESILIENCE IN MALAYSIA

Shereeza Mohamed Saniff[1]*, Mohd Sadiq Mohd Mokhtar[2], Ahmad Shaifful Anuar Ahmad Shukor[3], Azrin Ibrahim[4]

[1,2,3,4]*Centre for Islamic Development Management Studies (ISDEV),*
UNIVERSITI SAINS MALAYSIA

Abstract

This study examines differentiated livelihood transformation pathways among urban poor households through a longitudinal analysis based on participants of project situated in an urban setting in the northern part of Malaysia. Using qualitative document analysis and income trajectory monitoring across three programme phases, households were classified based on patterns of livelihood strategies, programme engagement and adaptive capacity. Findings reveal four livelihood typologies: Progressive–Resilient, Fluctuating–Vulnerable, Stagnant–Dependent, and Women-Led Entrepreneurial households. These typologies are synthesised into a four-quadrant conceptual framework that integrates engagement intensity and adaptation capacity. The study advances empirical understanding of urban poverty dynamics and highlights the need for differentiated gender-sensitive and resilience-oriented policy interventions for sustainable urban poor community-based transformation.

Keywords: Urban Poverty, Livelihood typology, Community empowerment, Household adaptive capacity, sustainable community

[1] Corresponding author. Email: shereeza@usm.my

INTRODUCTION

Urban poverty is a complex challenge in rapidly urbanising Malaysia, where socio-economic shifts have concentrated low-income households in dense settlements. Despite improved infrastructure, families face income instability, limited opportunities, and social exclusion (Ismail et al., 2025). Traditional analyses often treat households as homogeneous, measured only by static income thresholds, overlooking diverse livelihood strategies and resilience (Kakwani & Son, 2025).

The MASA@Sungai Nibong project, a community-based initiative in Northern Malaysia, integrates lifelong learning with longitudinal household monitoring (Mokhtar et al., 2025). This study addresses the gap by applying a livelihood typology approach (Pham et al., 2021) to four years of data, constructing a differentiated framework of urban poor household trajectories for targeted, resilience-oriented planning.

LITERATURE REVIEW

Urban Poverty

Urban poverty is widely recognised as a multidimensional phenomenon influenced by economic, social and spatial dynamics. Rapid urbanisation may generate employment and infrastructure development, but it also intensifies inequalities through rising living costs, housing congestion and unequal access to public services. (Avtar et al., 2025; Sakketa, 2025). As a result, poverty tends to concentrate within specific urban localities such as low-cost housing areas and marginal neighbourhoods, where residents remain vulnerable despite proximity to economic centres (Kasula et al., 2026). Household dynamics play a critical role in determining how urban poor families navigate these structural constraints. Studies show that households frequently adopt diversified livelihood strategies such as informal employment, gig work and small-scale entrepreneurship to manage economic uncertainty (Hossain, 2024). In many cases, gender roles within households have also evolved, with women increasingly contributing as income earners while simultaneously managing domestic responsibilities.

Community Resilience

Community resilience refers to the ability of households and communities to absorb shocks, adapt to socio-economic pressures and reorganise livelihood strategies in changing urban conditions (Do et al., 2025; Kapucu et al., 2024). Within the context of poverty governance, resilience is not only reflected in income improvement but also in the ability of households to maintain economic stability and long-term development orientation.

© 2026 by MIP

Livelihood Typology

Livelihood typology analysis has emerged as an important approach for understanding the diversity of livelihood strategies among poor households by classifying families based on behavioural patterns, adaptation strategies and economic trajectories rather than income levels alone (Evans et al., 2025). This approach allows researchers and policymakers to identify differentiated livelihood pathways and design more targeted policy responses.

Monitoring and Poverty Governance

Recent studies emphasise the importance of systematic monitoring and data-driven decision-making in poverty alleviation programmes. Continuous monitoring allows institutions to detect stagnation or regression in household economic performance and to adjust intervention strategies accordingly (Esposito, 2025). In Malaysia, empowerment initiatives targeting asnaf and low-income communities have increasingly incorporated structured monitoring frameworks to track household progress and ensure sustainable livelihood transformation (Ismail et al., 2025).

Research Gap and Contribution

Although urban poverty has been extensively studied, many existing studies continue to treat poor households as a homogeneous group, often categorised broadly under the B40 classification. Such approaches may overlook variations in livelihood strategies, adaptive capacity and programme engagement among households. Understanding these differences is essential for designing more effective poverty interventions. Furthermore, understanding these variations requires a deeper look into the underlying values of a community; for instance, Islamic values, particularly the concepts of Khalifah (stewardship) and Mizan (balance), provide a robust ethical foundation for urban communities to foster environmental responsibility and strengthen social resilience in the face of climate change (Al-Jayyousi et al., 2023). This study contributes to the literature by developing a longitudinal livelihood typology derived from four years of household monitoring within a community-based intervention programme. By integrating income trajectories, programme engagement and adaptive capacity, the study offers a differentiated analytical framework for understanding urban poverty transformation in Malaysia.

RESEARCH METHODOLOGY

Research Design and Unit of Analysis

This study adopts a qualitative research design through document analysis of Projek MASA@Sungai Nibong, a community-based socio-economic empowerment initiative. The household is established as the primary unit of

analysis to capture the collective livelihood strategies of urban poor families. While the dataset includes information on 17 Household Heads (KIR) and 9 spouses (PKIR), the analysis evaluates socio-economic performance and adaptive capacity at the family level, allowing a more holistic understanding of how households navigate economic constraints. The core community profile is summarised in Table 1.

Table 1: Profile information of Projek MASA@Sungai Nibong community.

Metric	Details
Total Households (n)	17 households
Total Individual	26 (17 KIR & 9 PKIR)
Monitoring Period	Longitudinal Tracking (4 years / 3 phases)
Data Integrity	No missing data; verified via monthly monitoring reports

Data Quality and Definitions

To ensure analytical consistency, several operational definitions were applied. Zero Income refers to households without active earners due to chronic illness or total disability. Income Volatility denotes unstable cash flow resulting from reliance on informal or gig-based employment. Income Stagnation describes household income that remains static or grows less than 5% across monitoring phases despite continuous institutional support.

Data Triangulation and Ethics

In accordance with ethical research practices, all personal data has been strictly anonymised through the use of codes such as KIR1 and PKIR1 to ensure respondent confidentiality. The validity of the findings is reinforced through a triangulation process involving three primary sources as illustrated in Figure 1. These sources consist of documented income records for periodic tracking, programmed documentation regarding participation continuity, and participatory observations by the Liaison Officer, also known as the Penghulu. These observational insights were cross-validated against predefined indicators to minimise potential observer bias and ensure an objective recording of the participants' engagement.

© 2026 by MIP

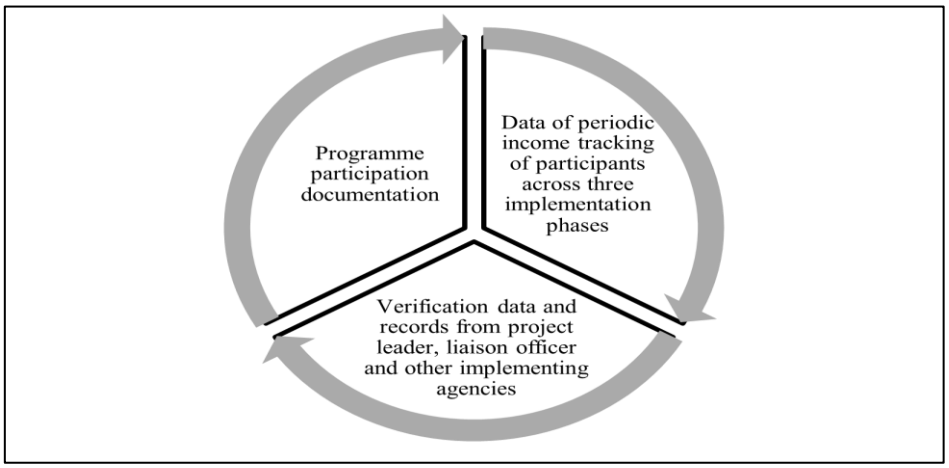


Figure 1: Triangulation process of the articles
Source: Author's Illustration (2025)

Data Analysis: Descriptive and Typological Classification

Data analysis was conducted in two stages. First, descriptive analysis examined household income patterns, stability trends and growth trajectories across the three implementation phases. Second, a typological classification was constructed to group households based on shared economic behaviour, gender-based livelihood roles particularly the participation of spouses (PKIR), and levels of programme engagement. This approach allows urban poor households to be analysed as diverse livelihood units with varying adaptive capacities, rather than as a homogenous population.

ANALYSIS AND DISCUSSION

This section presents the findings derived from document analysis of participants' income records under the project from December 2020 to December 2024. Descriptive and comparative analysis was applied to examine income trends, household transformation patterns and economic trajectories. Based on these observations, several typological patterns of urban poor households are identified and discussed in relation to the effectiveness of community-based interventions and urban poverty planning.

Longitudinal Income Patterns and Household Economic Trajectories

The document analysis indicates that household income trajectories among project participants vary significantly over time. Several participants demonstrated consistent income growth, reflecting successful adaptation to stable employment or micro-enterprise activities. For example, KIR8, KIR11 and KIR15 maintained income stability above RM1,200 across multiple monitoring

phases, indicating successful economic anchoring within the urban environment. In particular, the household of KIR8, with additional income contribution from spouse PKIR8, achieved an estimated combined monthly income of approximately RM3,500, illustrating a clear case of sustained economic improvement.

Moderate income growth was also observed among households engaged in micro-businesses or wage employment. Participants such as PKIR2, KIR3, PKIR6, KIR10, KIR12 and PKIR15 recorded gradual income increases through small-scale business activities, while others including PKIR1, KIR8, PKIR8, KIR11, KIR13, PKIR14, PKIR15 and KIR16 improved their income through paid employment. In both cases, livelihood improvements were closely linked to locality-based opportunities such as working as factory security guards, teaching at nearby preschools and selling food to factory workers. This highlights the important role of spatial proximity to employment opportunities in supporting incremental economic progress among urban poor households. However, several participants experienced fluctuating income due to health challenges and family transitions. PKIR2 continued supporting the household through her microbusiness while her husband KIR2 faced accident-related health complications. KIR4 experienced economic instability following the loss of a spouse, while KIR5 and KIR6 encountered work limitations due to spinal and nerve-related conditions. Nevertheless, spousal cooperation remained an important coping mechanism, as illustrated by KIR6, who assisted in his wife's enterprise (PKIR6) despite health limitations. A number of participants remained economically stagnant or recorded zero income due to severe health conditions, disability or age-related limitations. KIR1 was unable to work due to physical disability, while PKIR5 and PKIR14 faced serious illnesses including brain, bone and blood cancer. Elderly participants such as KIR7 and KIR9 were constrained by age and chronic health conditions, with KIR7 also prioritising caregiving for her adult child diagnosed with lung cancer. Meanwhile, KIR14 and PKIR16 experienced diabetes, visual impairment and mobility challenges that limited economic participation. These cases demonstrate how serious health burdens and caregiving responsibilities significantly restrict livelihood capacity and reinforce long-term dependency despite participation in empowerment programmes.

From a planning perspective, these findings demonstrate that urban poverty is dynamic rather than static, shaped by household capacity, access to opportunities, gender roles and levels of community engagement. The variation in household trajectories therefore highlights the need for differentiated and targeted planning interventions rather than uniform poverty alleviation strategies.

© 2026 by MIP

Identification of Urban Poor Family Typologies

The classification of households into typologies was guided by three analytical indicators: (1) income trajectory observed across the three monitoring phases, (2) intensity of programme engagement including participation in training, mentoring and monitoring activities, and (3) observable household adaptive strategies such as income diversification, spousal cooperation and livelihood adjustment. Households demonstrating consistent income growth and active programme participation were categorised as Progressive–Resilient, while those with unstable income patterns were classified as Fluctuating–Vulnerable. Households with persistent income stagnation or inability to generate income were categorised as Stagnant–Dependent, whereas households in which women emerged as the primary economic drivers through micro-enterprise activities were classified as Women-Led Entrepreneurial.

Based on consistent income movement patterns across the three project phases, four primary household typologies emerge. The identification of these four distinct typologies aligns with the necessity of adopting ethnographic and socio-cultural approaches in poverty studies, as conventional quantitative metrics often fail to capture the lived experiences and inherent dignity of households within their communal settings (Ahmad et al., 2025).

i. Progressive–Resilient Households

Progressive–resilient households refer to urban poor families that demonstrate a consistent upward trajectory in economic participation while maintaining adaptive coping capacities despite structural constraints. These households are characterised by stable or increasing income patterns, strong internal family support and active engagement in empowerment initiatives. In this context, resilience reflects not only the ability to withstand economic shocks but also the capacity to translate opportunities into sustainable livelihood strategies (Do et al., 2025). Within the project community, this typology is represented by families that consistently participated in skills training, entrepreneurship programmes and monitoring activities, demonstrating strong alignment between institutional support and household agency. Empirical patterns show that many progressive–resilient households achieved economic stability primarily through sustained wage employment rather than entrepreneurial expansion. Participants such as PKIR1, KIR8, PKIR8, KIR11, KIR13, PKIR14, PKIR15 and KIR16 transitioned from irregular income sources into more stable salaried or contractual employment in nearby factories, security services, educational institutions and service sectors. In several cases, both the household head (KIR) and spouse (PKIR) contributed economically, strengthening income diversification and reducing vulnerability to single-income shocks.

Beyond financial stability, these households also demonstrated stronger behavioural transformation and long-term developmental orientation, particularly through participation in lifelong learning activities, faith-based programmes and regular performance monitoring. These patterns reflect findings by Esposito (2025) and Kapucu et al. (2024) that resilience among urban poor households is reinforced through social capital, disciplined household management and future-oriented planning. A clear example is KIR8, who transitioned from unstable income to consistent earnings above RM2,000, with additional contribution from spouse PKIR8, resulting in an estimated combined household income of approximately RM3,500 per month. This case illustrates how strong institutional engagement combined with household discipline can produce sustainable economic stabilisation.

ii. Fluctuating–Vulnerable Households

Fluctuating–vulnerable households represent families experiencing unstable yet adaptive economic trajectories. Their livelihoods are characterised by irregular income patterns, job insecurity and reliance on multiple informal or semi-formal income sources. As described by Li et al. (2024) and Sun et al. (2025), these households operate within conditions of persistent vulnerability where periods of recovery and regression coexist.

Within the project community, participants such as KIR4, KIR17, KIR5, PKIR2 and KIR10 demonstrate this pattern. Income records show alternating phases of improvement and decline, particularly among households dependent on daily-wage employment, small-scale food trading, ride-hailing services or seasonal micro-business activities. Participants PKIR2 and KIR10, for instance, experienced income improvements during periods of active entrepreneurship training or favourable market demand but faced downturns due to health interruptions and childcare responsibilities. Despite income volatility, these households display adaptive capacity through labour flexibility, skill diversification and reliance on institutional support networks. However, their ability to consolidate long-term economic gains remains limited due to continued exposure to labour informality and household vulnerabilities. From a planning perspective, fluctuating–vulnerable households require stabilisation-oriented interventions, including employment security pathways, childcare support, income-smoothing mechanisms and financial management assistance. Systematic monitoring within the project has proven valuable in identifying these income oscillations and enabling targeted mentoring and programme adjustments. The experience of KIR10, whose income remained volatile despite active programme participation, illustrates that engagement alone is insufficient without structural buffers to support sustained transformation.

© 2026 by MIP

iii. Stagnant–Dependent Households

Stagnant–dependent households represent families experiencing minimal or inconsistent economic progress and remaining highly reliant on external assistance despite prolonged exposure to empowerment programmes. Their trajectories are typically shaped by multiple constraints including poor health, caregiving burdens, limited education and reduced adaptive capacity.

Within the project community, participants such as KIR1, PKIR5 and PKIR16 consistently recorded zero or near-zero income across monitoring phases despite participation in community initiatives. Similarly, KIR2 and KIR14 initially participated in training programmes but were unable to sustain economic activity due to health challenges, family crises or limited access to market opportunities. KIR7 and KIR9, both elderly single mothers, also remained economically inactive due to age-related limitations, with KIR7 further constrained by caregiving responsibilities for her adult child diagnosed with lung cancer. These cases illustrate how severe health conditions, caregiving responsibilities and structural disadvantages can significantly limit livelihood capacity. As noted by Blocker et al. (2023) and Hu and Xu (2025), persistent poverty often occurs when individuals lack the capability to convert available opportunities into sustainable outcomes. From a planning perspective, this typology highlights the limitations of standardised empowerment programmes. Stagnant–dependent households require long-term social protection, personalised mentoring and continuous psychosocial support, rather than productivity-driven interventions alone. The case of KIR1, who consistently recorded zero income due to severe physical disability, illustrates how deeply rooted health constraints may necessitate welfare-oriented protection alongside community support systems.

iv. Women-Led Entrepreneurial Households

Women-led entrepreneurial households represent a typology in which women emerge as the primary economic drivers through micro-enterprise activities. In these households, wives assume active income-generating roles either as household heads (KIR) or as spouses (PKIR), reflecting a shift from traditional male-centred income structures towards dual-earner or women-led livelihood strategies (Mohan, 2024).

Evidence from the project illustrates this transformation clearly. Participants such as KIR3, PKIR6, KIR12 and KIR15 transitioned from full-time homemakers into entrepreneurs following structured capacity-building, mentoring and institutional networking. These women accessed catalytic financial assistance through the Geran Bangkit Perniagaan (RM5,000) from Sadaqa House of Bank Islam Malaysia Berhad, alongside RM1,000 from Yayasan Aafiyat, enabling them to establish small-scale food businesses, service-

based ventures and home-based retail activities. In several households, entrepreneurial activities were further strengthened through spousal collaboration. For example, KIR6 and PKIR12, husbands of PKIR6 and KIR12 respectively, contributed operational support within the businesses, reinforcing income stability. These outcomes support findings by Alayed and Alateeg (2025) that women's economic participation enhances household income, decision-making capacity and long-term resilience.

Beyond income generation, women-led entrepreneurial households also demonstrate shifts in family roles, with women balancing economic responsibilities alongside childcare, education supervision and community engagement. As noted by Gad and Leone (2024), this productive–reproductive balancing reflects the multidimensional role of women in sustaining both household welfare and economic resilience. Within the project context, women entrepreneurs also actively participated in entrepreneurship training, faith-based development sessions and market exposure programmes, highlighting the importance of integrated economic and psychosocial empowerment in supporting sustainable poverty transformation.

The Constructed Family Livelihood Typology Framework

This study synthesises longitudinal income trends, programme participation and adaptive behaviours observed over a four-year project period to construct a four-tier typology of urban poor households. The framework demonstrates that urban poverty is not a uniform condition but evolves through differentiated livelihood strategies shaped by varying levels of adaptive capacity, vulnerability, gender dynamics and engagement with empowerment interventions.

Within this framework, Progressive–Resilient Households demonstrate the highest level of programme engagement and adaptive capacity. These households successfully translate empowerment opportunities into sustained livelihood gains through stable employment, income diversification and long-term household planning. In contrast, Fluctuating–Vulnerable Households experience persistent income instability and rely on short-term adjustments across informal, gig and seasonal activities. Although these households display coping flexibility, their inability to consolidate economic gains exposes them to recurring cycles of vulnerability. Stagnant–Dependent Households represent the most structurally constrained group. Their trajectories are characterised by prolonged income stagnation, heavy reliance on welfare assistance and limited engagement with empowerment initiatives. Multiple constraints, including poor health, caregiving burdens, psychological stress and low human capital, contribute to a dependency-lock pattern that restricts livelihood transformation. These households therefore require personalised and protection-oriented interventions beyond conventional entrepreneurship programmes.

© 2026 by MIP

The fourth typology, Women-Led Entrepreneurial Households, highlights a gender-driven restructuring of household livelihoods in which women emerge as primary income generators through micro-enterprise activities supported by targeted entrepreneurship assistance. This typology reflects adaptive economic transformation occurring primarily within the household unit, often driven by women's initiative rather than continuous institutional engagement. Together, these four typologies are synthesised into a four-quadrant conceptual framework structured along two analytical axes: programme engagement and adaptive capacity, as illustrated in Figure 2. Households were classified into each typology based on two dimensions: (1) the level of programme engagement reflected in training participation, mentoring attendance and utilisation of financial assistance, and (2) household adaptive capacity reflected in income diversification, livelihood stability and behavioural adaptation over time.

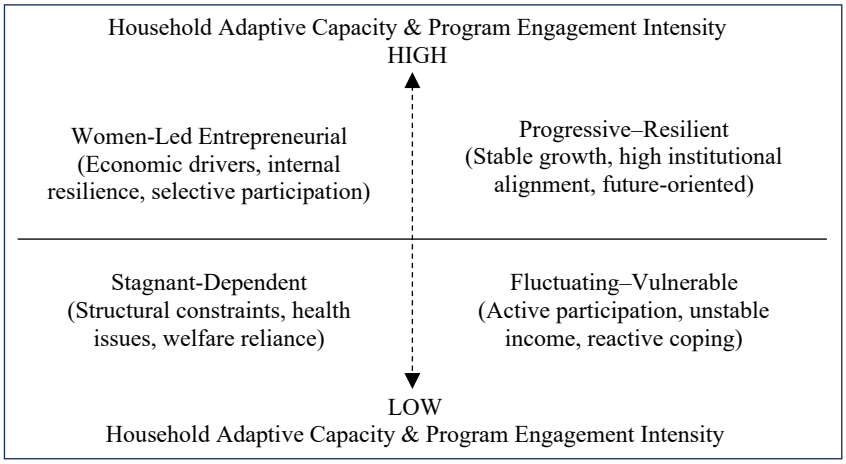


Figure 2: Four-Quadrant Livelihood Typology Framework of Urban Poor Household
Source: Author's Illustration (2025)

Figure 2 illustrates a conceptual framework that reframes urban poverty as a dynamic transformation spectrum rather than a linear condition. The framework provides a theoretically grounded lens for understanding diverse livelihood trajectories, including survival, stagnation, adaptation and transformation within constrained urban environments. Within this framework, Progressive–Resilient Households occupy the high engagement–high adaptive capacity quadrant. These families actively leverage empowerment programmes, training, mentoring and financial support to establish stable and diversified income systems. Strong behavioural discipline, consistent programme

participation and long-term livelihood planning enable them to absorb shocks and sustain economic stability. In contrast, Fluctuating–Vulnerable Households fall within the high engagement–moderate adaptive capacity quadrant. Although these households participate actively in training and development initiatives, structural vulnerabilities such as labour informality, health risks, caregiving responsibilities and seasonal employment limit their ability to achieve stable transformation. Their livelihood strategies therefore remain reactive, characterised by recurring cycles of income improvement and regression. Stagnant–Dependent Households are positioned in the low engagement–low adaptive capacity quadrant, representing the most structurally constrained group. Chronic health problems, psychological stress, caregiving burdens and prolonged income inactivity restrict their ability to participate consistently in empowerment programmes or convert available opportunities into sustainable livelihood outcomes. As a result, long-term welfare dependency persists. Meanwhile, Women-Led Entrepreneurial Households occupy the moderate engagement–high adaptive capacity quadrant, where economic transformation is primarily driven by women's micro-enterprise initiatives supported by targeted entrepreneurship programmes and catalytic financial assistance. Supported by small grants and short-term training, women in these households develop sustainable income-generating activities while balancing caregiving responsibilities. Although institutional engagement may be selective or intermittent, these households demonstrate strong adaptive capacity through opportunity recognition, market participation and income expansion.

Overall, the framework highlights that livelihood transformation among urban poor households is shaped not only by access to empowerment programmes but also by the interaction between institutional engagement and household adaptive capacity.

Policy and Planning Relevance

The construction of these livelihood typologies provides urban planners and policymakers with a strategic decision-support instrument that moves beyond the conventional, one-size-fits-all B40 classification. The need for differentiated planning interventions as proposed in this framework is consistent with Malaysia's structured planning system, where global sustainability goals are integrated into national policies to ensure that local development remains inclusive and responsive to specific household needs (Dariah et al., 2020). First, the framework enables Precision Targeting in urban poverty governance, where resources can be differentiated: providing long-term social safety nets for the Stagnant-Dependent Household while focusing on business-scaling and market access for the Progressive-Resilient Household and Women-Led Household groups. Second, the findings highlight the need for Inclusive Urban Housing

© 2026 by MIP

Design; the success of women entrepreneurs in this study suggests that low-cost housing policies should incorporate home-based enterprise (HBE) spaces and community childcare facilities to support gender-activated economic restructuring. Third, by adopting the Longitudinal Monitoring Logic used in this research, local authorities can develop an "Early Warning System" to detect household stagnation or regression in real-time. This shifting of the paradigm from reactive welfare to proactive, family-entered developmental planning ensures that urban intervention strategies are responsive to the actual adaptive capacities and structural constraints of the urban poor.

CONCLUSION

This study proposes a four-quadrant family typology to explain the fluid livelihood trajectories of urban poor households, showing that poverty shifts with engagement, adaptive capacity, and institutional support. Findings highlight that sustainable poverty exit is driven by consistent participation, income diversification and behavioural transformation. The typology offers policymakers a practical tool for designing differentiated, adaptive and gender-responsive urban poverty interventions.

ACKNOWLEDGEMENT

This study was supported by Zakat Majlis Agama Islam Negeri Pulau Pinang (or Zakat MAINPP) through the Projek Makmal Sosio-Akademik di Sungai Nibong (or Projek MASA@Sungai Nibong) grants. The authors extend their sincere appreciation for this support, which enabled the successful execution of the study.

REFERENCES

Ahmad, H., Wan Hasan, W. N., & Saniff, S. M. (2025). Constructing ethnographic protocols for zakat studies in the Muslim community. *International Journal of Islamic Finance and Sustainable Development, 17*(1), 75-91.

Alayed, S., & Alateeg, S. (2025). Women economic empowerment leads towards social innovation in rural setting of Saudi Arabia. *Cogent Economics \& Finance*, *13*(1), 2481228. https://doi.org/10.1080/23322039.2025.2481228

Al-Jayyousi, O., Wan Hasan, W. N., Mohamed Saniff, S., Sever, S. D., & Tok, E. (2023). A critical discourse analysis on climate change in a globalized world: The nexus of Islam and sustainable development. Sustainability, 15(19), 14515. https://doi.org/10.3390/su151914515

Avtar, R., Ahmad, S., Rahman, M., Alsulamy, S., & Meraj, G. (2025). *Impact of urban density on human well-being and sustainable development in Delhi, India*. 1–15.

Blocker, C., Zhang, J. Z., Paul, R., Caroline, H., Corus, C., Hutton, M., Dorsey, J., & Minton, E. (2023). *Rethinking scarcity and poverty: Building bridges for shared insight and impact*. *August 2021*, 489–509. https://doi.org/10.1002/jcpy.1323

Dariah, A. R., Salleh, M. S., Saniff, S. B. M., & Ernawati. (2020). Comparative study of

sustainable development planning in Southeast Asia countries. International Journal of Sustainable Development and Planning, 15(4), 469-476. https://doi.org/10.18280/ijsdp.150407

Ding, X., Wang, L., & Tan, Y. (2026). Influence pathways of village livelihood capital on the idle homesteads reuse. *Land Use Policy*, *160*, 107834. https://doi.org/https://doi.org/10.1016/j.landusepol.2025.107834

Do, M. H., Nguyen, T. T., & Grote, U. (2025). Insights on household's resilience to shocks and poverty: evidence from panel data for two emerging economies in Southeast Asia. *Climate and Development*, *17*(8), 684–698. https://doi.org/10.1080/17565529.2024.2446358

Du, S., Chandran, V. G. R., & Baskaran, A. (2025). Sustainable Livelihood Capitals and Livelihood Outcomes of Peasant Households in China. *Millennial Asia*, *0*(0), 09763996251338356. https://doi.org/10.1177/09763996251338356

Esposito, D. (2025). A Ladder of Urban Resilience: An Evolutionary Framework for Transformative Governance of Communities Facing Chronic Crises. *Sustainability*, *17*(13). https://doi.org/10.3390/su17136010

Evans, T., Fletcher, S., Failler, P., & Potts, J. (2025). Typologies of Transformation—Visualizing Different Understandings of Change for Sustainability. *Sustainability*, *17*(9). https://doi.org/10.3390/su17094075

Furszyfer Del Rio, J., Furszyfer Del Rio, D. D., Sovacool, B. K., & Griffiths, S. (2023). The demographics of energy and mobility poverty: Assessing equity and justice in Ireland, Mexico, and the United Arab Emirates. *Global Environmental Change*, *81*, 102703. https://doi.org/https://doi.org/10.1016/j.gloenvcha.2023.102703

Gaworek-Michalczenia, M. F., Sallu, S. M., Gregorio, M. Di, Doggart, N., & Mbogo, J. (2022). Evaluating the impact of adaptation interventions on vulnerability and livelihood resilience. *Climate and Development*, *14*(10), 867–883. https://doi.org/10.1080/17565529.2021.2018987

Hossain, M. R. (2024). Evaluating household's risk management strategies considering heterogeneities in the livelihood diversification: Evidence from farm households of Bangladesh. *Social Sciences & Humanities Open*, *9*, 100785. https://doi.org/https://doi.org/10.1016/j.ssaho.2023.100785

Hu, Z., & Xu, J. (2025). How Does the Risk of Returning to Poverty Emerge Among Poverty-Alleviated Populations in the Post-Poverty Era? A Livelihood Space Perspective. *Sustainability*, *17*(11). https://doi.org/10.3390/su17115079

Ismail, M. K., Hanim, S., Zailani, M., & Ahmad, N. (2025). Evaluating and Enhancing Sustainable Livelihoods of Urban Impoverished Groups in Kuala Lumpur. *Planning Malaysia*, *23*(2), 14–25.

Kakwani, N., & Son, H. H. (2025). Multidimensional Poverty: A New Perspective on Measurement. *The Journal of Development Studies*, *0*(0), 1–15. https://doi.org/10.1080/00220388.2025.2530471

Kapucu, N., Ge, Y., Rott, E., & Isgandar, H. (2024). Urban resilience: Multidimensional perspectives, challenges and prospects for future research. *Urban Governance*, *4*(3), 162–179. https://doi.org/https://doi.org/10.1016/j.ugj.2024.09.003

Kasula, P., Dedekorkut-Howes, A., Shearer, H., & Baum, S. (2026). Social inclusion of urban villages: A systematic review of global urban planning practices. *Cities*, *169*, 106509. https://doi.org/https://doi.org/10.1016/j.cities.2025.106509

 © 2026 by MIP

Kiconco, M., Nelmapius, A., Venter, E., & Alinda, K. (2025). Livelihood capital access and sustainable livelihood outcomes of park adjacent communities in Uganda. *IIMBG Journal of Sustainable Business and Innovation*, *3*(2), 192–212. https://doi.org/10.1108/IJSBI-06-2024-0029

Li, L., Xu, J., & Liang, Y. (2024). The formation and evolution of vulnerability risk of rural poor groups under the perspective of social support based on the analysis of "sensitivity-resilience." *Heliyon*, *10*(9), e30305. https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e30305

Liu, M., Wu, X., & Chen, J. (2025). Income, deprivation, and social exclusion: toward a comprehensive poverty measurement in Hong Kong. *Journal of Asian Public Policy*, *18*(1), 99–120. https://doi.org/10.1080/17516234.2023.2221977

Mokhtar, M. S. M, Mohamed Saniff, & Ahmad Shukor, A. S. A. (2025). Transformasi Kemiskinan Bandar Melalui Intervensi Komuniti Secara Holistik: Kajian Kes Projek MASA@Sungai Nibong. *Jurnal Islam Dan Masyarakat Kontemporari*, *26*(*2*), 49–64. https://doi.org/10.37231/jimk.2025.26.2.937

Prayitno, G., Auliah, A., Efendi, A., Hayat, A., Subagiyo, A., & Salsabila, A. P. (2025). The Role of Livelihood Assets in Affecting Community Adaptive Capacity in Facing Shocks in Karangrejo Village, Indonesia. *Economies*, *13*(1). https://doi.org/10.3390/economies13010013

Pham, T.T.H., Revilla Diez, J., & Garschagen, M. (2021), A typology of household livelihood changes in rural coastal areas of the Vietnamese Mekong Delta—Capturing the heterogeneity and complexity of the social-ecological context. *Singapore Journal of Tropical Geography*, *42*(*2*), 241-263. https://doi.org/10.1111/sjtg.12335

Sakketa, T. G. (2025). Understanding rapid urbanisation's influence on social cohesion: Insights from Africa. *Cities*, *160*, 105835. https://doi.org/https://doi.org/10.1016/j.cities.2025.105835

Sun, Y., Wang, Y., Tan, R., Wan, Y., Dong, J., Cai, J., & Yang, M. (2025). How Do Rural Households' Livelihood Vulnerability Affect Their Resilience? A Spatiotemporal Empirical Analysis from a Multi-Risk Perspective. *Sustainability*, *17*(17). https://doi.org/10.3390/su17177695

Tuihedur Rahman, H. M., Albizua, A., Soubry, B., & Tourangeau, W. (2021). A framework for using autonomous adaptation as a leverage point in sustainable climate adaptation. *Climate Risk Management*, *34*, 100376. https://doi.org/https://doi.org/10.1016/j.crm.2021.100376

Received: 27th January 2026. Accepted: 13th March 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 153 – 172

SUSTAINABLE URBAN DEVELOPMENT IN ISLAMIC PERSPECTIVE: A SYSTEMATIC SYNTHESIS

Wan Mohd Khairul Firdaus Wan Khairuldin[1,2,3], Shahir Akram Hassan[4], Abdul Hanis Embong[5], Wan Nur Izzati Wan Nor Anas[6], Mohamad Zaidin Mat@Mohamad[2,3], Muhammad Fuad Kamaludin[7], Mohd Sufi Ibrahim[8]

[1]*Faculty of Islamic Contemporary Studies,*
[2] *Research Institute of Islamic Product and Malay Civilization (INSPIRE),*
[3]*Artificial Intelligence Research Centre for Islam and Sustainability (AIRIS),*
[6]*Faculty of General Studies and Advanced Education,*
UNIVERSITI SULTAN ZAINAL ABIDIN
[4]*Centre for Islamic Development Management Studies (ISDEV),*
UNIVERSITI SAINS MALAYSIA
[5]*Center for Fundamental and Continuing Education,*
UNIVERSITI MALAYSIA TERENGGANU
[7]*The Inauguration of Imam Ahmad ibn Idris Chair of Islamic Studies,*
UNIVERSITÉ MOHAMMED-V, RABAT, MOROCCO
[8]*Department of Syariah,*
ISLAMIC COLLEGE AS-SOFA, SELANGOR

Abstract

Rapid global urbanization calls for sustainable systems that resonate with local cultural and religious values; however integration of Islamic principles and modern urban planning is still in theory, fragmented and not yet researched. This systematic literature review overcomes this gap by synthesizing knowledge already existing to present a comprehensive framework for ethical and ecological urbanism. Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, an exhaustive search was performed using the Web of Science (WoS) and the SCOPUS databases, in order to guarantee the high standard of academic trustworthiness. From an initial pool of literature, the study finally identified and analyzed a selection of 30 primary studies (n=30) which met the inclusion criteria. The findings of this synthesis are categorized into three critical thematic dimensions: (1) Sustainable Islamic Architecture and Heritage Conservation, which emphasizes bio-climatic traditional designs and culture; (2) Islamic Urbanism, Spatial Planning, and Environmental Resources, which emphasize the symbiotic relationship between human settlements and

[1] Corresponding author. Email: wanfirdaus@unisza.edu.my

natural ecosystems; and (3) Green Finance, Governance, and Socio-Economic Ethics, underlines the possibility of tools based on Shariah and ethical stewardship in the effort towards equitable growth. The numerical result shows the interest in and research on these intersections is increasing, especially in terms of the role of Waqf and Khaliffah (stewardship) in the management of the environment. The present review concludes that an Islamic perspective on sustainable urbanism presents a holistic human-centred way of thinking transcending technical solutions through integrating the spiritual values with socio-economic equity. These findings provide a vital roadmap for policymakers and urban planners to develop resilient cities that are both technologically advanced and culturally grounded. Specifically, this review translates these Islamic principles into actionable planning levers including land-use zoning, heritage overlay controls, Waqf-based land banking, green sukuk financing, participatory governance mechanisms, climate-responsive building standards, and public space provision policies offering a structured toolkit for planners operating in Muslim-majority urban contexts.

Keywords: Sustainable, Planning, Islamic Development, Urbanism, spiritual

INTRODUCTION

Sustainable urban development has become a highly important theme for many countries in the face of the elements of climate change and rapid urban growth. The concept of sustainability in relation to urban development involves various dimensions such as environmental, social and economic. In recent years, there is an increasing interest in learning how different cultural and religious perspectives can contribute to sustainable urban development (Cheshmehzangi et al., 2024; Guzmán et al., 2017).

The Islamic viewpoint offers a distinctive framework that is based on spirituality, morality, and ethics (Kamal et al., 2025; Kamal et al., 2023). This introduction is meant to present an overview of sustainable urban development from an Islamic point of view by pointing its relevance and possible contributions to our present-day urban planning. Sustainable urban development in the Islamic world has become an important research field, and it has become necessary because of the rapid urbanization, the environmental damage and the necessity to reconcile the doctrines of modern life with religious doctrines. This field covers a whole lot of disciplines, from architectural design and urban planning to financial mechanisms to social behaviour (Aydin, 2017).

© 2026 by MIP

As the climate risks and scarcity of resources are growing for cities in Muslim-majority countries, scholars are turning to history and theological principles in search of modern solutions. The importance of this topic is that it may provide alternative frameworks for sustainability that are culturally congruent and ethically grounded and may go beyond the generic global models to region-specific and spiritual models(Jimenez-Luque & Penha-Vasconcelos, 2023; Yogananthan et al., 2024).

Despite the growing volume of research, the existing literature remains fragmented, often operating in disciplinary silos that prevent a holistic understanding of the subject. For example, some research efforts make it very technical and specific to the law and technology of waste management and environmental jurisprudence (Maskun et al., 2025), others are deeply entrenched in historical analyses of agricultural revolutions and zooarchaeology (García García, 2026). There is a significant gap concerning the relationship between these historical precedents and modern financial instruments, such as green sukuk or municipal bonds, that are being evaluated in isolation these days (Alhowaish, 2025; Khairisma et al., 2025). Furthermore, while the conflict between economic growth and environmental protection is recognised (Kazak et al., 2025), studies examining the connection between these macroeconomic factors and individual level pro-environmental behavior driven by religiosity remain underdeveloped in the case of integrated urban strategies (Zafar & Abu-Hussin, 2025).

Islamic teachings stress on balance and moderation in everything in life including urban development. The principles of *Wasatiyyah* (moderation), *Khalifah* (stewardship), and *Maslahah* (public interest) are at the heart of the Islamic approach used for sustainability. These principles include the responsible use of natural resources, the protection of the environment, social justice and equity. These principles carry direct implications for urban planning practice. Wasatiyyah (moderation) supports density controls and mixed-use zoning that prevent urban sprawl while maintaining liveable neighbourhoods. Khalifah (stewardship) underpins mandatory green space ratios, environmental impact assessments, and the responsible governance of public land. Maslahah (public interest) provides the ethical basis for inclusive housing policies, community land trusts, and participatory planning processes that prioritise collective well-being over speculative development. By translating these principles into concrete planning instruments, Islamic urbanism moves beyond philosophical guidance to offer an operational framework for sustainable city-making. By incorporating these principles into urban planning, cities can ensure that a harmonious balance between development and environmental conservation is achieved in order to ensure the well being of present and future generations (Bsoul et al., 2022; Kamal et al., 2023; Khan & Haneef, 2022).

© 2026 by MIP

The Islamic approach to sustainable urban development is also focused on the community and individual responsibility. Teachings in the Islamic religion promote community development and environmental protection. This is reflected in the concept of Shura (consultative decision-making) and Hisbah (public oversight), which promote inclusive and participatory governance. Promoting a community responsibility and engagement with the community, the Islamic values would help in developing tough and sustainable city spaces (Ahmed, 2025; Zuraidi & Zainol, 2025).

LITERATURE REVIEW

Sustainable urban development literature identifies various main themes and principles as related to the Islamic view of the subject which can inform the modern systems of urban planning. The integration of environmental stewardship and social and economic development is one of the main themes. Islamic faith underlines the interrelation of every life sphere and believes in the holism of the development approach. This manifests in the idea of *Maqasid al-Shariah*, which would emphasize on ethical investment, social good, and the environment by using the Shariah compliant securities like *sukuk*, *zakat*, and *waqf* (Ahmad & Berghout, 2025; Khan & Haneef, 2022; Rahim et al., 2024). These tools can be employed in order to invest in projects that may ensure not only environmental sustainability but also social responsibility that will lead to the realization of the Sustainable Development Goals (SDGs).

The other issue that stands out in the literature is how Islamic finance can be used to facilitate sustainable urban development. Sustainable infrastructure and smart cities could be built with the help of various tools of long-term financing provided by Islamic finance, including sukuk. The financing mechanisms generate employment as well as enable self-sufficiency and mitigate the social economics effects of major development projects in less developed areas (Kamal et al., 2025). By leveraging Islamic finance, cities can secure the necessary funding for sustainable urban development while adhering to ethical and moral principles.

Another major topic that is obvious in the literature is the importance of urban green spaces (UGS) in ensuring sustainability in the Islamic perspective. There are many positive effects of urban green spaces such as increased quality of air in cities, less urban heat islands and increased well-being of the population. Islamic doctrines promote preservation and conservation of natural environments and development of UGS cannot be in contradiction with Islamic doctrines. An example of the interaction between green spaces, historical and cultural heritage through the authors of a case study can reveal how the chosen elements can strengthen the social, economic, and environmental conditions of cities (Abowardah, 2024; Ariff et al., 2024; Hatta et al., 2024).

Besides, the literature highlights the relevance of community participation and participatory governance in the process of sustainable urban development. Islamic values like *Shura* (consultative decision-making) and *Hisbah* (public oversight) translate directly into planning participation levers: mandatory community consultation requirements at the local plan stage, neighbourhood-level planning committees with binding advisory powers, and third-party environmental monitoring bodies modelled on Hisbah principles. These mechanisms move participatory governance from an aspiration to a procedural requirement embedded in planning law, ensuring that urban decisions reflect community priorities rather than top-down technocratic mandates. This would promote the social cohesion, responsibility and transparency that form the key to the successful execution of sustainable development efforts (Ahmed, 2025; Zuraidi & Zainol, 2025). By involving the community in the planning process, cities can create more resilient and adaptable urban environments that reflect the values and aspirations of their residents.

MATERIAL AND METHOD

Identification

To have a thorough literature acquisition of the relevancy, the identification stage of this systematic review incorporated a stringent methodological approach. The process involved identification of primary keywords, and this process was followed by the expansion of the primary keywords through the consultation of dictionaries, thesauri, and extant research in order to encompass all the relevant terminology. These keywords were informing the creation of certain search strings specific to the database of Scopus and Web of Science (see Table 1). The first search strategy provided 367 publications data, including 289 publications found on Scopus and 78 publications found on Web of Science.

TABLE 1

Scopus	TITLE-ABS-KEY ((Sustainability OR Sustainable OR Green OR Ecological OR Environmental OR Resilience) AND (Urban OR City OR Planning OR Infrastructure OR Architecture OR Settlement OR Town) AND (Islam OR Islamic OR Muslim OR Sharia OR Waqf OR Quranic OR Caliphate)) AND PUBYEAR > 2024 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) **Date of Access: January 2026**

© 2026 by MIP

Web of Sciences	TS=((Sustainability OR Sustainable OR Green OR Ecological OR Environmental OR Resilience) AND (Urban OR City OR Planning OR Infrastructure OR Architecture OR Settlement OR Town) AND (Islam OR Islamic OR Muslim OR Sharia OR Waqf OR Quranic OR Caliphate)) AND 2024-2026 (Publication Years) AND DT=(Article) AND LA=(English) **Date of Access: January 2026**

Screening

The literature located during the screening stage was strictly considered to make sure that the literature does not contradict the main research questions, which are concerned with the pedagogical practice of flipped classes applied to the Malaysian context.This phase included cleaning all the records systematically, in which eight duplicate records were found and the predetermined eligibility criteria. As a result, 36 articles were eliminated, which reduced a total number of papers chosen to be analyzed and discussed in terms of the parameters presented in Table 2, which is 331. In order to achieve the quality and relevancy of the findings, the inclusion criteria were focused on scholarly sources that included practical recommendations, including meta-analyses, systematic reviews, books, and conference proceedings that were not covered by the latest literature. In addition, the review was strictly focused on the English-language publications published between 2024 to 2026.

TABLE 2
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2024 – 2026	< 2023
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject	Social science, environmental science and Art and Humanities	Besides Social science, environmental science and Art and Humanities

Eligibility

In the third step of the selection process, which is the eligibility phase, the rest of the articles were put through a strict screening procedure to determine their appropriateness in terms of inclusion. It was a crucial stage of the evaluation

process that presumed an overall analysis of the titles and the substantive material to ensure it complies with the presupposed inclusion criteria and the overall aims of the study. Articles have been filtered out in an organized way based on the exclusion criterion that they had to be outside the field under study, irrelevant titles and abstracts that could not cover the research objectives. In addition, the papers were excluded when the complete versions of the articles could not be found or when they did not have a high empirical basis. The outcome of this purified selection process was a final list of 30 articles that will be incorporated in the review.

DATA ABSTRACTION & ANALYSIS

To integrate the different research designs and methodologies found in the 30 publications selected in this study, an integrative thematic analysis was adopted. The main idea was to derive and to classify over-riding themes and sub-themes pertaining to the issue of sustainable urban development in the Islamic worldview. The systematic data extraction step of analysis has started, and the authors started to carefully examine the 30 papers to formulate core assertions and empirical results (see Figure 2). This review has involved an inquiry into the research methodologies used and a research-content results that have been reported in both studies. After that, the authors form a thematic framework based on the evidence. To achieve analytical rigour and reflexivity, a research log has been kept as part of the process so as to record insights regarding interpretation, conceptual difficulties and developing attitudes.

Finally, the authors performed a comparative review of the results to clear and initiate any conflicts in the thematic organization, and all conceptual controversies were solved by a discussion and agreement with each other. Comparisons were also made by the authors to clear any differences in the theme making process. It should be noted that in case of any discrepancy on the themes to be discussed, the authors discusses the same with each other. Lastly, the themes that were developed were refined to make them consistent. It has been modulated according to the tool of the author depending on feedback and comments of experts. The questions are as follows below:

1. How can the principles of traditional Islamic architecture and heritage conservation be integrated into contemporary frameworks to promote sustainable urban development?
2. In what ways do Islamic concepts of urbanism and spatial planning facilitate the equitable and sustainable management of environmental resources?
3. What role do Islamic socio-economic ethics and green finance mechanisms play in shaping the governance and implementation of sustainable urban projects?

© 2026 by MIP

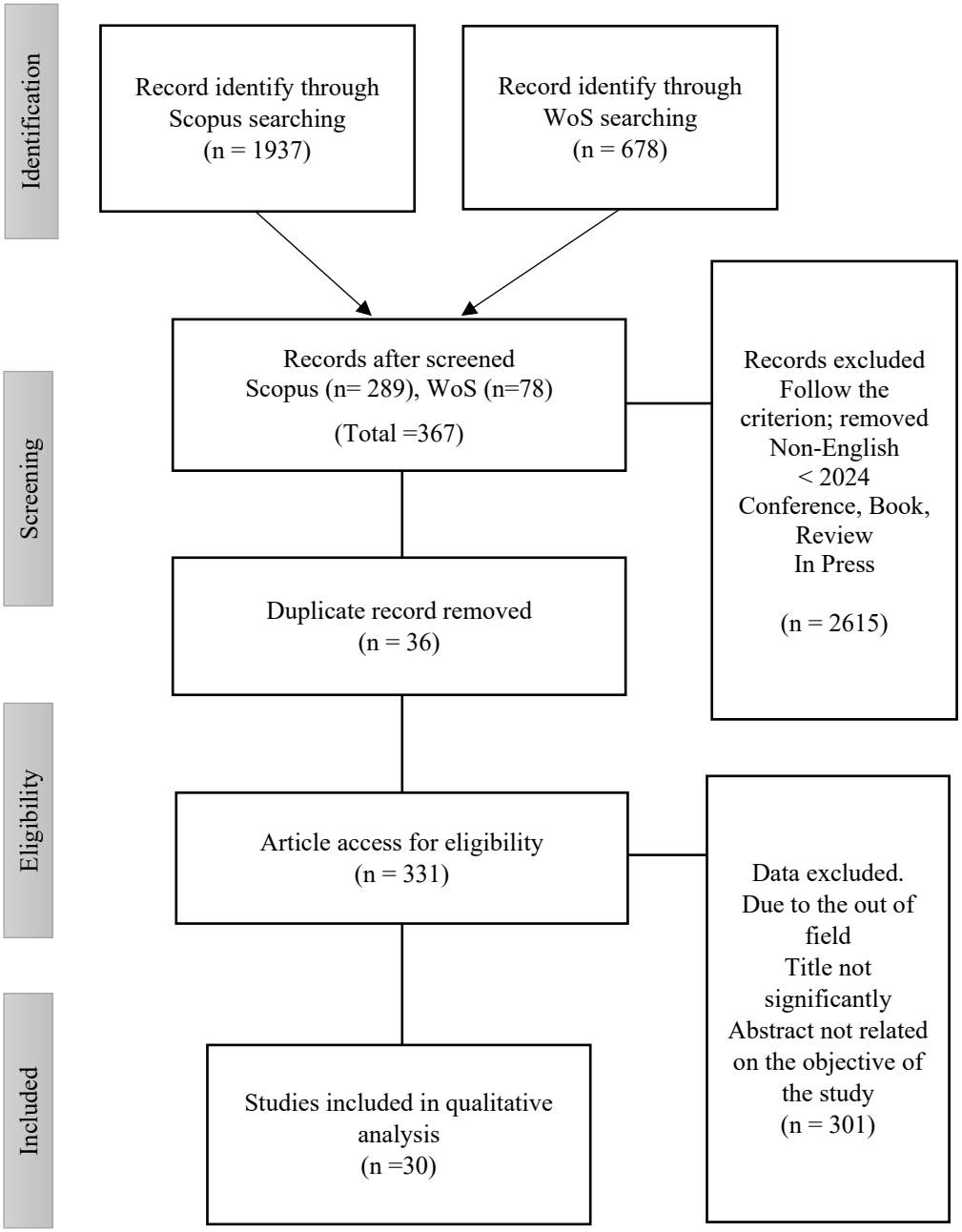


FIGURE 2. Flow diagram of the proposed searching study (Page et al., 2021)

RESULT AND FINDING

Sustainable Islamic Architecture and Heritage Conservation

Incorporation of environmental design solutions in the context of the Islamic architecture is a complex mix of cultural identity, religious ideals and adaptation to climatic conditions. According to the recent scholarship, historical architectural styles were not aesthetic solutions and designed to explicitly, practically, and critically adapt to environmental limitations, which provided important insights into contemporary sustainability. Mohson et al. (2025) insists that the morphological changes of Islamic buildings whether as complete form change or partial form change act as the historical archives of sustainable design as it can be noted in the comparison between Abbasid and other modern buildings such as the Louvre Abu Dhabi. Such a cooperation between material and performance is also measured by Abdelalim et al. (2025), who redesigns the decorative arabesque and traditional masonry, but not as ornamentation, but rather as environmental logic of use. The fact that the traditional walls of Bayt Al-Razzaz constructed using 40-cm of limestone perform much more efficiently in thermal regulation than modern concrete blocks shows that the historical methods of passive building construction were much more energy-efficient than most currently used variants that many people think they should be (Abdelalim et al., 2025).

Moreover, the focus on local resources and local engineering techniques, including the seismically robust Saka guru system in the Indonesian mosques, emphasizes the tradition of low embodied energy and durability (Sari, 2024). This is supported by Naghipour et al. (2025), who admits that the Sheikh Lotfollah Mosque is stable because of the constructions methods that were highly sensitive to the specifics of the local climate, which implies that these historical principles must be restored to ensure face-saving in the context of the modern shortage of resources (Mohson et al., 2025; Naghipour et al., 2025; L. H. Sari et al., 2024).

In particular, referring to religious infrastructure, the literature defines a dilemma between the innate sustainability of traditional mosques and the managerial issues confronting modern institutions. Yu et al. (2025) uses a case example of the Raja Haji Fisabilillah Mosque in Malaysia as a model of modern success, where the Platinum Green Building Index is obtained, which shows that the Islamic stewardship (*Khalifah*) can be implemented through the high-tech ecological restoration and energy efficiency. This is in contrast with the findings of Hamidi et al. (2025), who implements the Quadruple Bottom Line model (Prosperity, People, Planet, Prophet) to Indonesian mosques and finds out that even though the spiritual aspect of the framework is robust, most religious institutions have reactive or defensive responses to proactive sustainability, especially on the social aspect of the framework, which is the People. Although

© 2026 by MIP

Yu et al. (2025) points to the possibility of the existence of mosques as spreading the vegetation cover and serving as ecological hubs, the necessity of the managerial paradigm shift to put these values into reality. Pre-modern constructions aged to old and traditional tend to have sustainable balance with their surroundings, which modern structures are unable to match without pre-canvassed structures (L. H. Sari et al., 2024).

On a larger city size, the Islamic ideals are applied to landscape architecture, residential planning and urban planning, with the focus on social sustainability and human relations to nature. Abowardah (2024) uses the example of the Al-Azhar Park project where the historical sites are revived by the bottom-up method and says that, besides preserving the past, this strategy can be used as the engine of social and economic revitalization of densely built areas. This need to associate urban populations with the natural environment is also emphasized by Ariff et al. (2024), who reports that there is a significant lack of connection in Malaysian low-cost housing; the work proposes biophilic design based on Islamic ideologists to reinstate the right of the residents to a natural environment of good health and integration into nature. The author also points out the rationale of returning to conventional city planning and offers statistical data that the solar orientation of the streets in the vernacular M'Zab Ksour is much more effective in forming microclimates that are much more comfortable than non-traditional designs in arid areas (Dahmani et al., 2024). Meanwhile, Salam et al. (2024) suggests that these traditional sensibilities can be developed via biomimicry, but points out that there is a research gap in practicing the successful combination of biological emulation and the Islamic cultural values. All these studies provide insights that sustainable urbanism in the Islamic world relies on a simultaneous performance of heritage and a sense of biophilic access to both be in place.

Translating these architectural insights into planning levers, three instruments emerge as particularly actionable. First, heritage overlay zones can be adopted within local development plans to protect bio-climatic building typologies such as thick masonry walls, wind-catchers, and shaded courtyards from demolition or unsympathetic alteration. Second, climate-responsive building codes can mandate passive design standards (solar orientation, natural ventilation, thermal mass) informed by vernacular precedents, reducing reliance on energy-intensive mechanical systems. Third, mosque and religious building sustainability standards can be adopted nationally, requiring new religious infrastructure to meet minimum ecological performance benchmarks. Together, these levers institutionalise the wisdom embedded in Islamic architectural heritage within contemporary regulatory frameworks.

© 2026 by MIP

Islamic Urbanism, Spatial Planning, and Environmental Resources

Modern sustainable development could gain the most out of the historical development of Islamic agrarian systems and urban morphology. Recent research questions received histories of the so-called Islamic Green Revolution, especially in the management of resources and space organization. An example of this would be the use of zooarchaeology (García García, 2026) in al-Andalus to propose a multi-dimensional, integrated framework of agro-ecological transformation, as opposed to the more common, historical view, which isolates irrigated agriculture and livestock management.

Roskin et al. (2025)reports on the historical ingenuity of resource management by recording the level of the Early Islamic sunken groundwater-harvesting agroecosystems in aeolian sand. Such systems also offered water security with unceasing shallow groundwater access, which showed an exemplary site-specific resilience that modern planning frequently has failed to control. Regarding city structure, Alkhresheh (2025) deplores how modernist grid patterns disrupted the historic Arab-Islamic urban structure in Riyadh by considering cars idealistic instead of community. A dialectical synthesis of the theory of fused grids and Islamic fractal geometry is proposed to recover environmental adaptability and walkability as part of the restoration of historical spatial principles, in accordance with current safety and connection requirements.

Outside of historical institutionalized agricultural and structuring modes, the concept of incorporating faith-based values in planning and controlling urban green spaces is indispensable to the discourse of environmental stewardship. Suhartanto et al. (2025) shows that holistic faith-focused experiences in urban forests, which involve sense-making and enrichment factors, have a direct positive impact on visitor satisfaction and responsible environmental behaviors among the Muslim populations. The same correlation of spiritual values and practical use can be embraced by Rochani et al. (2024), who looks at the illustration of *Waqf* (endowment) space in Semarang. According to him, Waqf is not only a charitable gesture but also a creator of a sustainable community that offers communal amenities and viable coexistence. In addition, Iswoyo et al. (2025) discusses the profound lack of green field in the urban areas of cities such as Makassar, suggesting that the cemetery should be optimized. Unique patterns of planting which are adapted to religious customs (symmetrical tree spacing in Islamic cemeteries, etc.), may contribute greatly to vegetation cover and preserve the culture at the same time. From the other perspective, international models of green cities to the Islamic worldview by asserting that the Quran and the Hadith offer a solid theological basis to ensure green city ecological balance (Hatta et al., 2024; Suhartanto et al., 2025)

Sustainability in urban areas must also involve the aligning of governance structures, zoning policies and legal system with Islamic ethical

© 2026 by MIP

guidelines. Zuraidi and Zainol (2025) uses the framework of agile cities to inform the Banda Aceh case and concludes that the inclusion of such notions as *maslahah* (public welfare) into spatial planning can contribute to the economic resilience. These strategies are to balance between modernity and cultural identity include zoning flexibly and using adaptive reuse. Nevertheless, it has not been introduced in the law yet. There are also mismatch between the supposedly Islamic-based policies in Aceh about environmental regulations (*Qanun*) and actual Aceh policy (Natsir et al., 2024). He recommends rewriting these laws to facilitate the dispute resolution procedures that are grounded in Islamic jurisprudence to make religious values work in environmental management. It is consistent with the findings of Rochani et al. (2024), who claim that treating concepts of religion as a social-environmental one by abstracting them via adaptive comprehensiveness, or similar categories into that group can make urban systems more resilient. Thus, researchers believe that the planning strategy should depart superficial labeling and integrate the Islamic values structurally into the city regulatory and economic framework.

Lastly, water resource management is a critical crossroad in technology, popular society and religion among Muslims. To explore the feasibility of Rainwater Harvesting (RWH) systems in Brunei, Suni et al. (2025) uses a long version of the Technology Acceptance Model (TAM). The research shows that although there are technical and financial challenges, the fact that the use of recycled water in ablution is religiously acceptable is a motivating aspect towards its use. The modern sustainability potential of water is comparable to the historical tenacity of agroecosystems (sand) as described by Roskin et al. (2025), wherein investment in the sustainability of water security over long periods of time enabled the agricultural yield of arid zones. Further, the effective water management can be closely tied with overall agricultural approaches as described by García García (2026), where a continuity of care about the issue of water scarcity starts in the medieval period up to now. To facilitate the implementation of new technologies such as RWH, to achieve this, Suni et al. (2025) recommends the education and technical assistance, whereas Suhartanto et al. (2025) recommends to promote these environmental measures as an obligation of the religion, which is likely to enhance the involvement rates of people. Taken together, all these studies suggest that sustainable resource management in the areas dominated by Muslims becomes most efficient when technical solutions can be justified by cultural and religious frameworks.

These findings point toward a suite of spatial planning levers that can operationalise Islamic urbanism principles in contemporary practice. In land-use planning, the reintroduction of fractal street hierarchies and mixed-use zoning can restore walkability and reduce car dependency in rapidly expanding Muslim-majority cities. Water-sensitive urban design policies, informed by historical

agroecosystem management, can mandate rainwater harvesting systems and permeable surfaces as baseline requirements in development approvals. Waqf land can be formally recognised within national land tenure frameworks as a distinct category of community-held land, protected from privatisation and earmarked for affordable housing, urban green space, and community facilities. Regarding public space, cemetery greening programmes can be codified as a dual-purpose land use in zoning ordinances, simultaneously addressing green space deficits and cultural conservation. Climate resilience planning at the municipal level can draw on the site-specific hydrological intelligence embedded in historical Islamic water systems, integrating these lessons into flood risk mapping and drought contingency frameworks.

Green Finance, Governance, and Socio-Economic Ethics

The point of green finance, green governance and socio-economic ethics forms one of the crucial inquiries in the wider quest to incorporate Islamic values in urban sustainability. The current literature reveals the usefulness of financial tools to propel ecological aims, albeit with unequal successes across the sectors and regions. Kazak et al. (2025) says that green finance can be used as a statistically significant process to reduce the ecological footprint of carbon in Organization of Islamic Cooperation (OIC) member states, but there is also an evident trade-off between economic growth and the environment. In order to achieve fiscal deficits arising in these emerging economies, Alhowaish (2025) suggests implementing Green Municipal Bonds (GMB) in requirements such as Saudi Arabia, as this type of Shariah-compliant financing mechanisms would help to fill up to 40% of municipal revenue shortfalls and promote low-carbon infrastructure construction. Nevertheless, the extent to which these Islamic financial instruments are taken in the market is varied; Khairisma et al. (2025) notes that, whereas stocks of energy and climate sectors react positively to the issue of green sukuk issuance, the response of water and land related objectives has been slow and weak. These studies in aggregate imply that although financial resources are essential (Kazak et al., 2025), their effectiveness is determined by targeted sectoral focus (Khairisma et al., 2025). Also, the development of an efficient regulatory framework that would help balance Shariah compliance with international Environmental, Social, and Governance (ESG) requirements (Alhowaish, 2025).

In addition to these financial mechanisms, according to the literature, there is a need to incorporate religious ethics within legal and governance systems to generate just sustainability. Mascon et al. (2025) points out a problematic gap in waste management in Indonesia where weak enforcement of the law and the lack of funding remains even though the potential of Islamic-based tools such as Green Zakat and Eco-Waqf exists. The need of balancing national environmental

© 2026 by MIP

law and fiqh al-bi'ah (environmental jurisprudence) to establish a binding model of law. This correlates with the discussion by Allahham (2024), who compares capitalist urban reform with Islamic traditions, regarding the historical practice of Islamic built environments in achieving social equity and sustainability by rights-based governance, which the contemporary capitalist manner of doing so fails to achieve.

A modern notion of governance activity as discussed by Alibašić (2024), demonstrates that the effectiveness of resiliency planning in Muslim majority countries is not necessarily a result of religious identity but an indicator of pluralist societies, strong economies and inclusive governments. Successful governance therefore must be a combination of traditional ethical frameworks (Allahham, 2024), integration of religious principles into legal frameworks through their formatting (Maskun et al., 2025), and incorporation of modern administrative inclusivity (Alibašić, 2024).

Individual behavior and neighborhood ethics are players at the micro-social level that contribute significantly to the sustainability of any urban center and which are moderated strongly by religiosity. A cross-cultural example of this is given by Zafar and Abu-Hussin (2025) showing that religiosity is a strong predictor of pro-environmental behavior in Muslim-majority nations, in which there are more social norms that support environmental ethics compared to non-Muslim societies where faith is more individual. The behavioral connection is supported by Baran et al. (2024), which shows that religiosity plays a significant role in influencing the intention to minimize food waste among the Muslim population, and environmental concern serves as a mediator. To operationalise these values, schools are key vectors. Aulia et al. (2024) proves that eco-pesantrens (Islamic boarding schools) are effective in teaching green behaviours to children with role modeling by its leaders and habituation to sustainable behaviours because of their location in Indonesia. As a result, to achieve a sustainable urban culture, the intrinsic motivation that faith offers to people by itself (Baran et al., 2024; Zafar & Abu-Hussin, 2025) needs to be exploited, and community institutions should be used to exemplify and implement these abstract concepts into everyday routines (Aulia et al., 2024).

The integration of these various strands helps in coming up with an Islamic truth that to establish Islamic principles to modern sustainability systems, it is important that an integrated approach should be adopted that incorporates realms of strategic management, finance, and ethics. Sari et al. (2024) demonstrates this integration in the Micro, Small, and Medium Enterprise (MSME) sector and confirms that when the green management and digital transformation are adjusted to the Halal business ethics, they significantly improve ecological, social and economic performance. This smaller-scale achievement is reflected in the macro-scales suggestions of Kazak et al. (2025)

and Alhowaish (2025), who propose policy tools that balance economic growth and ecology protection. Nevertheless, issues on gaps in implementation and regulatory disharmony are still imminent (Maskun et al., 2025). Ultimately, the literature suggests that achieving the Sustainable Development Goals (SDGs) in this context relies on a synergistic model where financial innovation (Khairisma et al., 2025), governance (Allahham, 2024), and faith-driven behavioral changes (R. K. Sari et al., 2024; Zafar & Abu-Hussin, 2025) converge and form resilient and ethically grounded urban systems.

The literature collectively points toward a layered financing and governance architecture that planners and policymakers can adopt. At the financing lever, municipalities in Muslim-majority countries can issue Green Municipal Bonds structured as Shariah-compliant instruments, directing proceeds specifically toward low-carbon infrastructure, affordable housing, and climate adaptation, addressing the municipal revenue gaps identified by Alhowaish (2025). Green sukuk frameworks should be expanded beyond energy and climate sectors to cover water infrastructure and urban land rehabilitation, correcting the sectoral imbalance noted by Khairisma et al. (2025). At the governance lever, Waqf institutions can be restructured as urban land banks, acquiring and holding strategic parcels for public benefit uses a model that integrates traditional endowment law with modern land assembly mechanisms. Environmental jurisprudence (fiqh al-bi'ah) should be formally codified into national environmental legislation, giving Islamic ethical principles binding legal status rather than remaining as aspirational policy references. At the participation lever, eco-pesantren networks and mosque-based environmental committees can be formally recognised as community planning partners, channelling faith-driven behavioural change into structured neighbourhood improvement programmes. Finally, at the individual and household level, religiosity-based environmental education can be integrated into national sustainability literacy campaigns, leveraging the demonstrated link between faith and pro-environmental behaviour.

CONCLUSION

The findings of the current study show that there is consistency in the existing literature in that Islam is seen as a holistic framework for the path of sustainable urban development with a significant emphasis on the principles of stewardship, balance, and the unity of creation. Foundational concepts such as tawhid, and the role of human as khalifah, provide an ethical basis integrated with the ecological, social, and economic dimensions in a coherent manner. Previous work has also shown that traditional Islamic cities inherently incorporated the principles of sustainability in the form of compact cities, with natural ventilation and communal shared spaces which facilitated social cohesion and efficient use of resources.

© 2026 by MIP

At the level of planning practice, this review identifies seven actionable lever categories through which Islamic sustainability principles can be institutionalised: (1) governance — embedding Shariah-informed environmental jurisprudence into national planning law and establishing Hisbah-modelled oversight bodies; (2) land use — adopting heritage overlay zones and fractal street hierarchy guidelines in local development plans; (3) housing — recognising Waqf land as a distinct tenure category for affordable and community housing provision; (4) public space — mandating mosque greening, cemetery dual-use zoning, and biophilic design standards in urban parks; (5) climate resilience — integrating passive design codes and water-sensitive urban design requirements informed by vernacular Islamic precedents; (6) financing — expanding Shariah-compliant green municipal bonds and sukuk to cover a broader range of urban sustainability objectives; and (7) participation — formalising community consultation through Shura-based planning committees and recognising faith institutions as neighbourhood planning partners. Together, these levers provide urban planners and policymakers with a structured, culturally grounded toolkit for translating Islamic urbanism from theory into built reality

Contemporary trends in the literature show a resurgence of interest in adapting these approaches of Islamic architecture and urban planning to respond to current challenges in modern society, such as climate change and social fragmentation. In addition, this synthesis recognizes the remarkable contribution of Islam to promote a discourse on the sustainable city through the frame of the objectives of the Islamic legislation (maqasid al-shariah), especially the protection of life, intellect, family, and property. This perspective privileges as a meaningful alternative to the purely technocratic models for sustainability the incorporation of spiritual and cultural dimensions in urban planning practices. The results also hint that urban policies which are sensitive to local religious and cultural identities have the capacity to increase public acceptance and environmentally responsible behavior. Consequently, the integration of Islamic ethical values into urban planning aside from strengthening environmental resilience also contributes to creating more inclusive, resilient and human-centered cities.

REFERENCES

Abdelalim, M., Essam, B., & Fahmy, M. (2025). Ornament and efficiency: material performance and environmental logic of arabesque in Bayt Al-Razzaz. *Frontiers in Built Environment*, *11*. https://doi.org/10.3389/FBUIL.2025.1683871

Abowardah, E. S. (2024). Islamic Contemporary Architecture as An Approach for Social Sustainability in The Urban Parks Development. *Journal of Islamic Architecture*, *8*(2), 469–486. https://doi.org/10.18860/jia.v8i2.24663

Ahmad, K., & Berghout, D. A. (2025). Islamic finance and sustainable development: Balancing spirituality, values and profit. In *Islamic Finance and Sustainable*

Development: Balancing Spirituality, Values and Profit. https://doi.org/10.4324/9781003505570

Ahmed, S. S. (2025). The Evolving Role of Sustainable Development in Shaping Political Progress: A Contemporary Islamic Perspective on Human Rights and Civil Institution. *MILRev: Metro Islamic Law Review*, *4*(1), 1–30. https://doi.org/10.32332/milrev.v4i1.10128

Alhowaish, A. K. (2025). Green Municipal Bonds and Sustainable Urbanism in Saudi Arabian Cities: Toward a Conceptual Framework. *Sustainability (Switzerland)*, *17*(9). https://doi.org/10.3390/SU17093950

Alibašić, H. (2024). Exploring the influence of Islamic governance and religious regimes on sustainability and resilience planning: A study of public administration in Muslim-majority countries. *Public Policy and Administration*, *39*(4), 556–587. https://doi.org/10.1177/09520767231223282

Alkhresheh, M. (2025). A Dialectical Synthesis of Fused Grid Theory and Fractal Islamic Urbanism: Addressing the Deficiencies of Street Grid and Hierarchy Systems in Riyadh City. *Sustainability (Switzerland)*, *17*(19). https://doi.org/10.3390/SU17198549

Anas, W, N. I. W. N., Khairuldin, W. M. K. F. W., Embong, A. H., Mohd, H., & Wan Mokhtar, W. K. A. (2020). Trend of transsexualism problem and its implications towards muslim community in Malaysia. *International Journal of Pharmaceutical Research*, *12*(04). https://doi.org/10.31838/ijpr/2020.12.04.005

Ariff, A. A. A., Ismi, M. F., Hasnan, M. T. I. M. T., Mahadi, W. M. Z. W., Azmy, M. S., Ramli, S. A., & Alias, N. U. A. U. (2024). Natural Environment Accessibility through Green Architecture in Malaysian Low-Cost Housing Development from Islamic Principles. *Built Environment Journal*, *21*(S1), 357–385. https://doi.org/10.24191/bej.v21iSI.2426

Aulia, R. N., Abbas, H., Nurhattati, Jasin, F. M., & Mushlihin. (2024). Eco-pesantren modeling for environmentally friendly behavior: new lessons from Indonesia. *International Journal of Evaluation and Research in Education* , *13*(1), 223–229. https://doi.org/10.11591/IJERE.V13I1.25930

Aydin, N. (2017). Islamic vs conventional Human Development Index: Empirical evidence from ten Muslim countries. *International Journal of Social Economics*, *44*(12), 1562–1583. https://doi.org/10.1108/IJSE-03-2016-0091

Baran, T., Lupu, C., & Privitera, D. (2024). Faith and Sustainability: Exploring Religiosity's Impact on Intentions to Reduce Food Waste. *Sustainability (Switzerland)* , *16*(11). https://doi.org/10.3390/SU16114852

Bsoul, L., Omer, A., Kucukalic, L., & Archbold, R. H. (2022). Islam's Perspective on Environmental Sustainability: A Conceptual Analysis. *Social Sciences*, *11*(6). https://doi.org/10.3390/socsci11060228

Cheshmehzangi, A., Allam, Z., & Siew, G. (2024). Diversity in Cities and Addressing Urban Sustainability. *Urban Sustainability*, *Part F3805*, 1–9. https://doi.org/10.1007/978-981-97-8776-0_1

Dahmani, K., Aouissi, K. B., & Chettah, S. E. (2024). Implementing Sustainability In Urban Desert Regions Through Solar Orientation, The Islamic Vernacular Architecture Of The M'zab Ksour In Particular. *Journal of Islamic Architecture*, *8*(2), 408–422. https://doi.org/10.18860/JIA.V8I2.25531

© 2026 by MIP

Embong, A. H., Rahman, A. H. A., Kadir, F. K. A., Salamun, H., Khairuldin, W. M. K. F. W., Shahrani, S. S., & Karim, M. R. A. (2022). A Research Design Based on The Framework of Tafseer Al-Fiqhiy (Quranic Juristic Commentary). *Academic Journal of Interdisciplinary Studies*, *11*(2), 391. https://doi.org/10.36941/ajis-2022-0060

García García, M. (2026). Animalising the Islamic Green Revolution: zooarchaeology and socio-ecological change in the Islamic Far West. *Journal of Archaeological Science: Reports*, *69*. https://doi.org/10.1016/J.JASREP.2025.105553

Guzmán, P. C., Roders, A. R. P., & Colenbrander, B. J. F. (2017). Measuring links between cultural heritage management and sustainable urban development: An overview of global monitoring tools. *Cities*, *60*, 192–201. https://doi.org/10.1016/J.CITIES.2016.09.005

Hamidi, M. L., Setiawan, G., & Asutay, M. (2025). The quest for sustainable mosques: A paradigm shift with the quadruple bottom line framework. *Sustainable Futures*, *9*. https://doi.org/10.1016/J.SFTR.2025.100588

Shuhari, M. H., Hamat, M. F., Basri, M. N. H., Khairuldin, W. M. K. F. W., Wahab, M. R., Alwi, E. A. Z. E., & Mamat, A. Concept Of Al-Amanah (Trustworthiness) And Al-Mas'uliyyah (Responsibility) For Human's Character From Ethical Islamic Perspective. *J. Legal Ethical & Regul. Isses*, *22*(S1), 1-5.

Hatta, A. R., Jalil, N. A. A., Sham, R. J., & Hamidi, M. H. (2024). Urban Green Spaces: Social Cohesion, Human Health, and Islamic Green City. *Built Environment Journal*, *21*(S1), 402–409. https://doi.org/10.24191/bej.v21iSI.1507

Iswoyo, H., Farid, M., Nurfaida, N., Dariati, T., Faried, M., Djufrie, A. B., Amri, M., & Haya, R. (2025). Spaces for the living and the dead: Optimising cemeteries as sustainable urban green spaces. *Journal of Water and Land Development*, *2025*(66), 162–175. https://doi.org/10.24425/JWLD.2025.155312

Jimenez-Luque, A., & Penha-Vasconcelos, C. (2023). Addressing Environmental Challenges Through Intercultural Dialogue: Lessons from Latin America About "Good Living" or "Buen Vivir." *Handbook of Global Leadership and Followership: Integrating the Best Leadership Theory and Practice*, 585–610. https://doi.org/10.1007/978-3-031-21544-5_37

Kamal, I., Ismail, A. R., Dewidar, O., & Shazly, M. A. (2025). The Role of Islamic Finance in Achieving Sustainable Development Goals: A Conceptual Framework for Smart Cities and Urban Development Projects. In *Civic Synergy: Leading and Managing the Evolution of Smart Cities* (pp. 161–174). https://doi.org/10.1108/978-1-83708-042-720251012

Kamal, M. A., Warsi, T. R., & Nasir, O. (2023). Islamic Principles As A Design Framework For Urban System: Environmental Concern And Sustainable Development. *Journal of Islamic Architecture*, *7*(4), 699–712. https://doi.org/10.18860/jia.v7i4.21187

Kazak, H., Rahman, M. M., Akcan, A. T., Cetintas, H. B., Kocyigit, N., & Kilic, C. (2025). Performance of green finance: An evaluation of the OIC countries in the scope of 2030 Sustainable Development Goals. *Energy Policy*, *207*. https://doi.org/10.1016/J.ENPOL.2025.114838

Khairisma, K., Yoesoef, Y. M., & Syarif, M. F. (2025). Green sukuk impact: stock market reactions and SDG contributions of pioneering issuers. *Journal of Islamic Marketing*. https://doi.org/10.1108/JIMA-09-2024-0440.

Khairuldin, W. M. K. F., Anas, W. N. I. W. N., Suhaimi, M. A., Idham, M. A., Embong, A. H., & Hassan, S. A. a. (2024). Developing a Holistic Islam-Based Academic Integrity Model for Malaysian Higher Education Institutions. *Pakistan Journal of Life and Social Sciences*, *22*(1), 677–686.

Khairuldin, W. M. K. F. W., Anas, W. N. I. W. N., Embong, A. H., Hassan, S. A., Suhaimi, M. A., & Idham, M. A. (2024). Model Holistik Integriti Akademik Berteraskan Islam bagi Institusi Pengajian Tinggi di Malaysia. *Global Journal Al-Thaqafah*, 193–207. https://doi.org/10.7187/GJATSI122024-13

Khairuldin, W. M. K. F. W., Hassan, S. A., Anas, W. N. I. W. N., Mokhtar, W. K. A. W., & Embong, A. H. (2020). Al-Takyif Al-Fiqhi and its application in Islamic research methodology. Journal of Critical Reviews, 7(7), 462–467. https://doi.org/10.31838/jcr.07.07.80

Khan, F., & Haneef, M. A. (2022). Religious Responses To Sustainable Development Goals: An Islamic Perspective. *Journal of Islamic Monetary Economics and Finance*, *8*(2), 161–179. https://doi.org/10.21098/jimf.v8i2.1453

Maskun, Ratnawati, Wiranti, Asriyani, & Aslan, J. (2025). Legal Framework Model for Sustainable Solid Waste Management in Indonesia: A Contemporary Environmental Fiqh Perspective. *MILRev: Metro Islamic Law Review*, *4*(2), 1097–1122. https://doi.org/10.32332/MILREV.V4I2.11104

Mohson, Z. H., Ismael, Z. A., Naiem, S. R., & Shalal, S. S. (2025). Formal Transformations in Islamic Building Design and Their Sustainable Impact on Contemporary Architecture. *Street Art and Urban Creativity*, *6*(3), 860–878. https://doi.org/10.62754/AIS.V6I3.343

Naghipour, P., Naghipour, A., Shirdel, A. H., Behzadi, S. Z., Rahaei, O., & Salamati, S. (2025). Sustainability In Historical Islamic Architecture: Lessons From Sheikh Lotfollah Mosque's Construction Techniques. *Journal of Islamic Architecture*, *8*(3), 585–603. https://doi.org/10.18860/JIA.V8I3.29053

Natsir, M., Fuadi, Darmawan, Ulya, Z., & Sahara, S. (2024). The Relevance of Islamic Principles In Environmental Management In Aceh. *Petita: Jurnal Kajian Ilmu Hukum Dan Syariah*, *9*(1), 31–43. https://doi.org/10.22373/PETITA.V9I1.209

Rahim, R., Rathore, H. S., Rabbani, M. R., & Alam, M. N. (2024). Maqasid Al-Shariah and Green Finance: A Theoretical Framework on Islamic Finance with Sustainable Development Goals for a Greener Future. *2024 International Conference on Sustainable Islamic Business and Finance, SIBF 2024*, 255–261. https://doi.org/10.1109/SIBF63788.2024.10883847

Rochani, A., Yuliastuti, N., & Sudarwanto, B. (2024). Sustainable Waqf Space In Urban Kampong: The Case of Kampong Kauman, Semarang City. *Journal of Islamic Architecture*, *8*(2), 487–502. https://doi.org/10.18860/JIA.V8I2.24072

Roskin, J., Robins, L., Sánchez, R., Ostrowski, A., Bookman, R., & Taxel, I. (2025). Character and Evolution of Sunken Groundwater-Harvesting Agroecosystems in Aeolian Sand since Early Islamic Times, between Iran and Iberia. *Environmental Archaeology*, *30*(6), 637–654. https://doi.org/10.1080/14614103.2024.2411874

 © 2026 by MIP

Salam, H., Qariah, T. A., Shahbudin, M. S. A., & For, L. M. M. (2024). Examining Biomimicry-Based Sustainable Urban Design Solutions from an Islamic Tradition Perspective. *Built Environment Journal*, *21*(S1), 292–311. https://doi.org/10.24191/BEJ.V21ISI.1502

Sari, L. H., Wulandari, E., & Idris, Y. (2024). An investigation of the sustainability of old traditional mosque architecture: case study of three mosques in Gayo Highland, Aceh, Indonesia. *Journal of Asian Architecture and Building Engineering*, *23*(2), 528–541. https://doi.org/10.1080/13467581.2023.2245006

Suhartanto, D., Fadhlurrahmah, S. N. A., & Chaerunisa, K. A. (2025). Faith-aligned experience in urban parks: linking satisfaction to loyalty and responsibility among Muslim visitors. *Journal of Islamic Marketing*, 1–17. https://doi.org/10.1108/JIMA-06-2025-0357

Suni, S., Firdaous, M. H., Zailani, F. F., Gödeke, S., Mohd Raffi, R., & Abas, P. E. (2025). Urban Water Management and Public Acceptance of Rainwater Harvesting Systems: Insights from Young and Educated Respondents in Muslim Communities. *Sustainability (Switzerland)*, *17*(7). https://doi.org/10.3390/SU17073046

Yogananthan, S., Ulle, R. S., & Chinmayaaditya, M. (2024). Navigating the Nexus: How ethics and sustainability shape responsible business. *Strategies and Frameworks for Relearning in Organizations*, 31–59. https://doi.org/10.4018/979-8-3693-6312-6.CH002

Yu, H., Zahidi, I., Fai, C. M., & Madsen, D. Ø. (2025). Sustainable development in mosque construction. *Scientific Reports*, *15*(1). https://doi.org/10.1038/S41598-025-96786-X

Zafar, M. B., & Abu-Hussin, M. F. (2025). Faith, growth, and ethics: cross-cultural analysis of religiosity and environment protection vis-a-vis economic priorities among Muslims. *Journal of Environmental Psychology*, *106*. https://doi.org/10.1016/J.JENVP.2025.102716

Zuraidi, E., & Zainol, R. B. (2025). Agile Cities: Prospects And Challenges of Spatial Planning for Urban Economic Resilience in The Islamic Cultural Context of Banda Aceh, Indonesia. *Planning Malaysia*, *23*(2), 379–393. https://doi.org/10.21837/pm.v23i36.1726

Wan Khairuldin, W. M. K. F., Wan Nor Anas, W. N. I., Umar, R., Kamarudin, M. K. A., & Embong, A. H. (2022). Ethical Issues in Academic Authorship: A Study on Group Writing. *Academic Journal of Interdisciplinary Studies*, *11*(1), 226. https://doi.org/10.36941/ajis-2022-0020

Received: 27th January 2026. Accepted: 13th March 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 173 – 199

NAVIGATING NUSANTARA'S URBAN GREEN FABRIC: EXPLORING CULTURAL AND SOCIAL INFLUENCES IN SELECTED CITY PARKS

Najah Md Alwi[1], Syafiqah N. Mukhtar[2], Nor Hafizah Anuar[3], Khalilah Hassan[4]

[1,2] *Centre for Sustainable Urban Planning & Real Estate (SUPRE), Department of Architecture, Faculty of Built Environment,*
UNIVERSITI MALAYA, KUALA LUMPUR, MALAYSIA
[3]*Architecture and Interior Design Engineering Department, College of Engineering, Majmaah,*
UNIVERSITY OF MAJMAAH, KINGDOM OF SAUDI ARABIA
[4]*Landscape Architecture Department, Faculty of Architecture & Ekistics,*
UNIVERSITI MALAYSIA KELANTAN, BACHOK, KELANTAN, MALAYSIA

Abstract

Urban spaces in Southeast Asian cities, such as Jakarta and Kuala Lumpur, are undergoing transformative shifts in function and design, reflecting the complex interplay between cultural dynamics, historical contexts, and urban development trajectories. This research elucidates the evolving narratives of parks, open spaces, and eateries within these metropolises, stemming from the ancient archipelago of Nusantara, and examines their role in forming a unique urban experience. The study employs an interdisciplinary methodology, integrating historical analysis, ethnographic observations, and a review of urban planning literature to examine the changing roles and architectural developments in social spaces of Jakarta and Kuala Lumpur. Data were gathered through archival research, fieldwork, and interviews with urban planners and local stakeholders. The findings highlight a nuanced interaction between traditional practices from previous histories and modern Western and colonial influences, revealing how these social spaces serve as arenas for cultural expression and community engagement amidst the pressures of urbanisation. This investigation offers a framework for understanding the significance of cultural, historical, and urban factors in shaping the social and physical landscapes of Asian cities and to a broader discourse on the role of culture in urban development and its potential as a catalyst for creating resilient and vibrant urban spaces.

Keywords: urban parks; urban social spaces; Nusantara; urban green spaces (UGS)

[1] Corresponding author. Email: najah.alwi@um.edu.my

INTRODUCTION

The urban landscapes of Jakarta and Kuala Lumpur, two dynamic metropolises and capitals of Southeast Asia, stand as tributes to the profound influence of culture, history, and urban development on the configuration and functions of social spaces. Within the broader Southeast Asian context, often referred to as *Nusantara*, which represents the ancient *Malay Archipelago,* the cities have evolved into vibrant hubs where cultural diversity, historical legacies, and the inexorable march of urbanisation converge (Figure 1). The changing roles of social spaces in Jakarta and Kuala Lumpur in the post-pandemic era reflect the nuanced interplay between tradition and modernity, as well as the dynamic forces shaping urban life within this captivating region. This evolution is particularly evident in the adaptation of traditional urban elements, such as public squares and markets, alongside the integration of colonial structures, demonstrating a unique synthesis that defines the urban morphology of these cities (Sunaryo et al., 2013). The increasing population density and demand for diverse activities necessitate a re-evaluation of how urban green spaces are designed and utilized, moving beyond mere aesthetics to serve as dynamic social infrastructures that cater to the evolving needs of residents (Ebadi, 2015) (Putra et al., 2018).



Figure 1. Nusantara: Authentic Map Based on Indigenous Sources. Intel Prop
Source: *Anwar OdM, Zakaria Z, Hashim WAFW (2016)*

This inquiry explores the various narratives that shape architectural adaptations, including cultural influences and historical legacies, which have redefined and continue to redefine the use and value of urban spaces in Jakarta and Kuala Lumpur. This paper included photographs from both the pre- and post-pandemic periods in this study to facilitate a comparison of the rapidity of change between the years 2016 and 2021. In these specific case study urban parks, the aim is to unveil the nuanced shifts in the role of these spaces. A profound appreciation for the complex interplay between the historic culture of the people and the urban environment within the larger Southeast Asian narrative underpins this research endeavour.

Theoretical Contributions

This research contributes to urban planning theory by demonstrating that effective park planning in postcolonial, rapidly urbanizing contexts requires frameworks recognizing parks' multiple functions: social infrastructure for community cohesion, cultural infrastructure for identity expression, health infrastructure for wellbeing, and ecological infrastructure for environmental services.

From past to present

The rapid urbanization of Jakarta and Kuala Lumpur, as capital cities, has significantly transformed the design and function of the green spaces within these cities. As urban areas continue to develop, the demand for parks, green spaces, recreational areas, and communal gathering spots becomes increasingly crucial. Urban planners and architects face the challenge of redesigning these social spaces to cater to the changing requirements of residents while also ensuring the preservation of the cities' cultural heritage.

The evolution of urban landscapes brings forth a striking metamorphosis in modern parks, where lush greenery intertwines with innovative open spaces that invite exploration and leisure. Trendy eateries, often both affordable and eclectic, spring up like vibrant oases, catering to the diverse tastes of city dwellers. These areas are no longer mere locales, but vibrant environments infused with technology, sustainable practices, and active community engagement. Consequently, social spaces have blossomed into dynamic hubs, pulsating with energy and fostering connections among residents, thereby transforming ordinary interactions into memorable experiences.

The interaction between tradition and modernity in social spaces is a defining feature of cities like Jakarta and Kuala Lumpur. While traditional practices and cultural norms shape the social fabric of these cities (Nahuway et al., 2021; Nor et al., 2021; Santoso et al., 2021), modern influences such as globalization, technology, and urbanization also play a significant role in

© 2026 by MIP

redefining social spaces (Arif, 2019; Dwisusanto & Juwita, 2022). The juxtaposition of tradition and modernity creates a dynamic urban environment where old and new coalesce to form a unique identity. This dynamic is particularly evident in the transformation of public parks, which are increasingly seen not just as ecological assets but as vital social infrastructures that must adapt to evolving urban needs and demographic shifts.

The interplay of tradition and modernity significantly shapes the architecture, design elements, and programming of parks, open areas, and dining establishments. In cities like Jakarta and Kuala Lumpur, two countries that integrate traditional values with contemporary trends, these social spaces appeal to a wide range of preferences and lifestyles (McDonald et al., 2018). This blend of influences fosters inclusivity and promotes cultural exchange among diverse communities. These transformations often manifest in adaptive reuse projects, in buildings, urban spaces, and landscapes, where historical buildings and streetscapes are reimagined to serve modern functions (such as shopping, socialising, or dining out), yet retain cultural continuity while accommodating contemporary demands.

LITERATURE REVIEW

The rapid urbanisation of Asian city centres has led to notable transformations in the design and function of social spaces within these cities (Mahira et al., 2021, Lukito & Zahra, 2019). Maps showing more similar urban areas continue to develop in the *Nusantara* region, with the demand for green spaces, recreational areas, and communal gathering spots increasingly crucial. Urban planners and architects face the challenge of redesigning these social spaces to cater to the changing requirements of residents while also ensuring the preservation of the cities' cultural heritage. This re-evaluation extends to how these spaces contribute to cultural sustainability, a vital aspect of urban development that emphasizes the integration of local identity within contemporary design.

The evolution of urban and city landscapes brings forth a striking metamorphosis through modern parks, where lush greenery entwines with innovative open spaces that invite exploration and leisure use, which were once not part of local culture. Trendy eateries, often both affordable and eclectic, spring up like vibrant oases, catering to the diverse tastes of city dwellers. These areas in the cities are no longer limited to locals but consist of vibrant environments infused with technology, sustainable practices, and active community engagement with the city. As a result, social spaces have blossomed into dynamic hubs, pulsating with energy and fostering connections among residents, transforming ordinary interactions into memorable experiences.

The interaction between ancient *Nusantara* heritage and colonial modernity in social spaces is the new defining feature of both Jakarta and Kuala

Lumpur. While multi-ethnic traditional practices and cultural norms shape the social fabric of these cities, modern influences such as social media globalisation, technology, and urbanisation also play a significant role in redefining social spaces (i.e., Instagram-able, Wi-Fi use). The juxtaposition of tradition and modernity creates a dynamic urban environment where old and new coalesce to form a unique identity.

The influence of tradition and modernity on social spaces significantly shapes the architecture, design elements, and programming of parks, open areas, and dining establishments. In cities like Jakarta and Kuala Lumpur, the integration of traditional values with contemporary trends allows these social spaces to appeal to a wide range of preferences and lifestyles. This blending of influences fosters inclusivity and promotes cultural exchange among diverse communities.

Urban Community Spaces

Social green spaces generally encompass Urban Green Spaces (UGS) that serve as vital community gathering places. In Jakarta, the city government has implemented policies to preserve and expand public parks and green areas, such as Taman Mini Indonesia Indah and Monas National Monument, offering recreational opportunities and community events for the city's vast population. Similarly, Kuala Lumpur has designated several urban parks, like Kuala Lumpur City Centre Park (KLCC) and Perdana Botanical Garden, as social hubs where residents and visitors can enjoy nature, engage in leisure activities, and participate in cultural festivities. These green spaces play a crucial role in fostering social interaction and community cohesion within both cities' rapidly developing urban landscapes. This section presents studies detailing the various efforts by stakeholders in each city to balance the preservation of their cultural treasures with what may be considered a fundamental aspect of the city's identity.

Preserving historical and cultural assets presents a significant challenge for rapidly growing cities like Jakarta and Kuala Lumpur. Both cities have undertaken efforts to rehabilitate and revitalize old inner-city areas with varying degrees of success. In Penang, Malaysia, George Town, a United Nations Educational, Scientific and Cultural Organization (UNESCO World Heritage site, faces the challenge of balancing heritage preservation with modern development, a situation mirrored in Jakarta and Kuala Lumpur. This equilibrium is crucial for maintaining the cities' unique cultural identities and social fabric while accommodating the demands of urban growth. Studies indicate that integrating public art and community engagement can create more vibrant and inclusive public spaces that resonate with local culture and history.

Current practices in maintaining and preserving inherently culturally sensitive social spaces (such as prayer areas for different religious practices,

© 2026 by MIP

cemeteries) require further research. While existing literature highlights the challenges of balancing heritage preservation and modern urban development in cities such as Kuala Lumpur and Jakarta, a deeper exploration is needed into how these cities navigate potential conflicts between safeguarding cultural identities and accommodating the demands of rapid urbanization in the design and function of public spaces. Specifically, it is unclear how the interplay between rapid urban expansion patterns and the socio-cultural dynamics influences the amount and spatial distribution of green spaces (Nor et al., 2021).

The selection of case studies that exemplify the dynamics in Jakarta and Kuala Lumpur is crucial for understanding the complex interplay between tradition and modernity in the transformation of urban social environments in Southeast Asia. For instance, investigating Jakarta's lively street markets, where local traditional commerce merges with contemporary consumerism, can yield important insights into this relationship. The Daerah Khusus Ibukota (DKI) Jakarta Provincial Government's initiative to build Green Open Spaces in each urban village, featuring management buildings, parks, and children's play areas, aims to address this deficit by providing much-needed community facilities and fostering social interaction (Rustanto & Akhmad, 2021).

Likewise, in examining Kuala Lumpur's dynamic cultural festivals, which honour heritage while embracing modern artistic forms, it showcases how these cities manage the delicate balance between maintaining historical identities and adapting to the pressures of globalization. Collectively, these examples depict the intricate and shifting landscape of urban existence in Southeast Asia, reflecting the ongoing evolution of community and identity in a rapidly transforming world.

Post-Pandemic Urban Parks

The COVID-19 pandemic has fundamentally reshaped understanding of urban parks globally, elevating them from recreational amenities to essential public health infrastructure (Honey-Rosés et al., 2021). Studies document increased demand for accessible green spaces during lockdowns, with parks experiencing usage surges of 25-200% in various cities (Venter et al., 2020). This heightened awareness has prompted reconsideration of design standards, including spatial configurations enabling social distancing (Kleinschroth & Kowarik, 2020), enhanced sanitation facilities, and digital integration for capacity monitoring (Shoari et al., 2020). In Southeast Asian contexts, pandemic impacts intersected with existing cultural practices and spatial constraints, creating unique challenges (Xie et al., 2020). However, limited comparative research examines how cities like Jakarta and Kuala Lumpur adapted their urban green spaces to meet evolving public health and social needs within their specific cultural contexts.

© 2026 by MIP

RESEARCH METHODOLOGY

This study was conducted in a total of five parks: two urban parks in Kuala Lumpur, Malaysia, and three urban parks in Jakarta Central, Indonesia. The parks in Kuala Lumpur are the Botanical Gardens and KLCC Park, both located in the city centre of Kuala Lumpur, Malaysia (see Figure 1). The parks in Jakarta are Taman Menteng, Taman Suropati, and Taman Monas (see Figure 2), all located in the heart of the Capital of Indonesia. All three sites selected for Jakarta are both considered city parks and neighbourhood parks, defined by their location and proximity to residential areas as well as the city metropolitan areas. The selection of these five urban parks was informed by their diversity in function, location, and governance structures, offering a representative spectrum of public green spaces across varying socio-political urban landscapes.

Data Collection Methods

This research employs a multi-method approach to data collection and analysis, aiming to thoroughly examine the dynamics influencing social spaces in Jakarta and Kuala Lumpur (as shown in Figure 2). Semi-structured interviews were conducted with park officials and users, yielding valuable insights into the decision-making processes, challenges, and strategies related to the design, preservation, and management of social spaces in both cities. Field observations were carried out to document the physical characteristics, usage patterns, and social interactions within the selected case study sites. The data from these observations, combined with archival research on the historical development and design evolution of the areas under study, were analysed to uncover key themes and patterns.

© 2026 by MIP

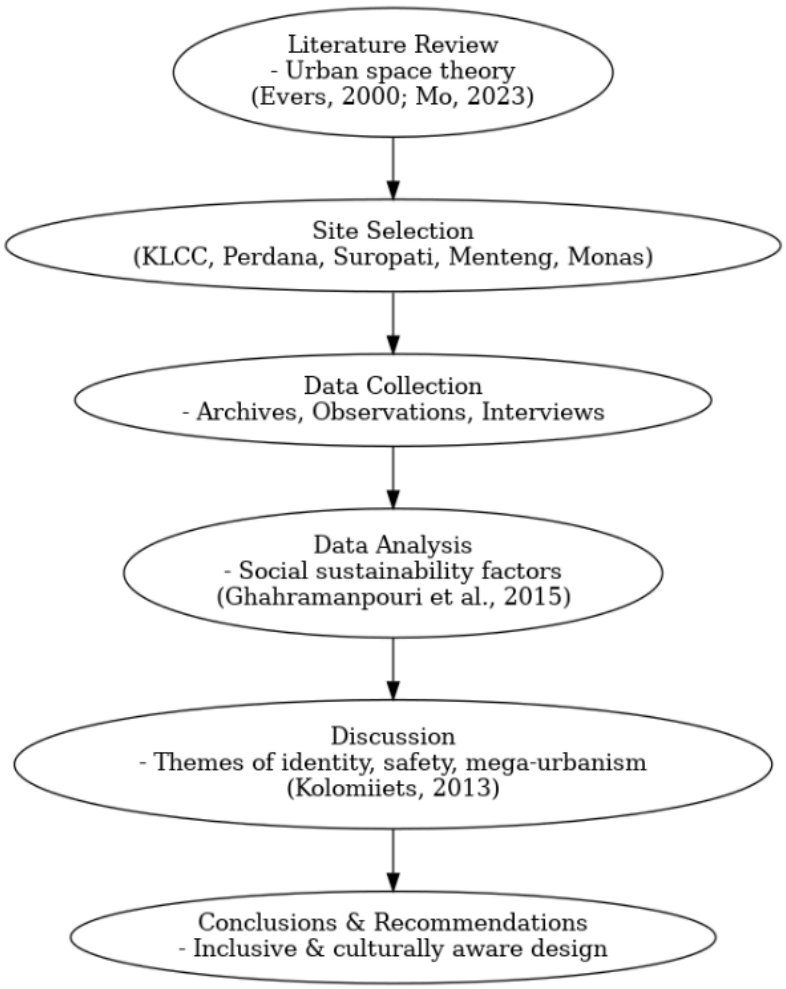


Figure. 2. Research Flow Adapted in this Study
Source: *Author*

Data Integration and Analysis

This study integrates three primary data sources to examine park evolution:

(1) **Field observations** conducted in 2016 documenting spatial configurations, design elements, and usage patterns across selected parks in both cities.
(2) **Archival research** analyzing historical documents, planning reports, and photographic records to establish temporal baselines and trace design evolution;

(3) **Literature review** synthesizing existing research on urban parks, cultural heritage, and post-pandemic urban planning to contextualize findings within broader scholarly discourse. These sources were analyzed thematically to identify patterns in park design, cultural integration, and governance approaches, enabling comparative analysis between Jakarta and Kuala Lumpur.

Limitations and Future Research

This study's limitations include focus on capital cities (potentially not representative of secondary cities), reliance on 2016 field observations (not capturing recent post-pandemic changes directly), and emphasis on formal municipal parks (potentially overlooking informal green spaces). Future research should conduct longitudinal studies tracking park evolution, expand to secondary cities, include other Nusantara cities (Bangkok, Manila, Singapore), and examine informal green spaces for more comprehensive understanding of urban nature access.

The COVID-19 pandemic has elevated urban parks from amenities to essential infrastructure. As Nusantara cities continue rapid urbanization, lessons from Jakarta and Kuala Lumpur offer valuable guidance for developing resilient, culturally responsive, and equitable urban green space systems through creative synthesis of local cultural resources, community agency, professional expertise, and evidence-based innovation.

ANALYSIS OF FINDINGS AND DISCUSSION

This study highlights varied approaches to urban park development in Jakarta and Kuala Lumpur, ranging from grassroots community-led initiatives to top-down, commercially driven models.

An inductive thematic coding process, based on Braun and Clarke's (2006) six-phase framework, was applied to field notes, interview transcripts, and visual data. Initial coding was conducted without predefined categories, identifying patterns related to spatial practices, user behaviour, symbolic elements, and civic interaction. Both manual and NVivo-assisted coding enabled integration of textual and photographic data, allowing, for instance, the correlation between informal seating patterns and themes of inclusivity or place attachment. Visual cues—such as signage, graffiti, or commemorative structures—were treated as embedded narratives and triangulated with verbal accounts to provide a comprehensive understanding.

Codes were refined into overarching themes through iterative analysis, supported by peer debriefing, intercoder calibration, and memo writing to ensure rigor and reflexivity. Cross-case comparisons examined key variables, including spatial design, accessibility, heritage integration, and user engagement. These

© 2026 by MIP

were interpreted through a sociocultural lens, grounded in theories of urban social sustainability and spatial justice, which allowed for a nuanced understanding of how public parks function as socio-spatial infrastructures in Southeast Asian megacities.

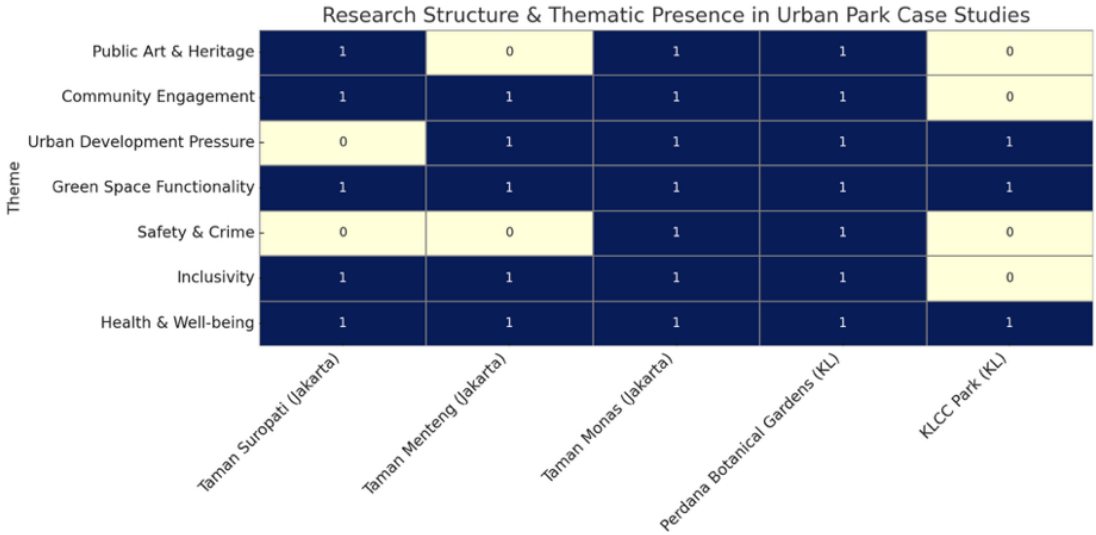


Figure 3. Emerging Themes Across All Five Selected Parks
Source: Author

Thematic coding followed principles from Braun & Clarke's framework **(**Table 1 below), identifying recurring socio-spatial patterns across cities (in Figure 3 above). Cross-case comparison was guided by variables such as spatial design, accessibility, heritage integration, and user engagement. These data sources were interpreted within a sociocultural lens, informed by the theoretical underpinnings of urban social sustainability and spatial justice.

Table 1. Braun and Clarke's (2006) Six-Phase Framework for Thematic Analysis

Phase	Description
1. Familiarisation with the data	Immersing in the dataset through repeated reading of transcripts, field notes, and visual material, noting initial insights.
2. Generating initial codes	Systematically coding key features of the data using manual or software tools; organising data in meaningful groups.
3. Searching for themes	Collating codes into potential themes; grouping relevant coded data extracts under thematic clusters.
4. Reviewing themes	Checking coherence of themes in relation to the dataset; refining and modifying themes as needed; developing a thematic map.
5. Defining and naming themes	Finalising themes with clear definitions; analysing their scope and interrelationships; assigning concise names.

Phase	Description
6. Producing the report	Weaving themes into a coherent narrative, selecting compelling examples, and relating findings to research questions and the theoretical framework.

KEY FINDINGS

Three principal findings emerge: First, Jakarta and Kuala Lumpur pursue fundamentally different approaches—Jakarta emphasizing high-density, community-managed, multifunctional spaces versus Kuala Lumpur's aesthetically refined, professionally managed parks serving both recreational and representational functions. Second, cultural integration manifests differently—organically and practice-based in Jakarta versus curated and representational in Kuala Lumpur—reflecting distinct nation-building trajectories. Third, governance approaches shape park outcomes, with Jakarta's participatory model building strong community ownership while Kuala Lumpur's centralized model ensures consistent professional standards.

CASE STUDY DATA FINDINGS

Case Study 1: Taman Suropati, Jakarta.

Taman Suropati, a public park in the heart of Jakarta, exemplifies how public art and community engagement can enhance the cultural significance and social function of urban green spaces. The park features diverse sculptures and art installations that reflect Indonesia's rich cultural heritage, ranging from traditional Javanese motifs to modern abstract designs. The integration of public art not only enhances the park's visual appeal but also fosters a sense of community ownership and pride among residents. Taman Suropati's design and programming have evolved to meet the changing needs and preferences of the community. It has transformed from a mere recreational hub into a vibrant venue for various cultural events and community gatherings, including traditional music performances, art exhibitions, and local festivals.

Observational research and stakeholder interviews reports on public art and community-focused activities in Taman Suropati have fostered greater social engagement, increased recreational use, and enhanced a sense of community ownership among park visitors (Lukito & Zahra, 2019) (Hutomo & Fuad, 2020). Consequently, the park has become a vibrant centre for cultural events, including traditional music performances and art displays, further solidifying its role as a space that celebrates Jakarta's rich artistic heritage. In Taman Suropati, a historic park in Jakarta, public art installations have been a strategy to balance cultural preservation with modern urban design. The study of Taman Suropati suggests that public art here can serve as a medium to enhance the quality of urban spaces, fostering community interaction and creating lively, attractive environments. For

© 2026 by MIP

instance, the placement of statues representing the pioneering Association of Southeast Asian Nations (ASEAN) countries in Taman Suropati has helped preserve the park's historical significance while attracting visitors and promoting cultural engagement. This integration of art within the urban landscape stimulates active engagement, moving beyond passive observation to foster dynamic social interactions within the park (Lukito & Zahra, 2018).

This case study highlights the potential for public art and inclusive design to preserve the cultural heritage and social function of urban green spaces in the face of rapid urbanization. This successful integration highlights the park's crucial role in enhancing the well-being of its users through both active and passive engagement with its diverse offerings (Hutomo & Fuad, 2020). The park's strategic location and accessibility, combined with its well-maintained infrastructure and diverse amenities, significantly contribute to its success as a public space (Lukito & Zahra, 2018).

Case study 2: Taman Menteng, Jakarta

Taman Menteng, another public park in Jakarta, provided a compelling case study for examining the interplay between urban development and the preservation of cultural heritage. As a spacious, centrally located green space, Taman Menteng serves as a gathering place for the city's residents, hosting various community events and cultural activities (Adiati et al., 2018; Darmawati & Sumadio, 2020; Nursanto, 2014). However, the park has faced increasing pressure from commercial development and urban renewal projects in the surrounding neighbourhoods. Efforts to revitalise the area during the pandemic have included renovating the park's facilities, introducing new recreational amenities, and incorporating modern architectural elements. While these changes have made Taman Menteng more appealing and accessible to the city's growing population, they have also raised concerns among residents and heritage advocates about the potential loss of the park's historic character and cultural significance.

While renovations have made Taman Menteng more appealing and accessible to the city's growing population, some residents and heritage advocates have expressed concerns about the potential loss of the park's historic character and cultural significance. However, others argue that the renovations and new amenities have helped the park better meet the community's needs and remain relevant in the face of rapid urbanisation. Observational studies and interviews with community members have revealed a complex dynamic result. Residents express a solid attachment to the park's traditional features, such as its lush greenery, iconic pavilions, and longstanding community gatherings and cultural celebration traditions. At the same time, they acknowledge the need for the park to adapt to the changing needs and expectations of modern urban life. Many residents emphasise preserving the park's historic character and cultural

© 2026 by MIP

significance, which they see as integral to the community's identity and sense of place.

This delicate balance between honouring the park's heritage and responding to contemporary demands requires careful consideration and negotiation among various stakeholders. The ongoing dialogue and negotiations between various stakeholders, including the city government, urban planners, and local communities, will be crucial in determining the future trajectory of Taman Menteng and other similar public spaces in Jakarta.

Case study 3: Taman MONAS, Jakarta

Taman Monas is a central gathering place for the public, where Indonesians from all walks of life come together to honour their shared history, engage in cultural activities, and express their national pride through the park's physical design and the many celebrations hosted within its bounds throughout the year (Kusno, 2004; Sushartami & Ristiawan, 2018). The park's National Monument, a striking 132-metre-tall obelisk (see Figure 3), is a powerful symbol of Indonesia's struggle for independence and has become a source of great national pride for its citizens. Studies have shown that the vibrant cultural events and festivals held at Taman Monas, such as the annual Independence Day celebrations, play a crucial role in fostering a sense of unity and strengthening the national identity among Indonesians.



Figure 4. *A Ground View Taman MONAS, Jakarta*
Source: Author



Figure 5. Top View of Taman Monas Tower
Source: Author

© 2026 by MIP

Taman Monas has also come under increasing pressure from urban development, with repeated proposals to introduce commercial buildings and large-scale infrastructure within its perimeter. While the park has historically served as a central venue for cultural expression, civic engagement, and collective memory, these functions have been increasingly challenged by the encroaching commercialisation of the surrounding district (Nor et al., 2021; Rustanto & Akhmad, 2021; Thedyardi & Husin, 2019). The introduction of contemporary architectural features and new facilities—often justified under the guise of modernisation—has raised public concern over the erosion of the park's historical and symbolic significance, as well as the risk of diminishing public access and cultural autonomy within the space.

This case exemplifies the delicate balance between safeguarding cultural heritage and accommodating the pressures of rapid urban growth. As Taman Monas evolves, the challenge lies not merely in resisting change but in ensuring that future developments remain contextually respectful, publicly accountable, and deeply rooted in the collective narratives that the park embodies. Only through such an approach can its role as a national and cultural landmark be meaningfully sustained amidst the flux of urban transformation.

Case Study 4: Perdana Botanical Gardens, Kuala Lumpur

Kuala Lumpur's Perdana Botanical Gardens, also known as the Lake Gardens, is a sprawling urban oasis over 92 hectares in the heart of the Malaysian capital. This lush green space is a renowned destination, providing a peaceful respite from the bustling city life (Samad et al., 2021). The botanical garden features a diverse array of plant species, carefully curated landscaping, and tranquil waterbodies, offering visitors an immersive experience in nature within the confines of the metropolitan area. It serves as a vital ecological lung for the city, contributing significantly to urban biodiversity and offering numerous recreational opportunities for residents and tourists alike, even during the global lockdown in 2020 (see Figures 6 and 7).

The Perdana Botanical Garden's long history dates to the late 19th century, when the area was first developed as a recreational space for colonial officers. Over the decades, the gardens have evolved to accommodate the changing needs and preferences of Kuala Lumpur's residents while maintaining their core national identity as a cherished urban green space that celebrates the city's natural heritage, like Taman Monas and Taman Suropati in Jakarta.

As urban development accelerates, concerns have arisen over the potential encroachment of commercial and infrastructure projects into public green spaces, threatening their cultural and ecological integrity (Ibrahim et al., 2020; Samad et al., 2021). Similar tensions are evident in Taiping Lake Gardens, where heritage preservation must contend with urban expansion (Ebadi, 2015;

Thani et al., 2015). This reflects a broader pattern in Malaysian urban planning, where limited prioritisation and funding for conservation often result in decisions that undermine the historical value and distinct identity of key cultural landscapes.



Figure 6. Different Segments of Perdana Botanical Gardens, Kuala Lumpur during September 2020
Source: Author



Figure 7. Different Segments of Perdana Botanical Gardens, Kuala Lumpur during September 2020
Source: Author

The Perdana Botanical Gardens have undergone several strategic redevelopment and expansion efforts, incorporating new recreational amenities and educational facilities to enhance the visitor experience during the global pandemic (see Figures 6 and 7). These upgrades aim to strike a balance between preserving the gardens' cultural legacy and ecological significance, while catering to the growing demands of the city's population (Khalid et al., 2023). The result is a harmonious blend of traditional and modern elements that continues to draw

© 2026 by MIP

residents and tourists alike, offering a tranquil respite and an opportunity to connect with Kuala Lumpur's natural and cultural heritage.

Kuala Lumpur's increasing urbanisation, marked by the transformation of green areas into built-up zones for infrastructure and housing, poses a substantial risk to the survival and integrity of crucial ecological assets, such as the Perdana Botanical Gardens (Kasim et al., 2018). The city's continuous expansion, propelled by economic growth and development priorities, often results in the fragmentation and isolation of green spaces. There is a critical need for a more comprehensive urban planning strategy that prioritizes environmental and social benefits over mere aesthetic enhancements or commercial interests (Nor et al., 2021).

This case study highlights the complexities and opportunities involved in preserving the Malaysian cultural identity of urban green spaces while adapting them to the evolving needs of a dynamic metropolitan area. As cities such as Kuala Lumpur advance, the Perdana Botanical Gardens serve as a benchmark for how public spaces can be strategically redeveloped and reimagined to honour heritage while embracing future advancements. This challenge is not unique to Kuala Lumpur; many rapidly developing Southeast Asian cities face similar pressures on their urban green spaces due to accelerated urbanisation.

Case Study 5: KLCC Park, Kuala Lumpur

In contrast to the more grassroots-driven approach observed in Taman Suropati, the development of KLCC Park in Kuala Lumpur represents a more top-down, commercially driven approach to urban space design. Located in the heart of Kuala Lumpur's central business district, KLCC Park was conceived as an integral part of the more considerable KLCC development, which includes the iconic Petronas Twin Towers and a sprawling shopping mall (Ayeghi & Ujang, 2014; Shafee & Kamaruddin, 2019). The park's design and programming aimed to influence a delicate balance between serving as a public green space and catering to the commercial interests of the surrounding developments.

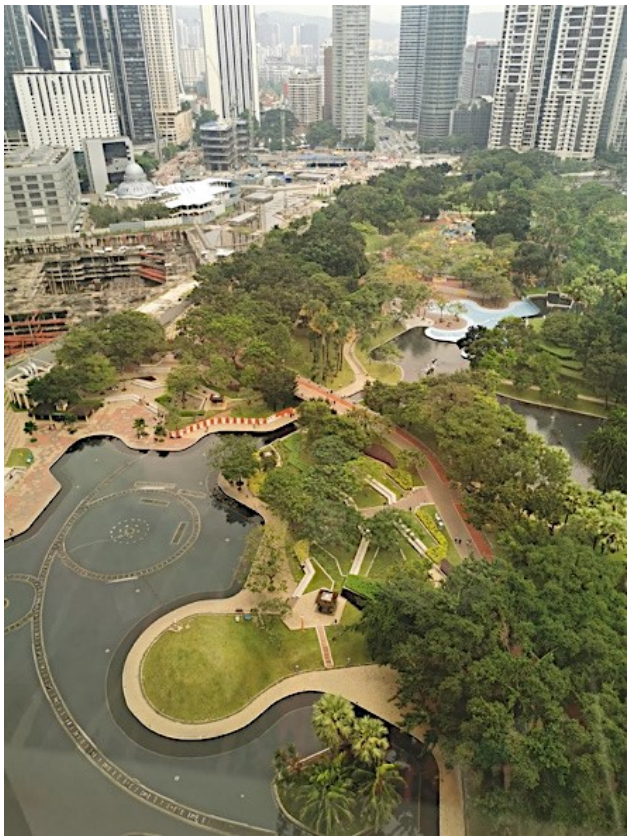


Figure 8. A Snapshot of Overview KLCC Garden Showing Greenery Area and Water Bodies of the Park Taken from Hyatt Hotel during September 2021
Source: Author

This strategic positioning, within a high-density commercial zone (Figure 8), highlights a deliberate effort to integrate nature into the urban core, aiming to enhance aesthetic appeal while offering recreational opportunities to a diverse population (Nor et al., 2021). While the park does provide a much-needed green respite within the urban core, its design and programming have been criticised for prioritising commercial interests over community engagement and cultural preservation. The park's landscaping, amenities, and facilities primarily cater to the needs and preferences of affluent residents and visitors from the surrounding high-end developments, potentially excluding or marginalising the broader local community.

© 2026 by MIP

Figure 9. Different Usage of Areas of KLCC Gardens during Day and Night, Kuala Lumpur during September 2021
Source: Author

Furthermore, the construction of KLCC Park and the larger KLCC development have been linked to the diminishing presence of traditional shophouses and the displacement of established communities, impacting historical and cultural elements in the surrounding area (Shams & Badarulzaman, 2014) (Chan, 2019). Despite these issues, the park remains a popular destination, attracting over 6 million visitors annually and offering a diverse range of recreational amenities, as well as hosting various cultural events (as shown in Figure 9).

This case study illustrates the complex dynamics inherent in urban green space development driven by commercial interests and centralized planning, rather than grassroots community needs. It raises crucial questions regarding the ability of urban green spaces to genuinely serve the public good when integrated into large-scale commercial developments. While the Petronas Towers and KLCC development were conceptualized to project Malaysia as a "world-class" nation and foster new perspectives among its populace, critical analyses suggest that these symbolic intentions can be contested and reinterpreted through the everyday lived experiences of urban dwellers (Bunnell, 1999).

COMPARATIVE ANALYSIS: JAKARTA VS KUALA LUMPUR

The case studies reveal distinct approaches to urban park development in Jakarta and Kuala Lumpur, reflecting differing cultural priorities, governance structures, and resource constraints.

Park Design Approaches

Jakarta's parks emphasize multifunctional, high-density spaces maximizing utility per square meter—a response to severe land constraints (4.3 m² green space per capita versus WHO's 9 m² recommendation). Parks like Taman Suropati and RPTRA Kalijodo feature compact layouts with intensive programming, incorporating traditional Javanese architectural motifs (pendopo structures, ornamental gates) within contemporary frameworks. Design prioritizes active recreation and community gathering over passive contemplation.

Kuala Lumpur's parks exhibit greater spatial generosity (14.8 m² green space per capita), emphasizing aesthetic refinement and botanical diversity. KLCC Park and Perdana Botanical Garden showcase expansive lawns, curated plant collections, and architectural elements blending Malay, Islamic, and colonial influences. Design philosophy balances active recreation with passive enjoyment and representational functions.

Community Engagement and Governance

Jakarta has increasingly embraced participatory models, particularly through the RPTRA (Ruang Publik Terpadu Ramah Anak) program launched in 2015, mandating community committees for park oversight. This bottom-up approach emerged partly from budget constraints but has generated strong local ownership, with residents contributing to programming, maintenance, and security.

Kuala Lumpur maintains centralized governance through Kuala Lumpur City Hall (DBKL), with limited formal community input mechanisms beyond consultation periods. While ensuring consistent maintenance standards, this can create disconnects between official programming and community preferences. Informal engagement occurs through user groups (tai chi associations, jogging clubs) negotiating space usage with authorities.

Cultural Integration

Jakarta's parks serve as sites for organic cultural expression—traditional music performances, communal meals (kenduri), and spontaneous religious gatherings. Cultural integration is practice-based, emerging from community usage. The presence of warungs (food stalls), informal gamelan sessions, and religious activities demonstrates vernacular cultural expression within modern urban contexts.

Kuala Lumpur's approach is more curated, with cultural elements deliberately incorporated to project national identity. KLCC Park's Islamic garden features and Perdana Botanical Garden's hibiscus collection (national flower) exemplify this strategy. Cultural programming is formalized through scheduled events rather than spontaneous practices, reflecting Malaysia's nation-building project balancing diverse ethnic traditions.

These differences have significant implications for urban planning policy. Jakarta's model demonstrates how participatory governance can build community ownership despite resource constraints, while Kuala Lumpur's model shows how professional management ensures consistent quality. Neither approach is inherently superior; rather, each represents context-appropriate strategies shaped by distinct urban realities, governance traditions, and cultural priorities.

Implications for Urban Planning Policy

The comparative analysis reveals critical lessons for urban planning policy in Nusantara cities. For participatory governance, Jakarta's RPTRA model demonstrates that community involvement can reduce municipal costs while increasing local ownership and responsiveness to community needs. Planning policies should establish frameworks supporting community park committees while ensuring minimum service standards. For design standards, the contrast

© 2026 by MIP

between Jakarta's high-density, multifunctional parks and Kuala Lumpur's aesthetically oriented parks suggests that design guidelines must be calibrated to local land availability and cultural priorities rather than adopting universal standards. For cultural integration, both cities demonstrate successful but different approaches—Jakarta's organic, practice-based integration versus Kuala Lumpur's curated, representational approach—indicating that cultural heritage can be preserved through multiple pathways. For pandemic resilience, literature suggests that parks with flexible design and governance structures (combining Jakarta's community adaptability with Kuala Lumpur's professional standards) are better positioned to respond to public health crises while maintaining essential functions.

EMERGING THEMES

Health And Well-Being

The preservation and enhancement of public green spaces in rapidly urbanising cities like Jakarta and Kuala Lumpur are increasingly recognised as vital to urban health, well-being, and liveability. Thoughtfully designed parks and gardens not only provide opportunities for physical activity and social interaction but also offer essential psychological relief from urban stressors. Iconic spaces such as Taman Monas and the Perdana Botanical Gardens exemplify the role of urban nature in promoting physical, mental, and environmental health (Raman et al., 2021). As Southeast Asian cities continue to densify, the strategic integration of green spaces becomes increasingly critical in mitigating environmental degradation and sustaining a high quality of life (Nor et al., 2021).

Moreover, public green spaces serve as vital platforms for social interaction, fostering community ties through gatherings, cultural events, and everyday encounters. By nurturing a sense of belonging and reducing social isolation, these spaces enhance individual well-being and strengthen urban social cohesion. As urban populations in both Jakarta and Kuala Lumpur continue to expand, safeguarding and enhancing these communal environments becomes essential—not just for leisure, but for sustaining quality of life and public health amid the pressures of rapid urbanisation.

Crime and Safety

Urban safety, understood as the quality of the urban environment for its inhabitants, critically impacts a city's sustainability and its citizens' ability to participate in community life without apprehension (Salazar et al., 2020) (Iqbal, 2021). Historically, the perception of nature as perilous during the 13th to 15th centuries gradually shifted, leading to the emergence of the urban park as a concept of secure public space in the 19th century (Lis et al., 2025). This historical progression underscores the need for deliberate design and

management interventions to transform natural areas into secure and accessible public amenities (Polko & Kimic, 2021).

While green spaces were integral to communal life during the Nusantara era, contemporary urban planning often overlooks the critical relationship between design, use, and safety, thereby undermining their potential to support community well-being and prevent crime (Guttman et al., 2021; Sukartini et al., 2021). Research shows that well-maintained, well-lit green areas can deter criminal activity. In contrast, neglected or poorly surveilled spaces may foster anti-social behaviour (Nor et al., 2021).

Taman Monas in Jakarta, for instance, has faced issues of theft, vandalism, and public disorder (Lavandya et al., 2020). In response, planners have implemented safety measures, including increased lighting, surveillance systems, and security personnel. However, proper safety extends beyond infrastructure—it requires the integration of defensible space principles and Crime Prevention Through Environmental Design (CPTED) strategies. These include promoting natural surveillance, territorial reinforcement, and routine maintenance to sustain a sense of order and safety (Marzukhi et al., 2018; Polko & Kimic, 2021; Ali et al., 2020)

Given the multifaceted nature of urban safety, future urban development strategies must prioritize consistent investment in the maintenance and improvement of these vital public spaces (Badiora et al., 2020). As urban environments continue to develop, the design and management of public spaces must prioritize safety and security to ensure continued accessibility and inclusivity for all users.

Community Engagement

The social spaces observed in the case study serve as evidence that they provide platforms for community engagement and social interaction. Encouraging residents to participate in the design and programming of these spaces can foster a sense of ownership and belonging among the local population, thereby strengthening social connections and cultivating a heightened sense of community belonging.

In Jakarta, Taman Monas has been the site of various community-led initiatives and events, from cultural festivals to recreational activities. These events have helped unite diverse residents, fostering a sense of shared identity and pride in the city's public spaces. Taman Menteng, as a hub for music and group exercise, enables the community to gather and socialize, thereby further strengthening social cohesion. The successful implementation of such initiatives, however, hinges on proactive community engagement, ensuring that the spaces genuinely reflect the needs and aspirations of their users.

© 2026 by MIP

Similarly, observed in Kuala Lumpur, the Perdana Botanical Gardens has hosted numerous community-based programmes and events, such as guided nature walks, educational workshops, and community gardening projects. These initiatives have encouraged residents to engage with and appreciate the natural environment, facilitating the development of interpersonal connections and a stronger sense of community. This proactive approach transforms public spaces into dynamic community hubs, fostering social cohesion and empowering residents to shape their urban environment. By prioritising community engagement and social interaction, the social spaces in Jakarta and Kuala Lumpur have become vibrant hubs that contribute to their respective urban environments' overall well-being and social fabric.

Segregation and Inclusivity

Urban green spaces serve as reflections of societal structure, and their design plays a crucial role in either reinforcing or challenging social divisions. Creating inclusive, welcoming environments requires the intentional removal of physical and symbolic barriers, fostering spaces where diverse communities feel a sense of belonging. This not only enhances accessibility but also strengthens social bonds and promotes cohesion.

The comparative analysis of Taman Monas, Taman Suropati, and Taman Menteng in Jakarta, alongside Taman KLCC and the Perdana Botanical Garden in Kuala Lumpur, illustrates how parks act as expressions of socio-cultural identity within Southeast Asian megacities. Rooted in Nusantara traditions of communal space and social permeability, these parks reveal differing capacities for inclusivity.

Taman Monas, while symbolically significant, can feel formal and exclusionary. In contrast, Taman Suropati and Taman Menteng, situated in older, community-based districts, support informal gatherings and cultural expression—echoing the kampung ethos. In Kuala Lumpur, Taman KLCC's curated design and controlled access reflect a cosmopolitan model that may unintentionally marginalise certain users. At the same time, the Perdana Botanical Garden, though ecologically rich, is limited by accessibility issues.

Collectively, these parks illustrate how *Nusantara* urbanism—once characterised by permeability, communal interaction, and ecological harmony—has been reshaped by modern planning paradigms. The most inclusive parks are those that balance these traditional values with contemporary needs, offering diverse, permeable, and culturally resonant spaces that foster community cohesion and equitable urban experiences.

© 2026 by MIP

CONCLUSION

This comparative study reveals how cultural heritage, governance structures, and contemporary pressures shape urban park development in Jakarta and Kuala Lumpur. The research demonstrates that effective park planning in Nusantara cities requires context-specific strategies balancing cultural authenticity with modern functionality, community participation with professional management, and flexibility with consistency.

ACKNOWLEDGEMENT

This unpublished work builds upon the lead author's doctoral research on urban parks in megacities, which Malaysia's Ministry of Higher Education funded under the SLAB/SLAI scheme at the University of Nottingham in 2020.

REFERENCES

Adiati, M. P., Lestari, N. S., & Wiastuti, R. D. (2018). Public parks as urban tourism in Jakarta. *IOP Conference Series: Earth and Environmental Science, 126*, 12063. https://doi.org/10.1088/1755-1315/126/1/012063

Al-Ghiyadh, M. A.-K., & Al-Khafaji, S. J. N. (2021). The role of urban planning and urban design on safe cities. *IOP Conference Series: Materials Science and Engineering, 1058*(1), 12065. https://doi.org/10.1088/1757-899x/1058/1/012065

Ali, S. N. M., Tarmidi, Z., & Noor, N. A. M. (2020). Review of conceptual model to spatially assessing safe city level of affordable housing in Malaysia. *IOP Conference Series: Earth and Environmental Science, 540*(1), 12046. https://doi.org/10.1088/1755-1315/540/1/012046

Anwar, O. d. M., Zakaria, Z., & Wan Hashim, W. A. F. B. (2016). Nusantara: Delineating its authentic map based on indigenous sources. *Intellectual Property Rights: Open Access, 4*(2), Article 163. https://doi.org/10.4172/2375-4516.1000163

Arif, A. (2019). Rethinking integrated urban governance in Jakarta: An institutional approach. *International Journal of Kybernology, 4*(1), 71. https://doi.org/10.33701/ijok.v4i1.646

Ayeghi, A., & Ujang, N. (2014). The impact of physical features on user attachment to Kuala Lumpur City Centre (KLCC) Park, Malaysia. *Malaysian Journal of Society and Space, 10*(3), 44. http://journalarticle.ukm.my/7464/1/4ok.geografia-jul2014-atefeh%26norsidah-edam.pdf

Badiora, A. I., Wojuade, C. A., & Adeyemi, A. S. (2020). Personal safety and improvements concern in public places. *Journal of Place Management and Development, 13*(3), 319. https://doi.org/10.1108/jpmd-03-2019-0013

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bunnell, T. (1999). Views from above and below: The Petronas Twin Towers and/in contesting visions of development in contemporary Malaysia. *Singapore Journal of Tropical Geography, 20*(1), 1. https://doi.org/10.1111/1467-9493.00040

© 2026 by MIP

Chan, R. S. K. (2019). In with the old: Community participation in heritage management in selected Malaysian tourist sites. *Journal of Southeast Asian Studies, 24*(2), 131. https://doi.org/10.22452/jati.vol24no2.8

Darmawati, D., & Sumadio, W. (2020). Citizen's sense of place of Menteng subdistrict. *IOP Conference Series: Earth and Environmental Science, 481*(1), 12075. https://doi.org/10.1088/1755-1315/481/1/012075

Dwisusanto, Y. B., & Juwita, R. D. (2022). Materialise thirdspace through socio-spatial integration (Cases of study: Thamrin 10, Jalan H. Agus Salim, Jalan Percetakan Negara, and Jalan Kramat Raya). *Dimensi, 49*(2), 105. https://doi.org/10.9744/dimensi.49.2.105-116

Ebadi, H. (2015). *Physical attributes on place attachment in Malaysian urban parks*. http://eprints.utm.my/id/eprint/54817/

Guttman, Z., Hebner, Y., & Varma, R. (2021). Urban greening: An alternative mechanism to address public health and safety in underserved communities. *Journal of Science Policy & Governance, 18*(4). https://doi.org/10.38126/jspg180411

Honey-Rosés, J., Anguelovski, I., Chireh, V. K., Daher, C., Konijnendijk van den Bosch, C., Litt, J. S., Mawani, V., McCall, M. K., Orellana, A., Oscilowicz, E., Sánchez, U., Senbel, M., Tan, X., Villagomez, E., Zapata, O., & Nieuwenhuijsen, M. J. (2021). The impact of COVID-19 on public space: An early review of the emerging questions – design, perceptions and inequities. *Cities & Health, 5*(sup1), S263–S279. https://doi.org/10.1080/23748834.2020.1780074

Hutomo, S., & Fuad, A. H. (2020). Engagement and well-being in public space. Case study: Suropati Park Jakarta. *Evergreen, 7*(1), 138. https://doi.org/10.5109/2740970

Ibrahim, R., Clayden, A., & Cameron, R. (2020). Tropical urban parks in Kuala Lumpur, Malaysia: Challenging the attitudes of park management teams towards a more environmentally sustainable approach. *Urban Forestry & Urban Greening, 49*, 126605. https://doi.org/10.1016/j.ufug.2020.126605

Iqbal, A. (2021). Inclusive, safe and resilient public spaces: Gateway to sustainable cities? In Intech Open eBooks. Intech Open. https://doi.org/10.5772/intechopen.97353

Kasim, J. B. A., Yusof, M. J. M., & Shafri, H. Z. M. (2018). Urban green space degradation: An experience of Kuala Lumpur city. *Environmental Management and Sustainable Development, 8*(1), 27. https://doi.org/10.5296/emsd.v8i1.13917

Khalid, I. K. M., Ismail, N. A., Tahir, O. M., & Ismail, N. H. (2023). Plant elements reinforcing the sense of place identity of the Muslim Malay royal town. *Journal of Islamic Architecture, 7*(3), 501. https://doi.org/10.18860/jia.v7i3.14079

Kleinschroth, F., & Kowarik, I. (2020). COVID-19 crisis demonstrates the urgent need for urban greenspaces. *Frontiers in Ecology and the Environment, 18*(6), 318. https://doi.org/10.1002/fee.2230

Kusno, A. (2004). Whither nationalist urbanism? Public life in Governor Sutiyoso's Jakarta. *Urban Studies, 41*(12), 2377. https://doi.org/10.1080/00420980412331297582

Lavandya, D., Dewi, O. C., & Widyarta, M. N. (2020). Taman Monas resilience on vegetation due to response to the festival or "Pesta Rakyat." *IOP Conference Series: Earth and Environmental Science, 452*(1), 12113. https://doi.org/10.1088/1755-1315/452/1/012113

Lis, A., Zalewska, K., Grabowski, M. J., & Zienowicz, M. (2025). Signs of children's presence in two types of landscape: Residential and park: Research on adults' sense of safety and preference: Premises for designing sustainable urban environments. *Sustainability, 17*(9), 4098. https://doi.org/10.3390/su17094098

Lukito, Y. N., & Zahra, R. A. (2018). Improving the quality of urban lives through public art in Taman Suropati, Jakarta. *IOP Conference Series: Earth and Environmental Science, 213*, 12030. https://doi.org/10.1088/1755-1315/213/1/012030

Lukito, Y. N., & Zahra, R. A. (2019). Public art in Taman Suropati as a medium in creating attractive and lively public space. *MATEC Web of Conferences, 280*, 3004. https://doi.org/10.1051/matecconf/201928003004

Mahira, E. D., Soemardiono, B., & Santoso, E. B. (2021). The uniformity concept of urban design: Impact of cultural traditions on the meaning of Balinese town. *IOP Conference Series: Earth and Environmental Science, 907*(1), 12017. https://doi.org/10.1088/1755-1315/907/1/012017

Marzukhi, M. A., Afiq, M. A., Zaki, S. A., & Ling, O. H. L. (2018). An observational study of defensible space in the neighbourhood park. *IOP Conference Series: Earth and Environmental Science, 117*, 12016. https://doi.org/10.1088/1755-1315/117/1/012016

McDonald, R. I., Beatley, T., & Elmqvist, T. (2018). The green soul of the concrete jungle: The urban century, the urban psychological penalty, and the role of nature. *Sustainable Earth Reviews, 1*(1). https://doi.org/10.1186/s42055-018-0002-5

Nahuway, L. C., Eni, S. P., & Sudarwani, M. M. (2021). Betawi arts and culture center with the application of modern tropical architecture. *IOP Conference Series: Earth and Environmental Science, 878*(1), 12026. https://doi.org/10.1088/1755-1315/878/1/012026

Nor, A. N. M., Aziz, H. A., Nawawi, S. A., Jamil, R. M., Abas, M. A., Hambali, K., Yusoff, A. H., Ibrahim, N., Rafaai, N. H., Corstanje, R., Harris, J. A., Grafius, D. R., & Perotto-Baldivieso, H. L. (2021). Evolution of green space under rapid urban expansion in Southeast Asian cities. *Sustainability, 13*(21), 12024. https://doi.org/10.3390/su132112024

Nursanto, A. (2014). *Analisa Taman Menteng sebagai Taman Kota berdasarkan kriteria Kualitas Taman Jakarta Pusat*. https://digilib.esaunggul.ac.id/bookmark/4499/ruang%20terbuka%20hijau

Polko, P., & Kimic, K. (2021). Condition of urban park infrastructure in the context of perceived security of park users. *IOP Conference Series: Earth and Environmental Science, 900*(1), 12036. https://doi.org/10.1088/1755-1315/900/1/012036

Putra, A. D., Kohdrata, N., & Gunadi, I. G. A. (2018). Studi desain Taman Tebet sebagai youth park. *Jurnal Arsitektur Lansekap, 159*. https://doi.org/10.24843/jal.2018.v04.i02.p05

Raman, T. L., Aziz, N. A. A., & Yaakob, S. S. N. (2021). The effects of different natural environment influences on health and psychological well-being of people: A case study in Selangor. *Sustainability, 13*(15), 8597. https://doi.org/10.3390/su13158597

Rustanto, A. E., & Akhmad, J. (2021). RPTRA activities program in services to the community during the Covid-19 pandemic. *Advances in Social Science, Education*

© 2026 by MIP

and Humanities Research/Advances in Social Science, Education and Humanities Research. https://doi.org/10.2991/assehr.k.210430.014

Salazar, N. N. G. de, Martın, M. C., Chamizo-Nieto, F. J., Rosa-Jiménez, C., & Muñoz, J. B. (2020). Indicator system to measure the qualities of urban space affecting urban safety and coexistence. *IOP Conference Series: Materials Science and Engineering, 960*(4), 42051. https://doi.org/10.1088/1757-899x/960/4/042051

Samad, N. S. A., Abdul-Rahim, A. S., Afandi, S. H. M., & Yusof, M. J. M. (2021). Factors influencing the public park use in Kuala Lumpur, Malaysia. *IOP Conference Series: Earth and Environmental Science, 756*(1), 12085. https://doi.org/10.1088/1755-1315/756/1/012085

Santoso, I., Setioko, B., & Pandelaki, E. E. (2021). The changing aspects of function and meaning of space in Alun-Alun Kidul Keraton Surakarta. *IOP Conference Series: Earth and Environmental Science, 780*(1), 12075. https://doi.org/10.1088/1755-1315/780/1/012075

Shafee, F. A. A., & Kamaruddin, S. M. (2019). The effective characteristics of an urban park through visitors perception. Case study: KLCC Park. *Built Environment Journal, 16*(2), 1. https://doi.org/10.24191/bej.v16i2.9692

Shams, A. R. A., & Badarulzaman, N. (2014). Evaluating the city image: A focus on landmarks of Kuala Lumpur, Malaysia. *Asian Social Science, 10*(4). https://doi.org/10.5539/ass.v10n4p241

Shoari, N., Ezzati, M., Baumgartner, J., Malacarne, D., & Fecht, D. (2020). Accessibility and allocation of public parks and gardens in England and Wales: A COVID-19 perspective. *PLOS ONE, 15*(10), e0241102. https://doi.org/10.1371/journal.pone.0241102

Silva, B. M. D. da, Bakay, E. K., & Morais, M. B. de. (2024). Safety in public open green spaces in Fortaleza, Brazil: A data analysis. *Sustainability, 16*(2), 539. https://doi.org/10.3390/su16020539

Subadyo, A. T., Tutuko, P., & Cahyani, S. D. (2018). Assessment of inclusive historical public spaces in achieving preservation of such areas in Malang, Indonesia. *International Review for Spatial Planning and Sustainable Development, 6*(4), 76. https://doi.org/10.14246/irspsd.6.4_76

Sukartini, N. M., Auwalin, I., & Rumayya, R. (2021). The impact of urban green spaces on the probability of urban crime in Indonesia. *Development Studies Research, 8*(1), 161. https://doi.org/10.1080/21665095.2021.1950019

Sunaryo, R. G., Soewarno, N., Ikaputra, I., & Bakti, S. (2013). Colonial and traditional urban space in Java: A morphological study of ten cities. *Dimensi, 40*(2). https://doi.org/10.9744/dimensi.40.2.77-88

Sushartami, W., & Ristiawan, R. (2018). The well of truth: Managing authenticity in the Pancasila Sakti Monument. *Asian Journal of Tourism Research, 3*(1). https://doi.org/10.12982/ajtr.2018.0007

Thani, S. K. S. O., Ibrahim, N. K., Mohamad, N. H. N., & Rodzi, N. I. M. (2015). Public awareness towards conservation of English landscape at Taiping Lake Garden, Malaysia. *Procedia: Social & Behavioral Sciences, 168*, 181. https://doi.org/10.1016/j.sbspro.2014.10.223

© 2026 by MIP

Thedyardi, C., & Husin, D. (2019). Reconstructing the past: From landform bath to spa-scraper of Taman Sari. *IOP Conference Series: Materials Science and Engineering, 508*, 12026. https://doi.org/10.1088/1757-899x/508/1/012026

Venter, Z. S., Barton, D. N., Gundersen, V., Figari, H., & Nowell, M. (2020). Urban nature in a time of crisis: Recreational use of green space increases during the COVID-19 outbreak in Oslo, Norway. *Environmental Research Letters, 15*(10), 104075. https://doi.org/10.1088/1748-9326/abb396

Xie, J., Luo, S., Furuya, K., & Sun, D. (2020). Urban parks as green buffers during the COVID-19 pandemic. *Sustainability, 12*(17), 6751. https://doi.org/10.3390/su12176751

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 200 – 216

A SYSTEMATIC REVIEW ON THE KEY ELEMENTS OF SUSTAINABLE CAMPUS INITIATIVES IN HIGHER EDUCATION INSTITUTIONS

Nurzalikha Sa'adi[1], Nur Azfahani Ahmad[2], Faisal Tamrulan[3], Nur Fasihah Ngah Seron[4]

[1,2]*College of Built Environment,*
UNIVERSITY TEKNOLOGI MARA
[1,3,4]*Centre for Borneo Regionalism and Conservation (BORC),*
UNIVERSITY OF TECHNOLOGY SARAWAK
[3,4]*School of Built Environment,*
UNIVERSITY OF TECHNOLOGY SARAWAK

Abstract

Higher Education Institutions (HEIs) play a crucial role in shaping intellectual development across social, economic, and environmental dimensions towards achieving the Sustainable Development Goals (SDGs). HEIs have undertaken significant initiatives to incorporate sustainability into their operational practices, and the implementation of sustainable campuses has become an increasingly important area of focus. HEIs are responsible for promoting sustainability through their operational practices while also educating future generations. However, the absence of effective sustainable campus initiatives poses a significant challenge to the ongoing pursuit of SDGs in HEIs. There remains a clear absence of key elements required to fully realise the goals of sustainability within these institutions. Hence, this study aims to identify the key elements of sustainable campus initiatives in HEIs. The systematic review approach was adopted in this study, where relevant articles were retrieved from the Scopus and Web of Science databases for analysis. The systematic review examined 902 articles from Scopus and Web of Science databases within the timeframe from 2015 to 2025. Inclusion, exclusion, and quality criteria were applied to ensure that only high-quality and relevant articles were selected. Ultimately, 34 relevant papers were identified for inclusion in this systematic review approach. The analysis revealed six key elements essential for the successful implementation of sustainable campus initiatives, including governance and leadership, strategic planning, operation, curriculum development, research and development, and community engagement. These findings underscore the importance of all six elements in achieving the successful implementation of sustainable campuses in HEIs.

Keywords: Higher Education Institutions, Initiatives, Key Elements, Sustainable Campus

[1] Corresponding author. Email: nurzalikha@uts.edu.my

INTRODUCTION

In recent years, Higher Education Institutions (HEIs) can foster a culture of sustainability through the implementation of sustainable campus initiatives (HEIs) to reduce environmental impacts. According to Badea et al. (2020), the effectiveness of these initiatives has been questioned, particularly regarding how HEIs integrate sustainability into their academic curricula to achieve United Nations Sustainable Development Goals (SDGs). The involvement of various stakeholders is often linked to the effectiveness of these initiatives, as they drive the implementation of these sustainable efforts. As a leader of this transformation towards sustainability, HEIs play a crucial role in shaping future generations to promote the action of sustainability. There are three dimensions of sustainability that underpin HEIs' sustainable practices, strategies, and policy implementation. As stated by Abad-Segura and González-Zamar (2021), these three dimensions are social, environmental and economic. HEIs, as influential societal entities which serve as hubs for creation and dissemination of knowledge, are responsible for encouraging sustainable practices in their campus operations to inspire wider societal change (Goni et al., 2017). The urgent need to address environmental issues has accelerated the implementation of sustainable practices across sectors, including HEIs (Filho et al., 2019). HEIs are very committed to addressing environmental challenges and fostering a culture of sustainability by focusing on Goal 4 of the SDGs, which is equitable and quality education. However, the absence of key elements within sustainable campus initiatives leads to inefficient resource management, rising operational expenses, and escalating waste, thereby hindering the nation's capacity to meet its SDG commitments. Thus, it is imperative to identify comprehensive sustainable campus initiatives for higher education institutions to achieve the desired sustainable outcomes.

LITERATURE REVIEW

Overview of Sustainability in Higher Education

Sustainability and green initiatives both aim to reduce environmental impacts but differ in terms of scope and focus. As outlined in the Brundtland Report, sustainability encompasses not only environmental practices but also social and economic dimensions in order to balance the use of resources with the preservation of ecological and social equity (Mahanayak, 2024). In contrast, green initiatives concentrate solely on environmental practices. Even though both concepts share the same goal in protecting the environment, the distinction between these concepts has often resulted in fragmented implementation strategies within Higher Education Institutions (HEIs), where environmental actions may be prioritised while social and economic aspects receive less attention (Syam et al., 2023).

© 2026 by MIP

In recent years, as noted by Din et al. (2021), the SDGs have become a main priority across various sectors, including HEIs, where many institutions have transformed into crucial players to become leaders in integrating sustainable practices. To achieve the SDGs, sustainable practices must be delivered across the economic, social and environmental dimensions (Abad-Segura & González-Zamar, 2021). HEIs not only demonstrate environmental responsibility by embedding sustainability into their frameworks but also serve as educational models, fostering a culture of sustainability and advancing global SDGs (Dawodu et al., 2022).

Despite the increasing emphasis on sustainability in higher education, existing literature largely focuses on the promotion and outcomes of sustainability initiatives, while comparatively less attention has been given to the institutional barriers that hinder their effective implementation. Studies have shown that universities often face structural, financial, and organisational challenges when attempting to operationalise sustainability strategies (Filho et al., 2019; Ribeiro et al., 2021). These limitations create a gap between sustainability commitments and the practical implementation of sustainable campus initiatives.

Furthermore, much of the existing research tends to treat HEIs as a homogeneous group, with limited discussion on how sustainability practices may differ across geographical and institutional contexts. Universities in developed countries often possess stronger financial capacity, advanced infrastructure, and institutional support for sustainability initiatives compared to those in developing regions. Consequently, the strategies and priorities for implementing sustainability initiatives may vary significantly depending on institutional size, funding availability, and national policy environments. This indicates the need for greater contextual understanding when examining sustainable campus initiatives, particularly in developing countries such as Malaysia where resource limitations may influence implementation strategies.

Key Dimension of Sustainable Campus Initiatives

Higher Education Institutions (HEIs) are pivotal in advancing sustainability by incorporating environmental, social and economic dimensions into their operations. These interconnected aspects often demand collaborative approaches, such as addressing financial challenges to support environmental upgrades or driving social change to adopt sustainable practices. HEIs focus on reducing ecological footprints, promoting sustainability education and engaging communities in ways that align with the SDGs (Gomez & Yin, 2019). Key initiatives include lowering carbon emissions, enhancing energy efficiency, and managing waste responsibly. Universities globally have adopted renewable energy solutions such as solar panels and wind turbines, alongside recycling

programmes and waste audits, to minimise environmental harm (Ribeiro et al., 2021; Abdulghaffar & Williams, 2021). Water conservation measures, like rainwater harvesting, and pollution prevention strategies, such as carbon pricing and plastic reduction programmes, further support these goals (Lee & Lee, 2021). Additionally, biodiversity projects, like green space integration, highlight HEIs' commitment to environmental stewardship. By seeking collaborations and understanding the needs of local communities, HEIs can strengthen their role in promoting sustainability and contribute to the broader implementation of the SDGs.

However, the implementation of environmental sustainability initiatives in HEIs is frequently constrained by several practical barriers. One of the most significant challenges is financial limitation, as many sustainability projects such as renewable energy infrastructure or green building retrofits require substantial initial investment. Limited institutional budgets and competing priorities may delay or restrict the adoption of such initiatives (Ribeiro et al., 2021). These challenges are often more pronounced in universities located in developing countries or in smaller institutions where financial resources and technical expertise may be limited.

The social dimension of sustainable campus initiatives emphasises well-being, inclusion, and community participation. Universities are actively promoting sustainability education and encouraging student involvement in green initiatives (Lee & Lee, 2021). Activities focusing on eco-friendly food alternatives, stress management programmes, and secure living environments aim to improve health and well-being. Furthermore, HEIs' sustainable strategies in promoting social justice can be achieved through equitable access to resources and the integration of gender and cultural diversity (Filho et al., 2019). These efforts highlight the role of universities in fostering a culture of sustainability, promoting equity, and engaging communities in achieving the SDGs.

Nevertheless, social sustainability initiatives may encounter resistance to change among stakeholders, including faculty members, administrative staff, and students. Resistance often arises from limited awareness, insufficient training, or perceptions that sustainability initiatives increase workloads without immediate benefits. In addition, the effectiveness of such initiatives may differ across institutions depending on organisational culture, leadership commitment, and available institutional support. Larger universities may possess greater capacity to institutionalise sustainability programmes, whereas smaller institutions may rely more heavily on individual initiatives or external collaborations.

The third dimension, which is the economic, focuses on reducing costs through the efficiency of resources, sustainable investments, and green economy practices. HEIs that invest in renewable energy can reduce their long-term

© 2026 by MIP

operational costs and enhance their economic resilience (Lee & Lee, 2021). Additionally, through sustainable procurement practices, cost-effectiveness can be further improved by purchasing renewable-certified energy and eco-friendly products. Similarly to the public-private partnerships, sustainability programmes and waste recycling initiatives can also generate funds for HEIs. These initiatives not only strengthen economic resilience but also support the broader implementation of the SDGs.

Despite these potential economic benefits, the transition towards sustainable campus initiatives often faces governance and policy-related barriers. Many HEIs lack clear sustainability policies, dedicated funding mechanisms, or integrated governance structures to coordinate sustainability efforts effectively. These challenges are particularly evident in developing countries where institutional priorities may focus more heavily on academic expansion and infrastructure development rather than sustainability transformation.

Therefore, there remains a significant research gap in understanding how sustainability initiatives are implemented across diverse institutional and geographical contexts. In particular, limited studies have examined how key sustainability elements operate within resource-constrained environments such as Malaysian HEIs. Investigating these contextual differences is important to identify practical strategies that align with institutional capacities and regional realities. Hence, by examining these key dimensions, this study contributes to the growing discussion on sustainable campuses by exploring how sustainability initiatives can be effectively implemented within the context of HEIs while addressing financial, organisational, and contextual challenges.

RESEARCH METHODOLOGY

This research employs a systematic review approach to retrieve and screen the literature in order to identify the key elements of sustainable campus initiatives in HEIs. To fulfil the aim of this research, a comprehensive literature review was conducted using the Scopus and Web of Science databases, focusing on key elements of sustainable campus initiatives in HEIs on a global scale. The databases are among the largest peer-reviewed collections available. This methodological approach has increasingly contributed to the review of scientific knowledge in recent years (Abad-Segura et al., 2020). Articles were identified using the search query in Table 1 [TITLE-ABS-KEY (elements) AND TITLE-ABS-KEY (sustainable) AND TITLE-ABS-KEY (campus) AND TITLE-ABS-KEY (initiatives) AND TITLE-ABS-KEY (higher education)], covering the period from 2015 to 2025.

Table 1: Terms used in the search engine.

Headline Search
elements AND sustainable AND campus AND initiative AND (higher AND education)

The process of selecting articles for systematic review was undertaken through a systematic three-stage approach, as illustrated in Figure 1.

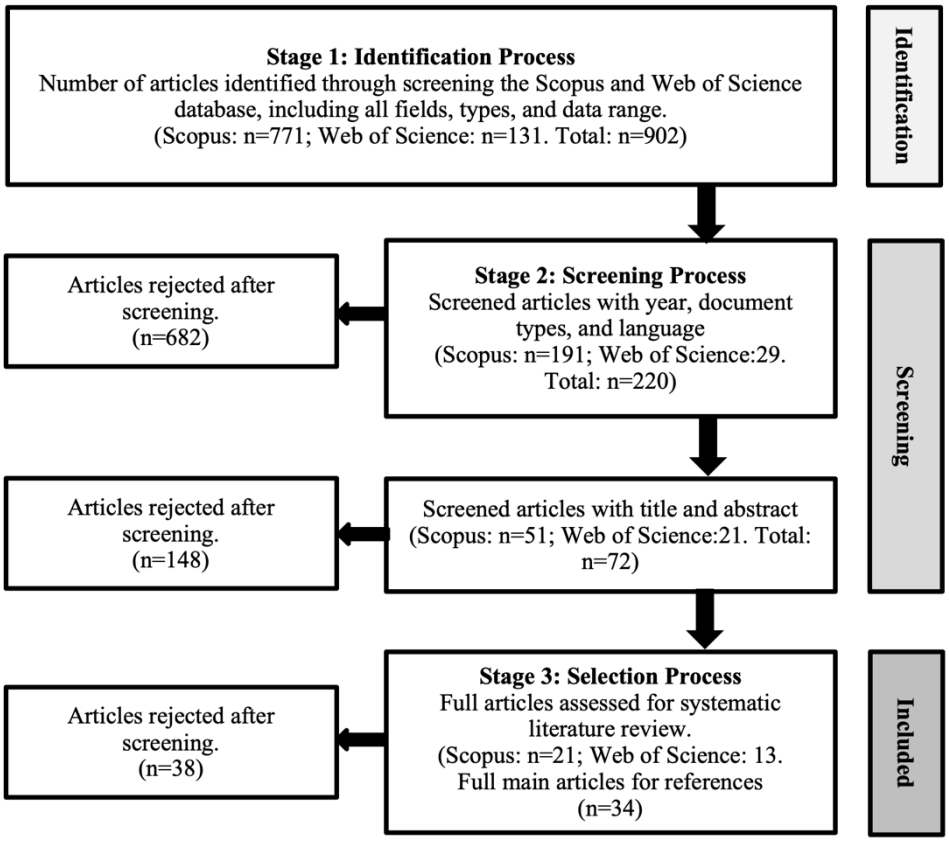


Figure 1: Process selection of articles for systematic review

In the identification stage, a comprehensive screening was performed to identify potentially relevant articles across two major databases, which are Scopus and Web of Science. The search considered all fields, document types, and the data range, resulting in a total of 902 articles, with Scopus (n = 771) and Web of Science (n = 131). Following this, a second stage, which is screening, identified articles based on a detailed screening process. In the screening stage, articles were further refined based on specific criteria such as publication year, document type, and language. This stage narrowed the selection to 220 articles for further analysis, with Scopus (n = 191) and Web of Science (n = 29). A total of 682 articles were excluded at this stage as they failed to meet the predetermined criteria or lacked relevance to the study. Subsequently, the remaining articles

© 2026 by MIP

were screened based on their titles and abstracts, which reduced the number of articles to 72, with Scopus (n = 51) and Web of Science (n = 21). At this step, 148 articles were rejected as they did not meet the inclusion criteria. Finally, in the selection stage, after successfully passing the screening phases, the full texts of the remaining articles were thoroughly assessed to determine their suitability for inclusion in the systematic literature review. Following this detailed selection, 34 articles were selected, with articles from Scopus (n=21) and Web of Science (n=13). This final stage ensured a refined and well-considered compilation of articles that would contribute effectively to the intended research aims. The remaining 38 articles were excluded due to insufficient relevance to the inclusion criteria.

Literature Inclusion and Exclusion Criteria

The selection of relevant and high-quality articles for this systematic review was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework proposed by Moher et al. (2009), where inclusion and exclusion criteria were designed. The PRISMA framework also guided the literature search and selection process to ensure methodological transparency and reproducibility. Articles were included if they were published from 2015 onwards, written in the English language, and aligned with the research aim of identifying the key elements of sustainable campus initiatives in HEIs. To enhance the feasibility of the study, a rigorous screening process was applied, especially excluding articles not written in the English language to avoid difficulties in the full reading and analysis process. Then, articles were screened based on title, abstract, and keywords following the initial filtering to determine eligibility. The final inclusion focused on the key elements of sustainable campus initiatives in HEIs were included, while several articles were excluded for not meeting the specific inclusion criteria. Ultimately, 34 articles in this study were chosen, as they met the inclusion criteria and were selected for data extraction and analysis. To further strengthen the transparency of the review process, a quality assessment was conducted on the selected articles to evaluate their methodological relevance to the research objectives. The quality assessment focused on several criteria, including (1) clarity of research objectives, (2) appropriateness of research methodology, (3) reliability of data sources, (4) relevance to sustainable campus initiatives in HEIs, and (5) the clarity of findings and discussion. Each article was assessed independently by the research team based on these criteria to ensure that only studies with sufficient methodological quality and relevance were included in the final synthesis. To ensure reliability, the selection process was conducted by three researchers. This systematic and transparent process ensured that only the most relevant and high-quality articles were selected in the review.

Screening of Studies

The screening process was conducted systematically to ensure the inclusion of relevant and high-quality articles. The process started with the manual removal of duplicate articles to enhance the efficiency and accuracy. The screening was then conducted in two phases. First, the titles and abstracts of all identified articles were reviewed by three researchers to assess their eligibility based on the predefined selection criteria. Only articles that aligned with the research aim were retained. Any disagreements among the researchers during this phase were resolved through discussion, with the third author acting as a mediator when necessary to reach a consensus. Next, to confirm the suitability of the selected articles, the full text of the articles was screened by the three researchers. This phase involved a detailed evaluation based on the following requirements: published from 2015 onwards, articles must be written in the English language and focused on the key elements of sustainable campus initiatives in HEIs to ensure they meet the inclusion criteria. Articles unrelated to these areas of study were excluded. During the full-text screening stage, the quality assessment criteria were also applied to ensure that the selected articles demonstrated sufficient methodological rigor and provided meaningful contributions to the topic. Articles that lacked clear research methods, insufficient empirical evidence, or weak analytical discussion were excluded from the final selection. The manual screening process allowed for thorough and transparent decision-making among the researchers. This collaborative approach ensured a unified selection process, which led to the inclusion of the most relevant and high-quality articles for the systematic review.

Data Extraction and Synthesis

To ensure the reliability and accuracy of the systematic review, the data extraction and synthesis process was conducted in this methodology. The first author played a significant role in conducting the initial data extraction, while the second author cross-checked the extracted data. The third author verified the consistency and correctness of the data extraction before the final decision. There are several categories for data extraction, which are characteristics of the systematic review, area of study, methods, results, and discussions. In addition, information related to the methodological quality and research design of each study was documented during the extraction process to support the quality assessment of the included articles. The extracted data were organised in tabular form to synthesise the findings. This tabular format facilitated the identification of patterns, trends, and gaps in the literature, enabling the authors to address the key elements effectively. Findings were summarised, and results were compared across studies during this synthesis process. This rigorous and collaborative approach ensured the

© 2026 by MIP

reliability and validity of the data extraction, which was essential for answering the research aim.

ANALYSIS AND DISCUSSION

Table 2: Number of selected articles and their year of publication.

Year of Publication	Scopus	WOS
2025	-	-
2024	7	4
2023	1	4
2022	1	3
2021	3	1
2020	3	-
2019	1	-
2018	1	1
2017	-	1
2016	1	1
2015	1	-
Total Manuscripts	**34**	

Table 2 displays the number of selected articles and their year of publication from 2015 to 2025, with a total of 34 articles included. Notably, no articles were selected from 2025. The data shows an inconsistent trend in the number of articles selected from both databases, Scopus and Web of Science (WOS). In 2024, there are seven articles chosen from Scopus and four articles from WOS, while fewer articles were selected from 2015 until 2019. Most articles chosen for analysis were from the Scopus database, with a total amount of 19 out of 34 articles. There is increasing concern in this research topic in recent years, with Scopus emerging as the dominant source of relevant literature. This distribution highlights the variability in research output over the years and underscores the absence of publications from 2025, which may reflect the time lag in academic publishing or the unavailability of relevant studies for the current year. The data underscores the importance of focusing on contemporary studies while also considering foundational works from earlier years to provide a comprehensive understanding of the topic.

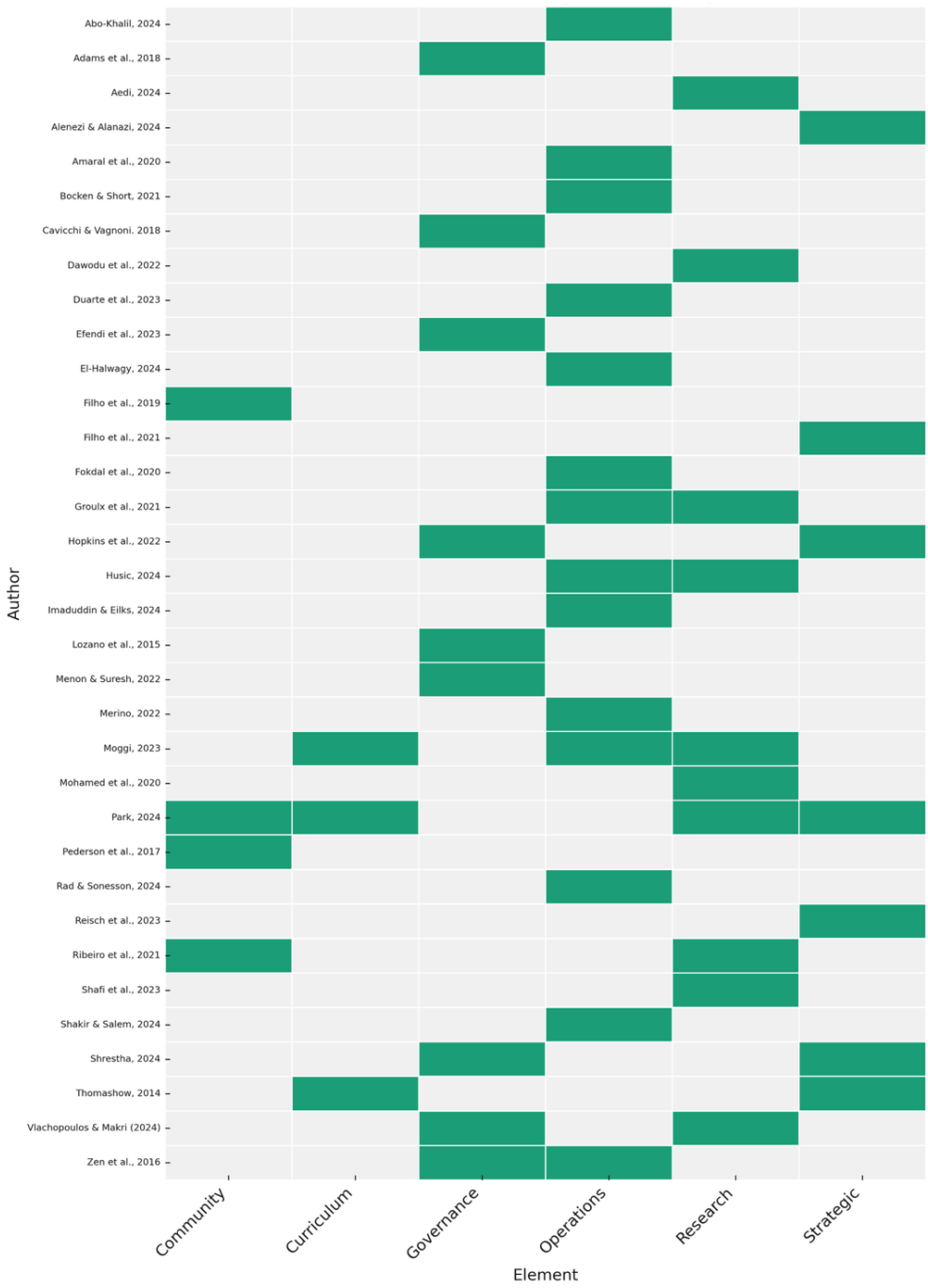


Figure 2: Tile Plot of Sustainable Campus Elements by Author

© 2026 by MIP

The tile plot in Figure 2 highlights the approach required to encourage sustainability within HEIs and provides a comprehensive overview of the key elements of sustainable campus initiatives as identified in previous studies. There are six key elements identified from previous studies, which are governance and leadership, strategic planning, campus operations, curriculum development, research and development, and community engagement. All these elements are interconnected and collectively contribute to the effective practices of sustainability in HEIs. Each element plays a distinct yet complementary role in advancing environmental stewardship, social responsibility, and economic resilience.

Governance and Leadership emerge as foundational elements, emphasising the importance of strong leadership and effective governance structures in driving sustainability initiatives. Studies such as those by Efendi et al. (2023) and Shrestha (2024) underscore the need for leaders to articulate a clear vision for sustainability, address cultural and socioeconomic barriers, and foster collaboration with stakeholders. Effective governance ensures that SDGs are integrated into institutional policies and practices, enabling HEIs to align with global sustainability frameworks. Leadership development programmes that emphasise Environmental, Social, and Governance (ESG) principles are critical for cultivating a culture of sustainability and ensuring long-term commitment (Zafar et al., 2024).

Strategic Planning is another critical element, as it provides a roadmap for integrating sustainability into campus operations and academic programmes. Reisch et al. (2023) and Park (2024) highlight the importance of developing strategic maps that align the SDGs with operational performance. This involves adopting participatory methodologies, engaging stakeholders in decision-making processes, and establishing comprehensive policies that define sustainability objectives. Strategic planning ensures that sustainability initiatives are not isolated efforts but embedded within the institutional framework, fostering a holistic approach to environmental, social, and economic sustainability.

Campus Operations represents the practical implementation of sustainability initiatives, focusing on reducing environmental impact and enhancing resource efficiency. Amaral et al. (2020) identify four dimensions of sustainable campus operations, including energy management, waste reduction, water conservation, and sustainable transportation. These initiatives are essential for addressing climate change and promoting resource efficiency. For instance, renewable energy systems, green building designs, and waste-to-energy programmes not only reduce operational costs but also contribute to environmental conservation. However, the applicability of these dimensions may vary across regions, necessitating tailored approaches suited to local contexts, such as those in Malaysian HEIs.

Curriculum Development is pivotal in equipping students with the knowledge and skills needed to address sustainability challenges. Integrating sustainability principles into academic programmes fosters interdisciplinary collaboration and experiential learning, empowering students to become "change agents" for sustainability (Park, 2024; Husic, 2024). Strong institutional policies and leadership are essential for the successful implementation of sustainability curricula, ensuring that sustainability topics are embedded across all disciplines and not limited to specific majors. This approach nurtures environmentally conscious leaders who are equipped to drive sustainable development in their respective fields.

Research and Development plays a crucial role in advancing sustainability initiatives by fostering innovation and generating knowledge. Collaborative research projects, interdisciplinary studies, and initiatives such as the "Campus as a Living Laboratory" provide students with hands-on learning experiences and contribute to the development of comprehensive solutions to sustainability challenges (Pilon et al., 2020). Hosting seminars, workshops, and conferences further enhances institutional visibility and promotes a culture of sustainability by disseminating best practices and fostering collaboration among researchers, students, and industry experts (Aedi, 2024; Ribeiro et al., 2021).

Community Engagement is the final key element, emphasising the importance of collaboration with local communities and student involvement in sustainability initiatives. Engaging students as active participants fosters a sense of responsibility and proactivity, enhancing their commitment to sustainable practices (Ribeiro et al., 2021). High-impact practices such as service learning and community engagement allow students to apply sustainability concepts in real-world contexts, reinforcing their role as future leaders in sustainable development (Husic, 2024). Collaborating with local communities also ensures that sustainability initiatives are inclusive and address the needs of diverse stakeholders, fostering a sense of shared responsibility (Efendi et al., 2023). Beyond community outreach activities, stakeholder engagement also plays a critical role in strengthening the research and development (R&D) element of sustainable campus initiatives. Universities increasingly integrate students, academic staff, and local communities into sustainability-oriented research and innovation processes. Students can contribute through project-based learning, research assistantships, and participation in interdisciplinary sustainability research projects. Academic staff contribute by leading research initiatives that address real-world sustainability challenges, while collaboration with local communities and external stakeholders provides practical insights, local knowledge, and opportunities for pilot testing innovative sustainability solutions. Such collaborative engagement not only enhances the relevance and applicability of sustainability research but also promotes knowledge co-creation between

© 2026 by MIP

universities and society. For example, partnerships with local communities can support research on waste management, renewable energy adoption, or sustainable urban development, allowing campuses to function as living laboratories for sustainability innovation. Through these participatory approaches, HEIs can strengthen both their research capacity and their societal impact in advancing sustainable development goals.

In conclusion, the six key elements identified in Table 3 represent effective practices for implementing sustainable campus initiatives in HEIs. While each element addresses specific aspects of sustainability, their integration is essential for achieving holistic and impactful outcomes. However, challenges such as financial constraints, cultural resistance, and the lack of robust governance structures remain significant barriers. To overcome these challenges, HEIs must prioritise strategic planning, invest in leadership development, and adopt tailored approaches that consider local contexts. By addressing these key elements, HEIs can serve as models of sustainability, driving transformative change and contributing to the global agenda for a more sustainable future.

CONCLUSION

In conclusion, this systematic review has identified six key elements essential for the successful implementation of sustainable campus initiatives in HEIs, including governance and leadership, strategic planning, campus operations, curriculum development, research and development, and community engagement. These elements collectively form a comprehensive framework that enables HEIs to address environmental, social, and economic challenges while fostering a culture of sustainability. The findings underscore the critical role of HEIs as leaders in promoting sustainable development, not only through operational practices but also by educating future generations and engaging with communities. However, challenges such as financial constraints, cultural resistance, and the absence of robust governance structures remain significant barriers to the effective adoption of these initiatives. To overcome these challenges, HEIs must prioritise strategic planning, invest in leadership development, and foster interdisciplinary collaboration. Furthermore, integrating sustainability into curricula and research, alongside active community engagement, will ensure that HEIs contribute meaningfully to global SDGs. This study highlights the need for tailored approaches that consider local contexts, particularly in regions like Malaysia, to ensure the relevance and effectiveness of sustainable campus initiatives. By addressing these key elements, HEIs can serve as models of sustainability, driving transformative change and advancing the global agenda for a more sustainable future.

ACKNOWLEDGEMENT
The researchers would like to sincerely thank the University of Technology Sarawak (UTS) for their financial support. This research was facilitated by the UTS Research Grant (URG), under the reference UTS/RESEARCH/4/2023/01.

DISCLOSURE STATEMENT
All authors have significantly contributed to this research. Author 1 managed the writing, methodology, and data analysis; Author 2 reviewed, edited, and finalised the paper; and Authors 3 and 4 wrote the literature review. This paper is original, unpublished, and not under consideration elsewhere. All authors approve the final manuscript.

REFERENCES
Abad-Segura, E., & González-Zamar, M. (2021). Sustainable economic development in higher education institutions: A global analysis within the SDGs framework. *Journal of Cleaner Production,* 294, pp. 126133. https://doi.org/10.1016/j.jclepro.2021.126133

Abo-Khalil, A. G. (2024). Integrating sustainability into higher education challenges and opportunities for universities worldwide. *Heliyon*, *10*(9), pp. e29946. https://doi.org/10.1016/j.heliyon.2024.e29946

Adams, R., Martin, S., & Boom, K. (2018). University culture and sustainability: Designing and implementing an enabling framework. *Journal of Cleaner Production,* 171, pp. 434–445. https://doi.org/10.1016/j.jclepro.2017.10.032

Aedi, N. (2024). Strategies and Best Practices for Implementing Green Campus: A Change Management Reviews. *Journal of Ecohumanism, 3*(4), pp. 2492–2502. https://doi.org/10.62754/joe.v3i4.3771

Alenezi, M. & Alanazi, F. (2024). Integrating environmental social and governance values into higher education curriculum. I*nternational Journal of Evaluation and Research in Education. 13*(5), pp. 3493-3503. https://doi.org/10.11591/ijere.v13i5.29440

Amaral, A. R., Rodrigues, E., Gaspar, A. R., & Gomes, Á. (2020). A review of empirical data of sustainability initiatives in university campus operations. *Journal of Cleaner Production,* 250. https://doi.org/10.1016/j.jclepro.2019.119558

Badea, L, Șerban-Oprescu, G.L., Dedu, S., & Piroșcă, G.L. (2020). The Impact of Education for Sustainable Development on Romanian Economics and Business Students' Behavior. *Sustainability. 12*(19) pp. 8169. https://doi.org/10.3390/su12198169

Bocken, N. M. P. & Short, S. W., (2021). Towards a sufficiency-driven business model: Experiences and opportunities. *Environmental Innovation and Societal Transitions*, 31, pp. 1-16. https://doi.org/10.1016/j.eist.2015.07.010

Cavicchi, C. & Vagnoni, E. (2018). Sustainability performance measurement inside academia. The case of a north Italian University. *Journal of Accounting & Organizational Change, 14*(2) pp. 138-166. https://doi.org/10.1108/JAOC-04-2016-0022

 © 2026 by MIP

Dawodu, A., Dai, H., Zou, T., Zhou, H., Lian, W., Oladejo, J., & Osebor, F. (2022). Campus sustainability research: indicators and dimensions to consider for the design and assessment of a sustainable campus. *Heliyon, 8*(12). https://doi.org/10.1016/j.heliyon.2022.e11864

Din, M.F.M., Omar, W., Taib, S., Sarip, S., & Krishnan, S. (2021). Humanizing the Localizing Sustainable Development Goals (SDGs) in Education and Research at Higher Education Institutions (HEIs). *Journal of Sustainability Perspectives*, 1, pp. 453-460. https://doi.org/10.14710/jsp.2021.12039

Duarte, M., Caeiro, S.S., Farinha, C.S., Moreira, A., Santos-Reis, M., Rigueiro, C., & Simão, J. (2023). Integration of sustainability in the curricula of public higher education institutions in Portugal: do strategic plans and self-report align? *International Journal of Sustainability in Higher Education, 24*(9) pp. 299-317. https://doi.org/10.1108/IJSHE01-2023-0001

Efendi, D., Swarga, A.B., Mudzakkir, M., Bustami, M.R. & Nasruddin, E. (2023). A crosscultural analysis on the practice of sustainable university initiatives. *Journal of Environmental Science and Sustainable Development, 6*(2), pp. 413-425. https://doi.org/10.7454/jessd.v6i2.1192

Filho, W. L., Amaro, N., Avila, L. V., Brandli, L., Damke, L. I., Vasconcelos, C. R. P., Hernandez-Diaz, P. M., Frankenberger, F., Fritzen, B., Velazquez, L., & Salvia, A. (2021). Mapping sustainability initiatives in higher education institutions in Latin America. *Journal of Cleaner Production*, 315, pp. 128093. https://doi.org/10.1016/j.jclepro.2021.128093

Filho, W.L., Vargas, V.R., Salvia, A.L., Brandli, L.L., Pallant, E., Klavins, M., Ray, S., Moggi, S., Maruna, M., Conticelli, E., Ayanore, M.A., Radovic, V., Gupta, B., Sen, S., Paço, A., Michalopoulou, E., Saikim, F.H., Koh, H.L., Frankenberger, F., Vaccari, M. (2019). The role of higher education institutions in sustainability initiatives at the local level. *Journal of Cleaner Production,* 233, pp. 1004–1015. https://doi.org/10.1016/j.jclepro.2019.06.059

Fokdal, J., Čolić, R. Rodić, D.M. (2020). Integrating sustainability in higher planning education through international cooperation: Assessment of a pedagogical model and learning outcomes from the students' perspective. *International Journal of Sustainability in Higher Education. 21*(1), pp. 1-17. https://doi.org/10.1108/IJSHE-01-2019-0045

Goni, F., Chofreh, A., Mukhtar, M., Sahran, S., Shukor, S., & Klemeš, J. (2017). Strategic alignment between sustainability and information systems: A case analysis in Malaysian public Higher Education Institutions. *Journal of Cleaner Production*, 168, pp. 263-270. https://doi.org/10.1016/J.JCLEPRO.2017.09.021

Groulx, M., Nowak, N., Levy, K. & Booth, A. (2021). Community needs and interests in university–community partnerships for sustainable development. International *Journal of Sustainability in Higher Education*, *22*(2) pp. 274-290. https://doi.org/10.1108/IJSHE-03-2020-0086

Hopkins, K.K., Barth, M.,C. Michelsen, G., Dlouh, J., Razak, D. A., Abidin, Z., Sanusi, B., Toman, I. & Razak, A. (2022). A whole-institution approach towards sustainability: a crucial aspect of higher education's individual and collective engagement with the SDGs and beyond. *International Journal of Sustainability in Higher Education, 23*(2) pp. 1467–6370. https://doi.org/10.1108/IJSHE-10-2020-

0398
Imaduddin, M. & Eilks, I (2024). A scoping review and bibliometric analysis of educational research on water literacy and water education. *Sustainable Chemistry and Pharmacy.* Volume 42. https://doi.org/10.1016/j.scp.2024.101833
Lee, S., & Lee, S. (2021). Can universities be a platform for climate mitigation? Exploring the impacts of carbon pricing in the university setting. *International Journal of Sustainable Development & World Ecology, 28*(8) pp. 759–770. https://doi.org/10.1080/13504509.2021.1902877
Reisch, O.C., Lima, J., Soares, T.C., Tutida, A.Y., Mazon, G., Andrade de Lima, M., Montenegro de Lima, C.R., Dutra, A.R.A. & Guerra, J.B.S.Osório de Andrade (2023). Implementing and performing sustainability strategies at campus operations: the case of Instituto Federal de Santa Catarina. *International Journal of Sustainability in Higher Education*. 26(5) pp. 987-1007. https://doi.org/10.1108/ijshe-08-2021-0332
Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F. J., Waas, T., Lambrechts, W., Lukman, R., & Hugé, J. (2015). A review of commitment and implementation of sustainable development in higher education: Results from a worldwide survey. *Journal of Cleaner Production, 108*(Part A) pp. 1–18. https://doi.org/10.1016/j.jclepro.2014.09.048
Mahanayak. B. (2024). Meaning and concept of sustainable development for the protection of environment and the role of India. *World Journal Of Advanced Research and Reviews*. *22*(03) pp. 1460–1465 https://doi.org/10.30574/wjarr.2024.22.3.1856
Menon, S., Suresh, M. (2022). Modelling the enablers of sustainability in higher education institutions. *Journal of Modelling in Management, 17*, pp. 405–439
Merino, A. G. P. (2022). Sustainable food, consensus, and debates: a study on university campuses in Mexico City. *International Journal of Sustainability in Higher Education*, *23*(8) pp. 337-353. https://doi.org/10.1108/IJSHE-03-2022-0096
Mohamed, N.H., Noor, Z.Z., Sing, C.L.I. (2019). Environmental sustainability of universities: Critical review of best initiatives and operational practices. Green Engineering for Campus Sustainability. *Springer Singapore,* pp. 6–17. https://doi.org/10.1007/978-981-13-7260-5_2
Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. P*LoS Medicine*, *6(*7), e1000097. https://doi.org/10.1371/journal.pmed.1000097
Moggi, S. (2023). Sustainability reporting, universities and global reporting initiative applicability: a still open issue. *Sustainability Accounting, Management and Policy Journal, 14*(4) pp. 699-742. https://doi.org/10.1108/SAMPJ-05-2022-0257
Pedersen, K. W., Pharo, E., Peterson, C., & Clark, G. A. (2017). Wheels of change in higher education. A collaborative, multi-stakeholder project as a vehicle for sustainability education. *International Journal of Sustainability in Higher Education, 18*(2) pp. 171-184. https://doi.org/10.1108/IJSHE-10-2015-0172
Rad, M., & Sonesson, U. (2024). Drivers of a more sustainable future food system – Lessons from Sweden. *Journal of Cleaner Production,* 462, 142639. https://doi.org/10.1016/j.jclepro.2024.142639

 © 2026 by MIP

Ribeiro, J.M.P., Hoeckesfeld, L., Magro, C.B.D., Favretto, J., Barichello, R., Lenzi, F.C., Secchi, L., Montenegro de Lima, C.R. Guerra, J.B.S.O.A (2021). Green Campus Initiatives as sustainable development dissemination at higher education institutions: Students' perceptions. *Journal of Cleaner Production.* 312, 127671*,* https://doi.org/10.1016/J.JCLEPRO.2021.127671

Shafi, R.M., Tarmudi, Z., Ismail, N. & Zain, S.R.S.M. (2023). Modelling Fuzzy Analytical Network Process for Sustainability Criteria of Malaysia Higher Education Institutions. *Advances in Social Sciences Research Journal, 10*(6.2), 187–203. https://doi.org/10.14738/assrj.106.2.15003

Shakir, H., & Salem, F. (2024). Energy management enhancement of a smart home supplied by renewable energy system. *Indonesian Journal of Electrical Engineering and Computer Science, 35*(1) pp. 20-31. http://doi.org/10.11591/ijeecs.v35.i1.pp20-31

Shrestha, P. (2024). Sustainability initiatives in higher education institutions: the stakeholder perspectives. *Journal of Applied Research in Higher Education*. *17* (4) pp. 1394–1410. https://doi.org/10.1108/JARHE-03-2024-0141

Syam, F.H., Wisdianti, D., Sajar. S. & Bahri, S. (2023). Study of Sustainable Architecture Concepts. *International Journal of Research and Review. 10*(4) pp. 419-424. https://doi.org/10.52403/ijrr.20230450

Thomashow, R.C. (2014). Mitchell Thomashow: "The nine elements of a sustainable campus". *Journal of Environmental Studies and Sciences.* pp. 248. https://doi.org/10.1007/S13412-0150282-4

Vlachopoulos, D. & Makri, A. (2024). A systematic literature review on authentic assessment in higher education: Best practices for the development of 21st century skills, and policy considerations. *Studies in Educational Evaluation*, Volume 83. https://doi.org/10.1016/j.stueduc.2024.101425

Zen, I. S., Subramaniam, D., Sulaiman, H., Saleh, A. L., Omar, W., & Salim, M. R. (2016). Institutionalize waste minimization governance towards campus sustainability: A case study of Green Office initiatives in Universiti Teknologi Malaysia. *Journal of Cleaner Production, 135,* pp. 1407–1422. https://doi.org/10.1016/j.jclepro.2016.07.053

Received: 11th November 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 217 – 232

USER-CENTERED FURNITURE DESIGN FOR PET CO-LIVING SPACES

Wei Wenchao[1], Athira Azmi[1*], Noranita binti Mansor[1] , Wan Mstura Shaik Mohamed Mossadeq[2]

[1]*Faculty of Design and Architecture,*
UNIVERSITI PUTRA MALAYSIA
[2]*Faculty of Veterinary Medicine,*
UNIVERSITI PUTRA MALAYSIA

Abstract

The efficiency and effectiveness of public bus services are essential for fostering sustainable urban transportation. In Malaysia, despite widespread concerns about lengthy commutes, congestion-related stress, and high traffic fatality rates, private vehicles remain the dominant mode of transport, even among university students. This examines university students' perceptions of public bus service efficiency and effectiveness, aiming to identify areas for improvement to increase public transport usage. A mixed-method approach was adopted to provide a comprehensive analysis of users' experiences and perceptions. Findings indicate that economic factors significantly influence ridership rates, particularly among young adults who often face financial constraints. At the same time, this demographic is highly mobile, relying on transportation for social, educational, and physical activities. Furthermore, satisfaction with service quality emerges as a critical determinant of public bus loyalty. To enhance efficiency and increase ridership, the study recommends addressing the multifaceted factors influencing public bus service use through a comprehensive strategy. Future research should delve into socioeconomic analyses to better understand these dynamics.

Keywords: Urban Mobility, Public Bus, User Perception, Service Quality, Ridership Rate

[1] Corresponding author. Email: weiwenchao413@163.com

INTRODUCTION

The bond between humans and pets has deepened, with cats becoming one of the most popular household companions. An estimated 700 million cats, both stray and adopted, live globally (Ovenden et al., 2024; Henning et al., 2022). This growing trend has spurred interest in furniture design that caters to both human lifestyles and feline behavior (Ellis, 2009). User-centered design (UCD), which focuses on user needs and preferences, has been widely applied in human product development (Müller et al., 2024), but its application in pet furniture remains limited. Notably, designing for cats requires balancing their instinctual needs, such as scratching and climbing, with human expectations for aesthetics and ease of maintenance (Zhang & McGlone, 2020).

Recent research stresses the need to integrate animal behavior insights into design to improve feline welfare, while also maintaining ergonomic and sustainable solutions for humans (Yurttaş & Altuncu, 2022). However, many current products still fall short in functionality, durability, or appeal. This review addresses the gap by analyzing trends, challenges, and design strategies, offering a theoretical basis and future directions for pet-inclusive, user-centered furniture design.

LITERATURE REVIEW

User-Centered Design in Furniture

Human-centered design (HCD) has long served as a foundational approach in product and furniture design, emphasizing ergonomics, user preferences, and functionality to enhance quality of life (Dangkua et al., 2024; Liu et al., 2023). Increasingly, sustainability is also prioritized, with designers favoring eco-friendly materials and manufacturing processes (Singhal et al., 2024). These principles remain essential when designing furniture for pet-owning households, where human comfort and aesthetics continue to be central.

However, as companion animals, especially cats, become integral family members, animal-centered design (ACD) has emerged as a complementary approach (Ruge & Mancini, 2022). ACD focuses on understanding animals' needs from their species-specific perspective to support their physical and psychological well-being (Al-S'di, 2022). For cats, this includes elevated spaces for security, surfaces for scratching, and private areas for rest, all of which reflect their instinctual behaviors (Curtis, 2020).

Research demonstrates that the provision of environmental enrichment, especially vertical space, reduces feline stress and supports cognitive engagement (Stone, 2019). As Vojtkovská et al. (2020) emphasized, incorporating such enrichment features into home furniture is vital for the health and well-being of indoor cats. Therefore, integrating HCD and ACD can enable the development of innovative furniture that supports harmonious human-cat cohabitation.

Balancing Human and Feline Needs

Designing furniture that meets the needs of both cats and their owners poses a unique set of challenges. Specifically, cats require structures that accommodate their instinctive behaviors, such as scratching, climbing, hiding, and perching, to feel safe and cognitively engaged in their indoor environment (Ellis et al., 2013). These behaviors are critical to their physical and mental health, so designs must include diverse surface materials and multi-level, enclosed resting spaces that match cat preferences (Ellis, 2009). On the other hand, pet owners prioritize furniture that is aesthetically pleasing, easy to clean and adaptable to different home décor (Rui & Firzan, 2025). Aesthetics play an important role in purchasing decisions, as traditional pet furnishings often fail to harmonize with modern home décor or appear bulky and obtrusive. In addition, maintenance-related issues can influence decisions regarding material selection and design preferences (Mutti et al., 2024). Balancing these competing demands is critical to creating products that are both functional and desirable. Effective pet-friendly furniture should seamlessly blend practical feline features with sleek, modern aesthetics to ensure that it improves the home environment.

Several studies have explored the concept of multi-functionality in pet furniture. For example, modular design is applicable to various spaces and user needs, and modular furniture may be a potential solution to address these needs (Garip et al., 2021; De Paris & Lopes, 2018). Similarly, multifunctional and multipurpose furniture has great potential in finding ways to help save and maximize space (Husein, 2021). These designs not only save space but also enhance the overall user experience by incorporating pet-friendly features into everyday household items.

Materials and Sustainability

Material selection is a crucial aspect of pet-friendly furniture design, as it directly impacts the product's durability, functionality and sustainability (Rossi et al., 2023). Cats exhibit natural scratching behaviors that, if not properly adapted, can lead to rapid deterioration of furniture surfaces and structural damage over time (Rossi et al., 2023). Therefore, designers must carefully select materials that are scratch-resistant, durable, and safe for pets to ensure that furniture remains functional and aesthetically pleasing despite frequent use. High-density wood, reinforced textiles, sisal rope, and metal reinforcements are commonly used to enhance durability and resistance to feline activity (Malamed & Sueda, 2022).

At the same time, growing awareness of sustainability and environmental responsibility has influenced material choices for pet-friendly furniture design. Consumers are increasingly seeking environmentally friendly alternatives to reduce carbon footprints, minimize waste, and utilize renewable resources (Zutshi et al., 2016). Sustainable materials (e.g., recycled wood, bamboo, cork, and biodegradable fabrics) are being incorporated into designs that

© 2026 by MIP

provide aesthetic appeal while conforming to environmental values[33]. In addition, non-toxic, VOC-free paints and adhesives are becoming increasingly popular to ensure that furniture is safe for both pets and humans, reducing exposure to harmful chemicals (Ulker et al., 2021).

In summary, this literature review examines the integration of human-centered design (HCD) and animal-centered design (ACD) principles in furniture for cats and their owners. HCD focuses on ergonomics, aesthetics, and sustainability, ensuring furniture meets human needs for comfort, style, and eco-friendliness. ACD addresses cats' natural behaviors, such as climbing, scratching, and seeking elevated spaces, to support their physical and mental health. Combining these approaches is essential for creating multifunctional, modular furniture that meets the needs of both humans and pets while maximizing space and improving usability. Material choice is crucial, with durable, scratch-resistant, and sustainable options, such as high-density wood, sisal rope, and recycled materials, being increasingly favored to ensure the furniture's longevity and safety. This review underscores the importance of integrating functionality, aesthetics, and sustainability to develop innovative pet-friendly furniture that benefits both cats and their owners.

Current studies highlight the need to balance human and feline needs but lack exploration of advanced technologies, such as IoT-enabled features or smart materials, in pet-friendly furniture. There is also limited research on how cultural and regional differences shape pet owners' design preferences, as well as the long-term effects of sustainable materials on pet safety and environmental impact. Addressing these gaps could lead to more innovative, inclusive, and globally adaptable solutions in pet-friendly furniture design.

RESEARCH METHODOLOGY

This study employed a qualitative research methodology and a case study research design (Yin, 2012). To examine innovative pet-friendly furniture design, it focused on exploring how functionality, material selection, and aesthetics contribute to the design of furniture that caters to both cats and their owners. Meanwhile, the study did not involve primary data collection, but rather used a structured design analysis framework to evaluate selected furniture. To ensure a systematic and rigorous evalutions, a structured design analysis framework was developed based on the key themes emerging from the literature review. This framework guided the comparative case study analysis across four predefined parameters: (i) Functional Design, assessing human usability, pet interaction, and multifunctionality; (ii) Material and Durability, evaluating pet-safe materials, scratch resistance, and maintenance requirements; (iii) Aesthetic Integration, examining the visual compatibility with modern interiors and design flexibility; and ((iv) Structural Integrity, considering stability and long-term wear. Each case study (Catable 1.0 and 2.0) was systematically analysed against these parameters

using available visual and descriptive documentation from the manufacturer and prior research. The findings for each parameter were then compared to identify common strengths, weaknesses, and design trade-offs, which are summarized in Tables 1 , 2 and 3 in the Analysis and Discussion section.

The study cases were selected based on the following criteria: (i) Furniture designed for human-cat coexistence that meets the needs of both humans and cats with seamlessly integrated pet-friendly features; (ii) Functional innovation, with each piece of furniture demonstrating novel design solutions that encourage cat engagement and interaction; (iii) Aesthetic and material considerations, designed to utilize high-quality materials while maintaining the visual harmony of modern interiors; (iv) Industry recognition and accessibility, the designs have been publicly displayed and are available for structured analysis. Based on these criteria, this study selected the "Catable 1.0" and "Catable 2.0" designed by LYCS Architects as case studies. Figures 1 and 2 show these two products.



Figure 3. Catable 1.0
Source: LYCS Architects (https://en.lycs-arc.com/projects/catable-1-0)



Figure 4: Catable 2.0
Source: LYCS Architects (https://en.lycs-arc.com/projects/catable-2-0)

The two selected furniture models exemplify the integration of human-centered and pet-friendly design, addressing the needs of both cats and their

© 2026 by MIP

owners (Ai, 2022). While many pet furniture products focus solely on basic functions, Cat Table 2.0 highlights the importance of human-pet interaction, offering valuable insights for future design (Ai, 2022). Both models feature multifunctional designs that optimize space and enhance cohabitation (Yurttaş & Altuncu, 2022). Their sculptural wooden forms blend well with modern interiors, and their public exhibitions provide accessibility for in-depth analysis (LYCS Architecture, 2014a; LYCS Architecture, 2014b). Notably, these prototypes were showcased at Milan Design Week and received PETA's Design for Animals Award (LYCS Architecture, 2014c), and have been used as case studies in research on human-cat living environments.

A comparative case study was carried out on two selected examples to examine various aspects such as functionality, aesthetics, and materials (Bartlett & Vavrus, 2017). This multi-dimensional and multi-scale approach not only highlights the similarities and differences between the cases but also provides a comprehensive perspective and robust foundation for refining and advancing pet-inclusive furniture design in the future.

ANALYSIS AND DISCUSSION

This section summarizes the main findings of the case studies. In order to address the research questions, a comparative case study analysis was conducted on the 2 selected cases in order to systematically analyze their functionality, materials, aesthetics, and special themes in order to gain insights into the characteristics and further development of pet-friendly furniture.

Functional design assessment

Catable 1.0 and Catable 2.0 exemplify innovative approaches to integrating pet-friendly features into furniture while maintaining aesthetic value. Both designs address human usability and feline needs, yet emphasize different aspects of functionality.

Catable 1. balances spatial practicality for humans with feline-oriented elements such as built-in tunnels and curved openings that support natural behaviors like hiding and playing (Ellis et al., 2013). It retains its primary function as a desk, enabling users to work or study uninterrupted. Additionally, its open structure encourages positive human-cat interaction, fostering a shared environment that benefits both parties. In contrast, Catable 2.0 prioritizes feline engagement and modular adaptability over human utility. Its stackable, customizable units support vertical movement and create enriched climbing and lounging spaces. While visually striking and suitable for modern interiors, its hard surface could benefit from soft finishes to improve feline comfort. Moreover, its reliance on anchoring for stability highlights the need for structural reinforcement, especially in multi-cat households.

© 2026 by MIP

As summarized in Table 1, both cases demonstrate successful multifunctional furniture design that enhances human-cat cohabitation. Catable 1.0 is ideal for shared human-pet use, while Catable 2.0 excels in promoting feline interaction and adaptability. Future designs could enhance comfort, adjustability, and safety, offering valuable insights into the development of next-generation pet-friendly furniture.

Table 1. Comparative Analysis of Functional Design Features in Catable 1.0 and 2.0

Evaluation Parameter	Catable 1.0	Catable 2.0
Human Usability	Provides a functional workspace while integrating pet features. Maintains a clean, minimal aesthetic, avoiding cluttered pet accessories.	Functions as a modular storage or display unit while doubling as a cat climbing. Stackable and customizable for different spatial configurations.
Pet Interaction & Comfort	Features built-in tunnels and curved openings, allowing cats to explore without obstructing the human workspace. Encourages natural feline behaviors.	Provides various levels for climbing, resting, and hiding, mimicking natural feline instincts. Openings are well-proportioned to accommodate different cat sizes.
Multi-functionality	Eliminates the need for separate cat tunnels, perches, or play areas. Integrates pet-friendly design without sacrificing traditional desk functionality.	Highly customizable and modules can be rearranged for different layouts. Serves as both a storage and display unit and a pet climbing.

Source: Author Summary

Material and durability assessment

Both Catable 1.0 and Catable 2.0 are primarily constructed from wood, a material known for its beauty, structural integrity, and sustainability (Viholainen et al., 2020). Wood is a pet-safe and visually appealing choice that integrates well with modern interior styles. However, it faces durability-related challenges, particularly in terms of scratch resistance, ease of maintenance, and structural furniture that must endure frequent wear and tear. One key reason is that cats' instinctive scratching and climbing behaviors mean pet-inclusive furniture must withstand sustained wear and tear. Additionally, the accumulation of pet hair and debris requires that such furniture be easy to clean and maintain.

Catable 1.0 is supported by four legs, providing greater structural stability and reducing the risk of tipping over. Its design includes internal tunnels, openings, and holes, offering cats spaces to hide, play, and rest. However, the exposed wooden surfaces are prone to scratches and stains over time due to cats' scratching behavior (Rossi et al., 2023). Applying a scratch-resistant, pet-safe

© 2026 by MIP

coating can enhance durability while preserving the wood's natural appearance and texture (Jirouš-Rajković & Miklečić, 2021).

On the other hand, Catable 2.0, while highly adaptable and engaging for cats, raises concerns about stability when stacked. In multi-cat households, the furniture may shift or tip if not securely anchored or fastened (Polat & Gül, 2023). Additionally, hardwood surfaces inherently lack sufficient cushioning, resulting in limited comfort for prolonged use, both for cats and humans. Incorporating cat-friendly materials, such as soft felt, at key contact points could improve both durability and comfort. Furthermore, to safeguard long-term usability, the wood should be treated with a pet-safe, stain-resistant sealant to prevent odor absorption and simplify routine cleaning.

As shown in Table 2, a comparison of materials reveals that while both designs show strong potential, minor improvements in material selection and durability could significantly enhance their longevity, pet-friendliness, and ease of maintenance. Strengthening scratch resistance, improving modular stability, and integrating soft, interchangeable surfaces would make these designs more suitable for pet-friendly living spaces.

Table 2. Comparative Analysis of Material and Durability in Catable 1.0 and 2.0

Evaluation Parameter	Catable 1.0 Catable 2.0
Human and Pet-Safe Material	Wood is non-toxic and safe for cats and human, provided it is untreated with harmful chemicals or finishes.
Scratch Resistance	Wood surfaces may be vulnerable to scratching, especially from cat claws, unless coated with a protective finish.
Cleaning and maintenance	Wood surfaces can absorb oils, fur, and stains, requiring frequent wiping and sealing. If untreated, wood may absorb pet odors, necessitating a protective, odor-resistant finish. Wood allows for sanding and refinishing, making it possible to restore surfaces if scratched or worn.
Sustainability	Wood can be an eco-friendly choice for furniture design.

Source: Author Summary

Aesthetic Appeal and functional balance

The Catable 1.0 and Catable 2.0 effectively integrate pet-friendly features with modern aesthetic design, thereby proving that such furniture can be both functionally practical and visually appealing, meeting the dual needs of cats and their owners. Unlike traditional furniture, these designs incorporate a mix of organic and geometric shapes that fit well into contemporary living spaces. Catable 1.0 achieves this by integrating subtle tunnels and curved openings into its sleek wooden surface, maintaining its functionality as a workspace while offering hidden spaces for cats to explore. Its natural wood grain and sculptural design make it ideal for minimalist or Scandinavian interiors, though it may not align as well with industrial or high-tech styles.

Catable 2.0, on the other hand, offers a highly flexible design, allowing users to arrange and combine its modules as needed. This modular approach not only creates spaces for cats to climb and rest but also adapts to various home aesthetics, making it both functional and decorative, as illustrated in Figure 3. This customizable feature is particularly appealing to pet owners who enjoy personalized design. However, the stackable nature of the modules can make the furniture appear bulky, thus requiring careful placement to avoid making the room feel cramped. By comparison, this design offers greater expandability and adaptability, making it a better choice for pet owners seeking long-term use and the ability to reconfigure their space over time.

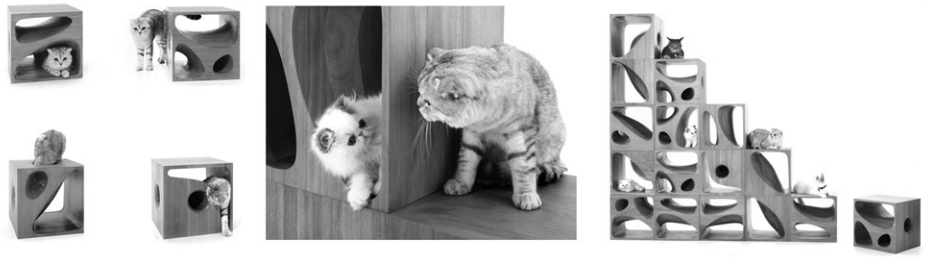


Figure 3. Changing forms of Table 2.0
Source: LYCS Architects (https://en.lycs-arc.com/projects/catable-2-0)

From an aesthetic perspective, both designs effectively balance utility and beauty but cater to different preferences. Catable 1.0 is ideal for those seeking a sleek, all-in-one solution that blends seamlessly into their home. Catable 2.0, meanwhile, appeals to those who value flexibility and creativity, thanks to its modular design. To further enhance their functionality, both designs could incorporate more adjustable features, softer materials, or customizable elements, ensuring a better balance between pet needs, practicality, and home aesthetics.

Table 3. Comparative Analysis of Aesthetic Appeal in Catable 1.0 and 2.0

Evaluation Parameter	Catable 1.0	Catable 2.0
Integration of Pet Features	Tunnels and curved openings are smoothly embedded within the table surface, allowing hidden interaction spaces for cats.	Openings and modular stacking serve dual purposes—resting zones for cats and a modern shelving system for humans.
Minimalist Aesthetic	wooden surface and organic curves create a sleek, sculptural appearance.	Geometric modularity allows for aesthetic versatility, adapting to different spatial layouts.
Intrusiveness in Home Interiors	Functions as a normal desk, avoiding the bulky look of conventional pet furniture.	Can appear bulky if not arranged with intentional spacing and alignment.

Source: Author Summary

© 2026 by MIP

This section summarizes several key points by comparing the pet-friendly desk and the modular cat carrier system, focusing on their design ideas, practicality, and functional integration for people and pets. These key points can be summarized into three areas: design ideas, practicality, and adaptability.

Catable 1.0 and Catable 2.0 take different approaches to integrating pet-friendly features into functional furniture. Catable 1.0 adopts a more unified design, embedding curved tunnels and openings into the desk to create spaces for cats to explore without disrupting human use. In contrast, Catable 2.0 prioritizes flexibility and customization, enabling users to rearrange its modules to suit their cat's climbing and resting preferences. While Catable 1.0 offers a fixed, all-in-one solution for those who prefer simplicity, Catable 2.0 is better suited for human caregivers seeking furniture with the flexibility to adapt as their human-cat dual needs evolve.

In terms of practicality, Catable 1.0 allows cats to move through its built-in tunnels without disturbing human activities, making it an excellent choice for those who work from home. Catable 2.0, however, emphasizes vertical exploration and movement for cats, which aligns better with their instincts but reduces direct interaction between pets and their owners compared to Catable 1.0.

When it comes to adaptability, Catable 1.0 is stable but lacks adjustability, while Catable 2.0 offers high flexibility, allowing users to reconfigure its modules as needed. However, this flexibility comes with challenges, such as ensuring the structure remains secure to prevent instability. Overall, Catable 1.0 provides a sleek and minimalist solution for shared human-cat spaces, while Catable 2.0 focuses more on meeting cats' needs for freedom and exploration. Future pet-friendly furniture could blend the strengths of both designs, striking a balance between practicality and flexibility to benefit both pets and their owners.

Critical Evalution and Long-Time Usablity and Market Viability

While both Catable designs demonstrate innovative concepts, their long-term success in the market hinges on factors beyond initial aesthetics and functionality. From a long-term usability perspective, Catable 1.0's enclosed wooden tunnels, while engaging, may present cleaning challenges, as hair and debris could accumulate in hard-to-reach areas. Over time, the exposed wooden surfaces in both models, are susceptible to scratching, which could lead to a worn appearance that may not align with owner expectations for longevity, despite the potential for refinishing.

Regarding market viability and user satisfaction, the designs cater to distinct consumer segments. Catable 1.0 functions as a premium, design-led workspace, likely appealing to design-conscious urban dwellers who view it as a long-term investment piece. Its success depends on its price and consumer willingness to pay a premium for integrated pet features.Catable 2.0's modularity

offers greater flexibility and scalability, potentially appealing to a broader range of households and budgets, as users can start with a smaller configuration. However, its market viability is challenged by the need for secure anchoring systems to ensure safety in active multi-pet homes, which adds complexity and potential cost. Future research should directly investigate user satisfaction through post-occupancy evaluations and surveys to gather empirical data on cleaning routines, perceived durability, and willingness to purchase, thereby grounding these.

THEORETICAL FRAMEWORK AND FUTURE DIRECTIONS

Theoretical Framework

Based on the literature review and case studies, this study proposes a conceptual framework to enhance the understanding and development of furniture designs that support human-cat co-use and guide future research directions, as shown in Figure 4.

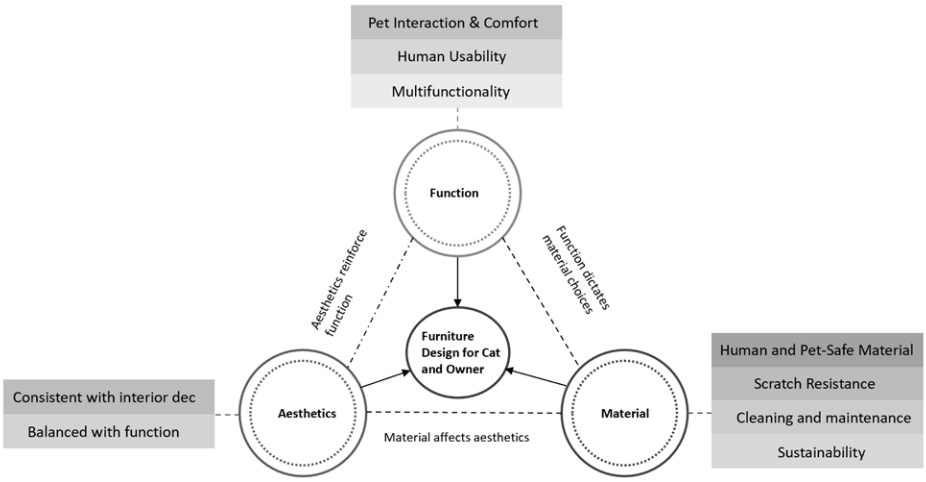


Figure 4. Theoretical Framework
Source: Author drawing

This framework highlights how function, materials, and aesthetics are deeply connected when designing furniture for both people and cats. At its core, human-feline dual functionality takes precedence, ensuring the furniture supports feline interaction and activity, meets human usage needs, and delivers overall versatility. The choice of materials affects how long the furniture lasts, how easy it is to maintain, and how safe it is for pets, with features like scratch resistance and eco-friendliness being particularly important. Aesthetics, on the other hand, make sure the furniture blends naturally into the home without sacrificing practicality. Together, these elements form a dynamic triangle: function shapes

© 2026 by MIP

material choices, materials influence aesthetics, and aesthetics, in turn, enhance function. When these three aspects are balanced, the result is furniture that is practically functional, durable, and visually appealing for both cats and their human caregivers. This balanced design model can serve as a useful guide for developing future pet-friendly furniture, ensuring designs meet the needs of humans and cats while maintaining a balance between usability, durability, and style.

Future Directions

Future pet-inclusive furniture must align with evolving human-cat cohabitation lifestyles, advancements in pet-centric smart technology, and the growing focus on environmental sustainability, all while adhering to a function-material-aesthetics framework. (i) Adapting to Urban Life: As urbanization accelerates and living spaces shrink, pet-friendly furniture should emphasize space-saving and multifunctional designs. Solutions like foldable, stackable, or wall-mounted units can maximize limited space while still providing pets with comfortable areas. With the rise of remote work and hybrid lifestyles, furniture such as desks with built-in pet spaces or quiet zones can enhance human productivity while keeping pets content and engaged. (ii) Customization and Personalization: Modern users increasingly seek tailored home solutions. Modular pet furniture, which allows for adjustable configurations and aesthetic customization, can cater to diverse lifestyles and interior design preferences. Adding pet-specific accessories further enhances its appeal and functionality. (iii) Smart and Technology-Enabled Features: As smart home technologies become more prevalent, future pet furniture can integrate features like automated litter boxes or IoT-enabled pet monitoring systems. For example, IoT-enabled monitoring systems could be discreetly integrated into a modular cat shelf to track a cat's activity levels and rest patterns, providing owners with health insights via a smartphone app. Automated play element, such as motorized teaser toys that activate at scheduled times within a furniture unit, could combat feline boredom when owners are away. Furthermore, the integration of wireless charging pads into a cat-friendly side table or desk surface (like a next-generation Catable 1.0) would also blend pet-centric and human-centric tech needs seamlessly. The key design challenge is to embed this technology in a way that is durable, pet-safe, and invisible, ensuring the furniture retains its aesthetic integrity. These innovations can make pet care more convenient while seamlessly blending into the home environment. (iv) Sustainable and Eco-Friendly Materials: With sustainability becoming a priority for consumers, pet furniture should utilize biodegradable, recyclable, or eco-friendly materials. These choices not only reduce environmental impact but also ensure durability and safety for pets.

By addressing these aspects, future pet-friendly furniture can achieve a balanced integration of functionality, aesthetics, and sustainability, ultimately

fulfilling the dual needs of cats and their human caregivers amid a rapidly changing world.

CONCLUSION

This study has emphasized the importance of balancing functionality, aesthetics, and sustainability in furniture designed for cats and their owners. For instance, from versatile designs like the Cat Table 1.0 to modular innovations like the Cat Table 2.0, the field of pet-friendly furniture design already demonstrates notable creativity and practical potential. However, challenges such as conflicts between human and feline needs, limited urban living space, and high production costs remain, highlighting the need for ongoing research and iterative development.

Moving forward, the incorporation of advanced technologies, eco-friendly materials, and customizable features presents exciting opportunities for growth. Collaboration across fields, such as design, veterinary science, and animal behavior, will be crucial to creating furniture that not only meets the needs of cats and their owners but also aligns with broader trends like sustainability and urbanization.

In summary, designing furniture is not merely a technical challenge; it is an opportunity to foster harmony in human-pet cohabitation. By prioritizing human-feline dual-centered design principles and embracing innovation, designers can develop products that elevate the quality of life for both cats and their human caregivers, ultimately contributing to a more inclusive and sustainable future.

At last, we encourage designers, researchers, and manufacturers to continue exploring this emerging field to address existing gaps and push the boundaries of what is possible. By doing so, we can create a world where pets and people thrive together in shared spaces that are functional, beautiful, and enriching for all.

REFERENCES

Ai, J. (2022, January). Interactive cat furniture design. In *2021 International Conference on Culture, Design and Social Development (CDSD 2021)* (pp. 43–48). Atlantis Press. https://doi.org/10.2991/assehr.k.220109.009

Al-S'di, A. (2022, September). User centred design methods in animal centred design: A systematic review. In *2022 International Conference on Theoretical and Applied Computer Science and Engineering (ICTASCE)* (pp. 84–89). IEEE. https://doi.org/10.3389/fvets.2022.885973

Bartlett, L., & Vavrus, F. (2017). Comparative case studies: An innovative approach. *Nordic Journal of Comparative and International Education (NJCIE), 1*(1). https://doi.org/10.7577/njcie.1929

Curtis, T. M. (2020). Behavior problem or problem behavior. *Veterinary Clinics of North America: Small Animal Practice, 50*(4), 707–718. https://doi.org/10.1016/j.cvsm.2020.03.002

© 2026 by MIP

Dangkua, N. Y., Nandito, M. A., Jamil, F. H. P., & Rahayu, M. (2024). Implementing human-centric design in developing a multifunctional chair and storage solution for children. *Jurnal Sistem Teknik Industri, 26*(2), 180–190. https://doi.org/10.32734/jsti.v26i2.15362

De Paris, S. R., & Lopes, C. N. L. (2018). Housing flexibility problem: Review of recent limitations and solutions. *Frontiers of Architectural Research, 7*(1), 80–91. https://doi.org/10.1016/j.foar.2017.11.004

Ellis, S. L. H. (2009). Environmental enrichment: Practical strategies for improving feline welfare. *Journal of Feline Medicine and Surgery, 11*(11), 901–912. https://doi.org/10.1016/j.jfms.2009.09.011

Ellis, S. L., Rodan, I., Carney, H. C., Heath, S., Rochlitz, I., Shearburn, L. D., … & Westropp, J. L. (2013). AAFP and ISFM feline environmental needs guidelines. *Journal of Feline Medicine and Surgery, 15*(3), 219–230. https://doi.org/10.1177/1098612x13477537

Garip, E., Sağlar Onay, N., & Garip, S. B. (2021). A model for mass customization and flexibility in mass housing units. *Open House International, 46*(4), 636–650. https://doi.org/10.1108/OHI-02-2021-0053

Henning, J. S. L., Fernandez, E. J., Nielsen, T., & Hazel, S. (2022). Play and welfare in domestic cats: Current knowledge and future directions. *Animal Welfare, 31*(4), 407–421. https://doi.org/10.7120/09627286.31.4.005

Husein, H. A. (2021). Multifunctional furniture as a smart solution for small spaces for the case of Zaniary Towers apartments in Erbil City, Iraq. *International Transactions Journal of Engineering, Management, & Applied Sciences & Technologies, 12*, 1–11. https://doi.org/10.14456/ITJEMAST.2021.8

Jarža, L., Čavlović, A. O., Pervan, S., Španić, N., Klarić, M., & Prekrat, S. (2023). Additive technologies and their applications in furniture design and manufacturing. *Drvna Industrija, 74*(1), 115–128. https://doi.org/10.5552/drvind.2023.0012

Jirouš-Rajković, V., & Miklečić, J. (2021). Enhancing weathering resistance of wood—A review. *Polymers, 13*(12), 1980. https://doi.org/10.3390/polym13121980

Liu, Y., Hu, W., Kasal, A., & Erdil, Y. Z. (2023). The state of the art of biomechanics applied in ergonomic furniture design. *Applied Sciences, 13*(22), 12120. https://doi.org/10.3390/app132212120

LYCS Architecture. (2014). Catable 1.0. Retrieved March 13, 2025, from https://www.lycs-arc.com/project/catable-1-0

LYCS Architecture. (2014). Catable 1.0. Retrieved March 13, 2025, from https://www.lycs-arc.com/project/catable-2-0

LYCS Architecture. (2014). LYCS Architecture awards the World Kindness for Animals Design Award for animal innovation. *LYCS Architecture*. https://en.lycs-arc.com/current/2014-innovator-for-animals-award

Malamed, R., & Sueda, K. L. C. (2022). Nuisance/destructive/unruly behaviors. In *Clinical handbook of feline behavior medicine* (pp. 190–211). https://doi.org/10.1002/9781119653271.ch12

Müller, A., Steinke, J., Dorado, H., Keller, S., Jiménez, D., Ortiz-Crespo, B., & Schumann, C. (2024). Challenges and opportunities for human-centered design in CGIAR. *Agricultural Systems, 219*, 104005.

https://doi.org/10.1016/j.agsy.2024.104005

Mutti, M. A. I., Khalid, N. A. M., & Yassin, H. R. M. (2024). Furniture design concept for the era of new norm. *PaperASIA, 40*(6b), 309–317. https://doi.org/10.59953/paperasia.v40i6b.236

Ovenden, K., Bassett, I., & Sumner, C. L. (2024). 'I want you to want me': How owners value cats' choices has implications for cat containment. *People and Nature, 6*(2), 548–561. https://doi.org/10.1002/pan3.10580

Polat, A. I., & Gül, M. (2023). An analysis of mitigation measures for furniture in education buildings to prevent earthquake hazards. *Journal of Interior Design and Academy, 3*(1), 77–95. https://doi.org/10.53463/inda.20230186

Rossi, A. P., Dos Santos, C. R., Maia, C. M., Terzian, C. C., Predebon, D. F., de Queiroz, J. S., … & Corrêa, T. M. (2023). Rescued cats prefer to scratch fabrics commonly used to cover upholstered furniture. *Journal of Applied Animal Welfare Science, 26*(3), 313–324. https://doi.org/10.1080/10888705.2021.1949595

Ruge, L., & Mancini, C. (2022). An ethics toolkit to support animal-centered research and design. *Frontiers in Veterinary Science, 9*, 891493. https://doi.org/10.1109/ICTACSE50438.2022.10009842

Rui, L., & Firzan, M. (2025). Emotional design in contemporary interior spaces: User experience and emerging trends. *Multidisciplinary Science Journal, 7*(1), 2025040. https://doi.org/10.31893/multiscience.2025040

Singhal, T. S., Jain, J. K., Ramacharyulu, D. A., Jain, A., Abdul-Zahra, D. S., Manjunatha, M., & Srivastava, A. P. (2024). Eco-design of products and processes: A review on principles and tools for sustainable manufacturing. In *E3S Web of Conferences* (Vol. 505, p. 01033). EDP Sciences. https://doi.org/10.1051/e3sconf/202450501033

Stone, E. (2019). What's in it for the cats?: Cat shows as serious leisure from a multispecies perspective. *Leisure Studies, 38*(3), 381–393. https://doi.org/10.1080/02614367.2019.1572776

Ulker, O. C., Ulker, O., & Hiziroglu, S. (2021). Volatile organic compounds (VOCs) emitted from coated furniture units. *Coatings, 11*, 806. https://doi.org/10.3390/coatings11070806

Viholainen, N., Kylkilahti, E., Autio, M., & Toppinen, A. (2020). A home made of wood: Consumer experiences of wooden building materials. *International Journal of Consumer Studies, 44*(6), 542–551. https://doi.org/10.1111/ijcs.12586

Vojtkovská, V., Voslářová, E., & Večerek, V. (2020). Methods of assessment of the welfare of shelter cats: A review. *Animals, 10*(9), 1527. https://doi.org/10.3390/ani10091527

Yin, R. K. (2012). Case study methods. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol. 2: Research designs: Quantitative, qualitative, neuropsychological, and biological* (pp. 141–155). American Psychological Association. https://doi.org/10.1037/13620-009

Yurttaş, N. B., & Altuncu, D. (2022). New possibilities of living together in post-humanist society: Interior and furniture design for pets. *Journal of Design for Resilience in Architecture and Planning, 3*(3), 281–294. https://doi.org/10.47818/DRArch.2022.v3i3058

© 2026 by MIP

Zhang, L., & McGlone, J. J. (2020). Scratcher preferences of adult in-home cats and effects of olfactory supplements on cat scratching. *Applied Animal Behaviour Science, 227*, 104997. https://doi.org/10.1016/j.applanim.2020.104997

Zutshi, A., Creed, A., Holmes, M., & Brain, J. (2016). Reflections of environmental management implementation in furniture. *International Journal of Retail & Distribution Management, 44*(8), 840–859. https://doi.org/10.1108/IJRDM-10-2015-0154

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 233 – 251

THE IMPACT OF GREEN BUILDING MAINTENANCE PRACTICES IN MITIGATING PROMINENT DEFECTS AT UNIVERSITI TEKNOLOGI MARA (UiTM): A SYSTEMATIC LITERATURE REVIEW (SLR)

Zaimah Zainal Abidin[1], Nur Azfahani Ahmad[2], Nor Rima Mohamad Ariff[3], Wan Norizan Wan Ismail[4]

[1,2,3,4] *Department of Built Environment Studies & Technology, College of Built Environment,*
UNIVERSITI TEKNOLOGI MARA MALAYSIA

Abstract

The presence of building defects poses significant challenges to the sustainability and functionality of university facilities over time. At Universiti Teknologi MARA (UiTM), these defects negatively impact building performance, visual appeal, and operational efficiency, underscoring the need for an effective solution. Implementing green building maintenance practices provides a feasible way to address these challenges by merging eco-friedly strategies with modern maintenance techniques. This study conducts a Systematic Literature Review (SLR) to examine the impact of green building maintenance practices on addressing critical defects at UiTM. To identify crucial maintenance techniques, their benefits, and their real-world applications, the review compiles the body of available research. The results highlight effective approaches that align with the Sustainable Development Goals (SDGs) and identify significant gaps in existing frameworks. To enhance building performance, reduce defects, and encourage sustainable maintenance practices at higher education institutions, this study aims to develop an institutional framework tailored for UiTM.

Keywords: Green Building Maintenance, Prominent Defects, Universiti Teknologi MARA (UiTM), Sustainable Development Goals (SDGs), Systematic Literature Review (SLR), Sustainable Practices, Higher Education Institutions

[1] Corresponding author. Email: eymahzainal@gmail.com

INTRODUCTION

Public universities in Malaysia play a crucial role in national development by producing skilled graduates and supporting various sectors of the economy (Othman, 2018). To ensure a conducive learning environment for students and staff, university facilities must be properly maintained to guarantee safety, functionality, and operational efficiency. Building maintenance therefore represents an essential component in sustaining the long-term performance and serviceability of institutional buildings.

However, many public institutions tend to adopt a reactive approach to building maintenance, where repairs and improvements are carried out only after defects are detected. According to Jones and Brown (2018), such reactive maintenance strategies often lead to higher maintenance costs, increased building deterioration, and disruptions to institutional activities. In large and complex facilities such as university campuses, delayed maintenance interventions may further accelerate the occurrence of building defects.

In the Malaysian context, building defects remain a common issue in many public university buildings. These defects may result from various factors, including poor design decisions, construction errors, material deterioration, and inadequate maintenance practices (Fateh & Nikmat, 2023). In addition, many university buildings in Malaysia have been in operation for several decades, which increases their exposure to age-related deterioration such as water leakage, dampness, and structural wear (Hong et al., 2016; Yacob et al., 2019; Othman et al., 2015; Hassan et al., 2015; Suffian, 2013; Mydin et al., 2014). If not properly managed, these defects can significantly affect building performance, user comfort, and operational sustainability.

To address these challenges, the concept of green building maintenance has gained increasing attention in recent years. Green building maintenance focuses on integrating environmentally responsible maintenance strategies with sustainable building management practices. These practices aim to reduce environmental impacts, improve energy efficiency, and enhance building durability while maintaining optimal building performance.

In Malaysia, sustainability initiatives in the built environment are supported through several national policies and regulatory frameworks. These include the National Green Technology Policy, the Green Building Index (GBI) certification system, and sustainability initiatives promoted by government agencies such as the Construction Industry Development Board (CIDB) and the Public Works Department (JKR) (CIDB, 2021; Green Building Index, 2020; Ministry of Energy, Green Technology and Water, 2009). These policies encourage institutions, including universities, to adopt more sustainable building management and maintenance strategies in line with national sustainability goals.

Despite the increasing emphasis on sustainable building practices, limited studies have systematically reviewed the role of green building maintenance practices in mitigating building defects within Malaysian higher education institutions. Previous research has primarily focused on individual aspects of maintenance management, technological solutions, or sustainability practices, without providing a comprehensive synthesis of how these elements collectively contribute to defect mitigation in university buildings.

Therefore, this study aims to conduct a **s**ystematic literature review (SLR) to examine the impact of green building maintenance practices in mitigating prominent defects at Universiti Teknologi MARA (UiTM). By synthesizing existing literature, this study seeks to identify key maintenance practices, technological approaches, and regulatory considerations that contribute to sustainable building performance. The findings of this study are expected to provide valuable insights for improving maintenance strategies in Malaysian universities while supporting broader sustainability objectives.

METHODOLOGY

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

To conduct a systematic review of the literature on green building maintenance methods for reducing significant weaknesses at Universiti Teknologi MARA (UiTM), this study adopts the PRISMA framework (Figure 1), which was specifically adapted for this research. Although initially developed for scientific study, PRISMA's structured methodology has been widely applied in the social sciences and built environment, ensuring an organised and open review process (Shaffril et al., 2021).

Within a defined timeframe, PRISMA assists with the establishment of inclusion and exclusion criteria, the refinement of research questions, and the systematic analysis of literature databases (Abu Samah et al., 2021). There are several frameworks for systematic reviews, especially in environmental management, like the Reporting Standards for Systematic Evidence Syntheses (ROSES) (Shaffril et al., 2021). However, PRISMA was used for this study, as it can generate concise and accessible results, making it appropriate for assessing green building maintenance practices (Belle & Zhao, 2023).

© 2026 by MIP

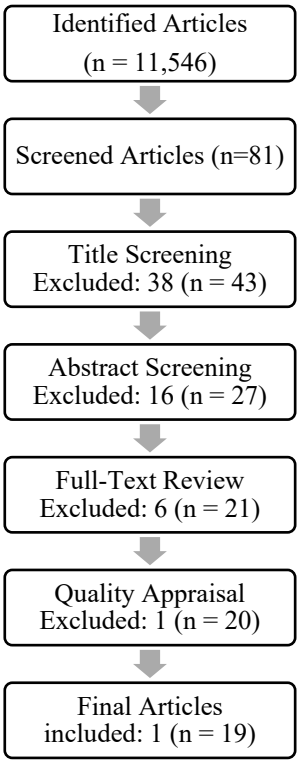


Figure 1: PRISMA Flow Diagram
Source: Author

Formulation of Research Question

The first step in conducting a Systematic Literature Review (SLR) is to develop a clear research topic to guide the review process. In line with the study's objective, the following research question was formulated: "What are the current green building maintenance practices in mitigating prominent defects at Universiti Teknologi MARA (UiTM)?"

Systematic Searching Strategies

As suggested by Abu Samah et al. (2021), three systematic processes, identification, screening, and eligibility, were applied to obtain relevant research on green building maintenance approaches for reducing critical defects at Universiti Teknologi MARA (UiTM). By implementing these procedures into practice, it ensures that the Systematic Literature Review (SLR) remains comprehensive, clear, and well-organised. Each procedure is explained in detail in the following sections:

Identification

To make sure the review is relevant, the identification procedure aims to refine the primary keywords (Abu Samah et al., 2021). Based on the research topic, five key keywords were selected for this study, including Universiti Teknologi MARA (UiTM), building defects, sustainable maintenance practices, mitigation approaches, and green building maintenance. These keywords were further expanded with synonyms, related terms, and variations to improve the search process. To maximise the retrieval of relevant material, various search strategies were employed, such as field numbers, keyword searching, wildcards, and reduction.

Four scholarly databases were explored, including Google Scholar, Web of Science, ScienceDirect, and Scopus. Depending on their relevance, these methods were used separately or in combination. As a result of these search efforts, potential articles were found from the chosen databases.

Table 1: Search String Used in the Selected Databases

Databases	Keyword Used
Scopus	("green building maintenance" OR "sustainable maintenance") AND ("building defects" OR "mitigation strategies") AND ("Universiti Teknologi MARA" OR "UiTM")
Web of Science	("green maintenance" OR "sustainable maintenance") AND ("building defects") AND "Malaysia"
ScienceDirect	("green building" AND "maintenance practices") OR ("sustainable building management")
Google Scholar	("green building maintenance" AND "Malaysia") OR ("building defects mitigation")
Total Articles Identified	**11,546**

Source: Author

In total, 11,546 potential articles were identified across the chosen databases after a thorough search process.

Screening

The screening stage involved examining the retrieved articles, either through manual evaluation or database filtering, to decide whether to include them in the study. Table 2 outlines the predetermined requirements, such as type of literature, language, and publication year, that served as a guide for the selection process. As journal articles include original data, which is necessary for carrying out a systematic literature review, they were given priority as primary sources.

© 2026 by MIP

Table 2: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Type of Literature	Peer-reviewed journal articles, conference papers	Books, non-peer-reviewed articles, reports
Language	English	Non-English
Publication Year	2012–2023	Articles published before 2012
Research Scope	Green building maintenance, building defects, and sustainability practices	Studies unrelated to construction
Type of Literature	Peer-reviewed journal articles, conference papers	Books, non-peer-reviewed articles, reports

Source: Author

Based on Table 2, this review limited the screening procedure to articles published between 2012 and 2023, consistent with the research scope suggested by Abu Samah et al. (2021). This timeframe was chosen to guarantee that there were enough papers included for a representative analysis. Only articles written in English were taken into consideration to ensure uniformity. Furthermore, choosing research related to construction was essential in obtaining relevant publications, given the study's focus on green building maintenance practices.

Following screening, 81 articles remained for further evaluation, with 11,465 having been eliminated for not meeting the inclusion criteria. Two duplicate articles were also removed, leaving 79 papers for eligibility assessment.

Eligibility

The eligibility stage was the last step in making sure that every article that remained after the screening process met the specified inclusion criteria requirements. To ensure their applicability, articles were reviewed using their titles and abstracts. A full-text review was carried out to confirm that they were suitable for inclusion in the study if there was still concern.

At this stage, a total of 38 items were removed following title screening. A further 16 articles were excluded after abstract review, and six additional papers were eliminated after evaluating the full content. Ultimately, 19 articles proceeded to the final quality appraisal stage, after a total of 60 articles had been eliminated. 18 final papers were chosen for the systematic literature review after one article had been removed during the quality appraisal for being unable to meet the required criteria

Quality Appraisal

This stage was taken to make sure the methodology and analysis of the chosen articles were conducted to the highest possible level. To assess systematic mixed-studies reviews, Hong et al. (2018) used the Mixed-Method Appraisal Tool (MMAT), which evaluates five different research types, including mixed-methods research, qualitative research, non-randomised research, quantitative and qualitative studies, and controlled trials. Five main criteria outlined in the research design were used to assess the quality of the chosen articles.

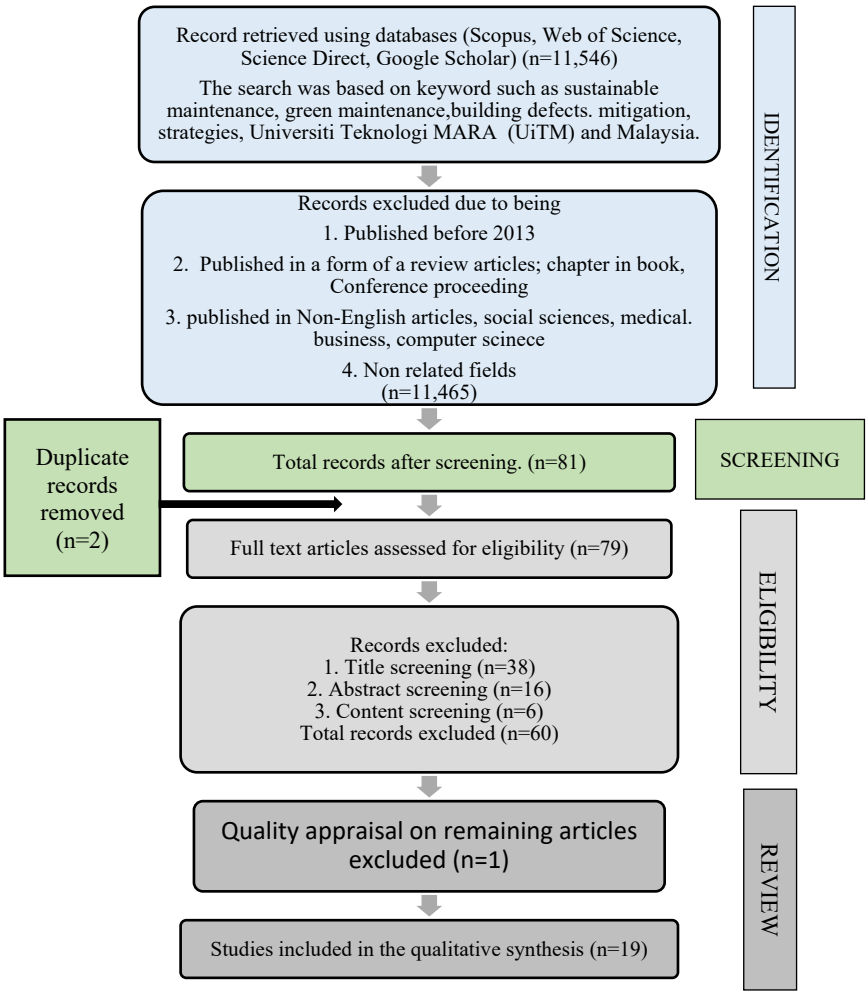


Figure 2: Flow diagram of the search process
Source: Author

© 2026 by MIP

Using this systematic framework, the researchers evaluated the quality of the 19 chosen publications, with particular focus on the suitability of statistical analysis, sampling techniques, data collection, research question clarity, and confidence in the findings. Based on the five predetermined criteria, each item was rated as "yes", "no", or "cannot tell". The review includes articles that met at least three of the five requirements. Consensus among the reviewers ensured that all chosen research satisfied the minimal requirements for data analysis and rigorous methods.

Table 3: Assessment Criteria

Research Design		Assessment criteria
Qualitative (Q1)	i.	Is the qualitative approach appropriate to answer the research question?
	ii.	Are the qualitative data collection methods adequately derived from the data?
	iii.	Is the interpretation of results sufficiently substantiated by data?
	iv.	Is there coherence between qualitative data sources, collection, analysis and interpretation?
Quantitative randomised controlled trials (Qn (rc))	i.	Is the randomisation process clearly described and appropriately implemented?
	ii.	Is the sample size justified and sufficient to ensure statistical power?
	iii.	Are the outcome measures valid, reliable, and consistently applied?
	iv.	Is the handling of attrition, missing data, and follow-up appropriately managed?
	v.	Are the statistical analyses appropriate and clearly reported?
	vi.	Is there evidence of selective outcome reporting being avoided?
Quantitative non-randomised (Qn (nr))	i.	Are the study participants selected using clear and appropriate inclusion/exclusion criteria?
	ii.	Are the outcome measures valid, reliable, and objectively assessed?
	iii.	Is the comparison group adequately described and matched where possible?
	iv.	Is the sample size sufficient to support the findings with statistical power?
	v.	Is the follow-up period appropriate and clearly reported (if applicable)?
	vi.	Are the statistical analyses appropriate to the study design and data type?
	vii.	Are the results presented clearly, with confidence intervals or effect sizes where relevant?
	viii.	Is there transparency in reporting, with no evidence of selective reporting or bias?
Quantitative descriptive (Qn (d))	i.	Are the research objectives or questions clearly stated and appropriate for a descriptive design?
	ii.	Is the sampling method clearly described and appropriate to the study population?
	iii.	Are the measurement instruments valid and reliable for capturing the required data?
	iv.	Are the data collection procedures clearly outlined and systematically applied?
	v.	Are the results presented clearly using appropriate descriptive statistics (e.g., frequencies, percentages, means)?
Mixed methods (MM)	i.	Is there a clear rationale for using a mixed methods approach to address the research objectives?
	ii.	Are both qualitative and quantitative components clearly described and appropriately integrated?
	iii.	Are the data collection and analysis procedures for both components rigorous and appropriate?
	iv.	Is there evidence of integration at the interpretation and discussion stage to generate comprehensive insights?

Source: Hong et al., 2018

Table 4: Result of Quality Assessment

Study	Research Design	QA1	QA2	QA3	QA4	QA5	Number Criteria Fulfilled	Inclusion in the Review
Abu Bakar and Kamaruzzaman (2023)	Qn(d)	/	/	C	/	/	4/5	/
Norazman et al. (2023)	Ql	/	/	/	/	/	5/5	/
Dzulkifli et al. (2021)	Ql	/	/	/	/	/	5/5	/
Razali et al. (2021)	Qn(d)	/	x	/	C	/	3/5	/
Hauashdh et al. (2020)	Ql	/	/	C	/	/	4/5	/
Kayan (2019)	Qn(d)	/	/	/	C	/	4/5	/
Au-Yong et al. (2019)	Qn(d)	/	/	/	/	/	5/5	/
Khalid et al. (2019)	Qn(d)	/	/	/	/	/	5/5	/
Mong et al. (2019)	Qn(d)	/	x	/	C	/	3/5	/
Kamaruzzaman et al. (2018)	Qn(d)	/	x	/	x	/	3/5	/
Au-Yong et al. (2017)	MM	/	/	/	/	/	5/5	/
Rahmat & Nawawi (2017)	Ql	x	x	x	x	x	0/5	x
Ali et al. (2016)	MM	/	/	/	/	/	5/5	/
Douglas (2016)	Qn(d)	x	/	/	C	/	3/5	/
Zawawi et al. (2016)	MM	/	/	/	/	/	4/5	/
Raja Mazlan & Mohammed (2015)	Qn(d)	/	/	/	/	/	5/5	/
Rani et al. (2015)	Qn(nr)	/	/	/	C	C	3/5	/
Myeda & Pitt (2014)	Ql	/	/	/	C	/	4/5	/
Adnan et al. (2012)	Ql	/	/	/	/	/	5/5	/

QA= Quality Assessment; QN (d)= Quantitative descriptive; QN (nr)= Quantitative non-randomised; QL= Qualitative; MM= Mixed Methods; C= Cannot tell

Source: Author

Of the 19 articles assessed, seven fulfilled all five requirements, seven fulfilled four of the five, and five satisfied only three. One article was excluded from further analysis as it did not satisfy the minimal quality criteria.

© 2026 by MIP

Data Extraction and Analysis

The remaining articles were then reviewed and analysed. Each article's important information was extracted, with particular emphasis on the research question. The review specifically focused on abstracts, results, and discussions of both primary and secondary empirical data. To facilitate synthesis, the data were systematically organised in tables.

A thematic analysis was conducted to identify important topics in green building maintenance practices for defect mitigation at UiTM. Thematic analysis, as described by Abu Samah et al. (2019) and Braun and Clarke (2019), involves identifying, categorising, and summarising common themes. Following the steps outlined by Kiger and Varpio (2020), the researchers repeatedly examined the dataset to gain familiarity and acquire important knowledge for later stages.

In the following stage, researchers created preliminary codes by systematically classifying the data according to recurrent patterns. Data relevant to the research questions were extracted following a careful analysis of the chosen papers. An inductive coding framework was used to identify patterns and connections in the coded material during the theme generating stage. These themes represented the entire dataset and were connected to the original data (Braun & Clarke, 2019).

The analysis produced four major themes and several subthemes. Two green building maintenance experts were consulted to validate the identified themes and subthemes in order to verify their reliability and relevance. Following their validation, four themes and ten subthemes were finalised for further study discussion.

RESULTS

General Background of the Selected Studies

Of the total 18 articles that were chosen, 11 of them, including Abu Bakar and Kamaruzzaman (2023), Razali et al. (2021), Au-Yong et al. (2019), Kayan (2019), Khalid et al. (2019), Mong et al. (2019), Kamaruzzaman et al. (2018), Douglas (2016), Mazlan and Mohammed (2015), Rani et al. (2015), and Myeda and Pitt (2014), focused on quantitative analyses of green building maintenance practices for defect mitigation at UiTM. Four articles, including Adnan et al. (2012), Mong et al. (2021), and Norazman et al. (2023), adopted qualitative analysis, while three applied mixed-method techniques.

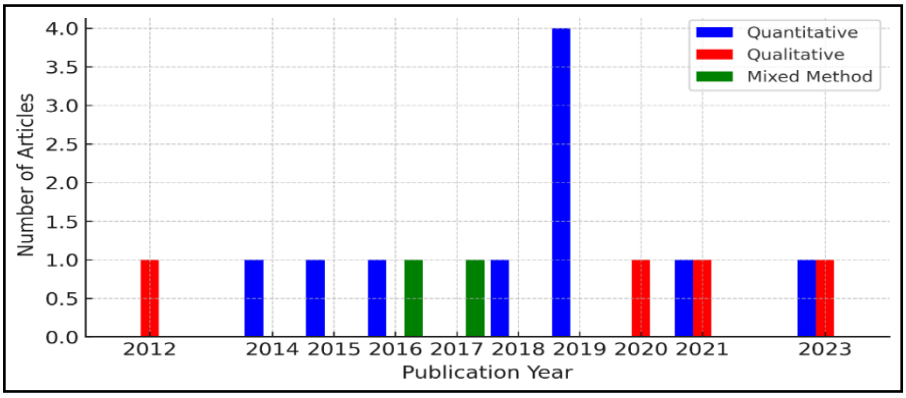


Figure 3: Publication Year and Number of Articles
Sources: Au-Yong et al. (2017); Chu et al. (2016); Zawawi et al. (2016)

The distribution of research designs across the 18 chosen papers on green building maintenance practices for defect mitigation at UiTM is shown in Figure 3. The studies are divided into three research approaches:

1. Quantitative research (Blue bars): This category evaluated many aspects of green building maintenance using statistical and numerical techniques. This category has 11 articles in total, with 2019 showing the highest focus, suggesting an important focus on quantitative analysis in that year's research.
2. Qualitative Research (Red bars): Four studies used qualitative approaches to fully investigate green building maintenance issues, mostly through the use of case studies, interviews, and thematic analyses. These studies were published across different years, with a minor increase in more recent publications.
3. Mixed-Method Research (Green bars): To get an improved understanding of green building maintenance practices, three studies combined qualitative and quantitative methodologies, including both descriptive and statistical analysis. Most of this research was released between 2016 and 2017.

Figure 3 shows that research on green building maintenance has increased noticeably over the past five years, with quantitative studies leading this trend. A comprehensive understanding of UiTM's defect mitigation measures is ensured by the inclusion of qualitative and mixed-method studies, which show how to investigate the problem from various perspectives.

© 2026 by MIP

Table 5: Selected Journals and Their Rankings

Journal Name	Article No.	Indexed by WoS	WoS Quartile	Indexed by Scopus	Scopus Quartile
Journal of Facilities Management	3	Yes	Q1	Yes	Q1
Sustainable Cities and Society	2	Yes	Q1	Yes	Q1
Building and Environment	2	Yes	Q1	Yes	Q1
Facilities	1	No	-	Yes	Q2
Journal of Building Engineering	3	Yes	Q1	Yes	Q1
International Journal of Building Pathology and Adaptation	2	No	-	Yes	Q2

*Last ranking before the journal was discontinued
Source: Author

The journals chosen for this study were evaluated according to their quartile rankings and Web of Science (WoS) and Scopus indexing, as shown in Table 5. Seven important journals were identified, with a particular focus on defect reduction and green building maintenance methods. With a quartile score of Q1, the Journal of Facilities Management, Sustainable Cities and Society, Building and Environment, and the Journal of Building Engineering were indexed in both WoS and Scopus, showing their excellent quality and impact in the field.

Meanwhile, the journal Facilities was not indexed in WoS, even though it was indexed as a Q2 journal in Scopus. Similarly, the International Journal of Building Pathology and Adaptation was excluded from WoS but had a Q2 ranking in Scopus. The choice of these publications ensures that the research is based on accurate data and provides robust and reliable insights into maintenance practices for green buildings. The chosen papers' scientific importance is further supported by their quartile rankings, which show their relevance in discussing defect mitigation practices in the context of UiTM.

The Developed Themes

A structured overview of the studies selected, according to their focus areas, Specifically, green building maintenance practices, defect mitigation approaches, and policy and regulatory compliance, are presented by the themes and subthemes listed in Table 6. The table shows the distribution of research efforts in addressing sustainable maintenance solutions and defect reduction in UiTM's built environment, highlighting each author's contributions to these key areas. All three themes are thoroughly addressed in studies such as those by Abu Bakar and

Kamaruzzaman (2023), Dzulkifli et al. (2021), and Khalid et al. (2019), indicating a thorough approach to green building maintenance and regulatory compliance. Other research, on the other hand, highlights different emphasis in the literature by focusing on either defect mitigation or maintenance procedures independently. In creating a systematic framework for green building maintenance at UiTM, this thematic classification makes it easier to understand research trends, gaps, and future directions.

Table 6: Themes and Subthemes Listed

Authors/ Theme	**Green Building Maintenance Practices**	**Defect Mitigation Strategies**	**Technology**	**Policy and Regulatory Compliance**	**Overall Rank**
Abu Bakar & Kamaruzzaman (2023)	√	√	√		2
Norazman et al. (2023)	√	√		√	3
Dzulkifli et al. (2021)	√	√	√	√	1
Razali et al. (2021)	√		√	√	4
Hauashdh et al. (2020)		√			5
Kayan (2019)	√	√			2
Au-Yong et al. (2019)	√	√			2
Khalid et al. (2019)	√	√	√	√	1

Sources: Author

Table 6 illustrates the thematic classification of the selected studies based on four key dimensions: green building maintenance practices, defect mitigation strategies, technological applications, and policy and regulatory compliance. The table highlights how each selected study contributes to one or more thematic areas, demonstrating the multidimensional nature of green building maintenance research.

This thematic mapping also helps identify research trends and gaps within the literature. While most studies emphasize maintenance practices and defect mitigation strategies, fewer studies focus on regulatory compliance and the integration of policies. This finding indicates the need for stronger alignment between institutional maintenance practices and national sustainability policies in the context of Malaysian higher education institutions.

© 2026 by MIP

Green Building Maintenance Practices

With 15 out of 18 articles addressing this theme, it was the most frequently discussed. Three subthemes were identified. 12 papers examined the first subtheme, which organised maintenance techniques designed for green buildings. The second subtheme, which is covered in nine articles, addresses ways to improve sustainability through preventive maintenance. 11 articles addressed the third subtheme, which highlights systematic green maintenance techniques aiming to mitigate environmental effects.

Defect Mitigation Strategies

13 of the 18 articles had this theme, which included three subthemes. Ten articles address the first subtheme, which focuses on predictive maintenance methods for identifying and correcting defects early. Seven articles cover the second subtheme, which is sensor-based monitoring for fault detection. Furthermore, eight papers address the third subtheme, which highlights the importance of quick reactions and routine inspections in avoiding serious defects.

Technology in Green Building Maintenance

11 of the 18 articles had this theme, which included three subthemes. The first subtheme, which has been examined in nine articles, focuses on how smart technologies, such as BIM and IoT, are utilised in building maintenance. Six articles address the second subtheme, which studies the use of digital platforms for reporting and scheduling maintenance. The use of machine learning and artificial intelligence for predictive maintenance in green buildings is the third subtheme, which is the subject of seven papers.

Policy and Regulatory Compliance

Ten of the 18 articles investigated this theme, which included three subthemes. Eight articles examined the first subtheme, which examines the compliance with national and international certified green building requirements. The second subtheme addresses how government rules influence maintenance policies and is covered in six articles. The enforcement approaches that guarantee compliance with sustainable maintenance practices are the focus of the third subtheme, which is discussed in seven articles. The long-term sustainability and regulatory compliance of green buildings in Malaysia are guaranteed by these themes, which offer a thorough review of green building maintenance practices and defect mitigation techniques.

© 2026 by MIP

DISCUSSION

The outcomes of the systematic literature study provided significant understanding on how Malaysian UiTM buildings, in particular, employ green building maintenance processes and defect mitigation techniques. According to the quality appraisal, seven studies fulfilled all five quality evaluation criteria, while only one study was removed for not meeting the minimum threshold. This indicates that the majority of the articles fulfilled methodological consistency, thereby reinforcing their reliability in providing a strong framework for maintaining green buildings.

Four primary themes emerged from the thematic analysis, including policy and regulatory compliance, technology in green building maintenance, defect mitigation measures, and green building maintenance practices. With 15 out of 18 research addressing the topic, green building maintenance practices were identified as the most common theme, highlighting the significance of structured maintenance frameworks for sustainability. There was extensive discussion on defect mitigation strategies, with research highlighting real-time monitoring systems and predictive maintenance methods as essential steps in defect prevention.

Additionally, 11 studies identified the use of technology in maintenance, specifically through digital tools such as BIM and IoT, indicating an increasing reliance on intelligent alternatives for effective building maintenance. Finally, ten studies highlighted the importance of strict adherence to government regulations and green building certification standards, highlighting policy and regulatory compliance as a key subject.

Overall, the reviewed studies support the claim that increasing green building sustainability and reducing building defects requires the implementation of structured maintenance procedures, the adoption of technology, and the enforcement of regulatory frameworks. The systematic selection and review of papers ensured that only high-quality research was included in the discussion, which enhanced the reliability of the findings.

Policy and Regulatory Implications for UiTM

Green building maintenance practices in Malaysian public universities are also influenced by several national policies and regulatory frameworks. In Malaysia, sustainability initiatives in the built environment are supported through policies such as the National Green Technology Policy, the Green Building Index (GBI) certification framework, and sustainability guidelines promoted by agencies such as the Construction Industry Development Board (CIDB) and the Public Works Department (JKR) (Ministry of Energy, Green Technology and Water, 2009; Green Building Index, 2020; CIDB, 2021). These policies encourage institutions to adopt environmentally responsible practices in building operation and

© 2026 by MIP

maintenance while improving long-term building performance and sustainability (Kamaruzzaman et al., 2018; Au-Yong et al., 2019).

For Universiti Teknologi MARA (UiTM), aligning maintenance strategies with these national sustainability policies can significantly improve building performance and reduce recurring building defects. For example, preventive maintenance planning, energy-efficient building operation, and the use of sustainable materials can help extend building life cycles while minimizing environmental impacts (Ali et al., 2016; Dzulkifli et al., 2021). Integrating these regulatory frameworks into institutional maintenance strategies also supports Malaysia's commitment to the Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production) (United Nations, 2015).

However, implementing green building maintenance practices at the university level may also present several challenges. One major challenge is financial limitation, as the adoption of advanced technologies such as IoT monitoring systems, BIM-based maintenance management, and predictive maintenance tools may require significant investment (Au-Yong et al., 2017; Khalid et al., 2019). In addition, institutional resistance to change and limited awareness among maintenance personnel may slow down the adoption of sustainable practices (Myeda & Pitt, 2014; Hauashdh et al., 2020).

Furthermore, large university campuses such as UiTM consist of numerous buildings with different ages, functions, and maintenance conditions. This complexity may complicate the standardization of green maintenance strategies across all facilities. Therefore, strong institutional commitment, proper training for facility management personnel, and strategic long-term planning are essential to ensure the successful implementation of green building maintenance practices (Kayan, 2019; Zawawi et al., 2016).

CONCLUSION

This systematic literature review highlights the significant role of green building maintenance practices in mitigating prominent building defects in Universiti Teknologi MARA (UiTM). The findings demonstrate that effective maintenance strategies, supported by technological integration and regulatory compliance, are essential in improving the sustainability and performance of university buildings.

Four major themes were identified through the thematic analysis, namely green building maintenance practices, defect mitigation strategies, technological integration, and policy and regulatory compliance. Among these themes, structured maintenance practices and proactive defect mitigation strategies were the most frequently discussed in the selected studies, indicating their importance in maintaining sustainable building performance.

The increasing use of digital technologies such as Building Information Modelling (BIM), Internet of Things (IoT), and predictive maintenance tools also highlights the potential of technology-driven solutions in improving maintenance efficiency and reducing operational risks in university facilities. These technologies can enhance early defect detection, improve maintenance planning, and support data-driven decision-making.

In the context of UiTM, implementing green building maintenance practices requires a comprehensive institutional approach. Preventive maintenance planning, technology adoption, and alignment with national sustainability policies are essential strategies to ensure effective building management. In addition, strengthening collaboration between facility management teams, sustainability experts, and institutional leadership can further support the successful implementation of green maintenance initiatives.

Despite these potential benefits, several challenges remain, including financial constraints, technological readiness, and the complexity of managing large campus facilities. Addressing these challenges requires long-term strategic planning, adequate resource allocation, and continuous capacity-building among maintenance personnel.

Overall, this study contributes to the growing body of knowledge on sustainable building maintenance by providing a structured overview of green building maintenance practices and their role in mitigating building defects in higher education institutions. The findings can serve as a reference for UiTM and other Malaysian universities in developing more sustainable and effective maintenance management strategies.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Universiti Teknologi MARA (UiTM) Perak Branch for its support and cooperation throughout this research. Special thanks are also extended to all individuals who generously contributed their time and assistance during the process. This study would not have been possible without their valuable support and commitment.

DISCLOSURE STATEMENT

The authors declare no conflict of interest related to this research.

REFERENCES

Abu Bakar, N. A., & Kamaruzzaman, S. N. (2023). Green building maintenance practices for defect mitigation: A case study in Malaysia. *Journal of Building Performance, 12*(1), 45–60.

Adnan, H., Yusuwan, N. M., & Baharuddin, H. E. (2012). Maintenance management of green buildings in Malaysia. *Procedia - Social and Behavioral Sciences, 65*, 1–7.

© 2026 by MIP

Ali, H., Ahmad, N., & Hassan, S. (2016). A mixed-method approach in assessing sustainable maintenance in Malaysian green buildings. *International Journal of Sustainable Construction Engineering and Technology, 7*(2), 12–25.

Ali, H., & Samad, R. (2022). Institutional challenges in building maintenance implementation. *Planning Malaysia, 20*(2), 45–56. https://doi.org/10.21837/pm.v20i2.1405

Au-Yong, C. P., Ali, A. S., & Ahmad, F. (2017). Predictive maintenance model for building facilities using mixed-method approaches. *Facilities, 35*(9/10), 546–559.

Au-Yong, C. P., Ali, A. S., & Ahmad, F. (2019). Green maintenance strategies for sustainable building performance. *Journal of Facilities Management, 17*(3), 270–285.

Chu, C. Y., Wong, P. Y., & Lee, T. W. (2016). A mixed-method study on green building maintenance strategies in Malaysia. *Building Research & Information, 44*(5), 405–420.

Construction Industry Development Board (CIDB). (2021). *Construction industry transformation programme (CITP) 2016–2025: Sustainability initiatives in the Malaysian construction industry*. CIDB Malaysia.

Douglas, J. (2016). Defect prevention in green buildings: A quantitative analysis. *Journal of Building Pathology and Adaptation, 34*(3), 280–295.

Dzulkifli, M. A., Rahman, S. A., & Hassan, H. (2021). A qualitative approach to green maintenance management in Malaysian universities. *Sustainable Cities and Society, 68*, 102780.

Green Building Index. (2020). *Green building index rating system for non-residential new construction (NRNC)*. Green Building Index Organisation.

Hauashdh, A. R., Rahmat, M. N., & Abdul Hadi, M. Y. (2020). The role of maintenance management in ensuring sustainable building performance. *Built Environment Journal, 17*(2), 65–80.

Kamaruzzaman, S. N., Lou, E. C. W., Zawawi, E. M. A., & Wong, P. F. (2018). Green maintenance practices for sustainable buildings: A Malaysian perspective. *Facilities, 36*(3/4), 168–181.

Kayan, B. (2019). A framework for green maintenance in Malaysian universities. *International Journal of Building Pathology and Adaptation, 37*(2), 112–130.

Khalid, R., Ismail, Z., & Jaafar, M. (2019). Assessing defect mitigation strategies in green buildings: A quantitative study. *Journal of Construction Engineering and Management, 145*(6), 1–15.

Ministry of Energy, Green Technology and Water. (2009). *National green technology policy*. Government of Malaysia.

Mohd, N. A. (2021). Strategic maintenance management in public facilities. *Planning Malaysia, 19*(4), 1–10. https://doi.org/10.21837/pm.v19i4.1261

Mong, S. W., Rahmat, I., & Zainal, S. M. (2019). Implementation of green maintenance in Malaysian higher education institutions. *Sustainability in Practice, 5*(4), 199–213.

Mong, S. W., Ismail, Z., & Rahman, S. A. (2021). A qualitative assessment of defect mitigation in green buildings. *Asian Journal of Sustainable Development, 8*(2), 60–75.

Myeda, N. E., & Pitt, M. (2014). Facilities management practice in Malaysia: Key issues and future direction. *Facilities, 32*(9/10), 512–523.

Rahmat, M. N., & Nawawi, A. H. (2017). The challenges of maintaining sustainable building performance in Malaysia. *Journal of Building Performance, 8*(1), 33–47.

Raja Mazlan, S., & Mohammed, A. A. (2015). Evolution of facilities management in Malaysia: A historical perspective. *Journal of Facilities Management, 13*(4), 345–361.

Rani, N. S., Ahmad, T., & Hassan, H. (2015). The transformation of maintenance management in Malaysian green buildings. *International Journal of Sustainable Development and Planning, 10*(2), 243–256.

Razali, N. A., Ali, H., & Jaafar, S. (2021). Green maintenance strategies and defect mitigation in Malaysian buildings. *Facilities Management Journal, 19*(3), 211–230.

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. United Nations.

Zawawi, E. M. A., Kamaruzzaman, S. N., & Lou, E. C. W. (2016). A mixed-method evaluation of sustainable maintenance in Malaysian buildings. *Building Research & Information, 44*(6), 543–558.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 252 – 269

INTEGRATING PASSIVE AND ACTIVE STRATEGIES: A CONCEPTUAL FRAMEWORK FOR BUILDING ENERGY EFFICIENCY IN HIGHER EDUCATION INSTITUTIONS

Mohd Mubarak Shamsuddin[1], Wan Norisma Wan Ismail[2], Fadli Arabi[3], Norsafiah Norazman[4]

[1,2,3]*Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA
[4]*School of Housing, Building and Planning,*
UNIVERSITI SAINS MALAYSIA

Abstract

Facility management in higher education institutions face the challenge of improving building energy efficiency due to the large size and high energy demand. In Malaysia, polytechnics confront additional challenges of operating on ageing building and limited operational budgets. Existing approaches in operation and maintenance and energy monitoring remain fragmented which hindering energy efficiency efforts. This paper introduces a proposed framework to measure building energy efficiency among Malaysian polytechnics using passive and active parameters while supported by technologies. Passive parameters include building orientation, natural ventilation, daylighting, and building envelope, while active parameters are HVAC and lighting systems. The framework is systematically strengthened by the adaptation of Technology-Organization-Environment framework, Six Sigma and Business Process Redesign principles. Research Methodology used is mixed method that combining questionnaire surveys and case studies of identified Malaysian polytechnics. Findings from this study will assist facility managers and policymakers to optimise energy monitoring protocols and drive operational decisions making towards sustainable facility management practices aligned with national and international goals.

Keywords: Building Energy Efficiency, Sustainable Facility Management, Higher Education Institutions, Energy Performance Framework, Passive and Active Strategies

[1] Corresponding author. Email: mubarakshamsuddin@gmail.com

INTRODUCTION

Background

The building sector represents one of the most massive energy consumers across the globe while substantially adding to both energy consumption rates and greenhouse gas emissions. Heating, cooling, ventilation, lighting and equipment usage make the operational phase of building lifecycles consume the most energy (Amaral et al., 2020). Malaysian polytechnics and other higher education institutions (HEIs) manage sophisticated building facilities which consume substantial energy resources and therefore sustainability requires a strong focus on energy efficiency in their facility management (FM) processes.

Malaysian public HEIs struggle to enhance energy performance because of outdated infrastructure combined with sporadic FM practices and traditional O&M methods (Dzulkifli et al., 2021). Global progress in digitalization and data-focused energy management practices has not yet reached many Malaysian polytechnics which continue to use reactive maintenance approaches that cause operational inefficiencies and higher costs alongside greater energy consumption. Due to the nation's dedication to sustainability through programs like the United Nations Sustainable Development Goals (SDGs) and Malaysia's Low Carbon City Framework (LCCF), it is critical to develop structured and innovative methods to improve building energy efficiency (UNDP, 2023).

Problem Statement

Different global frameworks and methods such as ISO 50001 (Energy Management Systems), Building Energy Index (BEI), and Building Information Modeling (BIM)-integrated energy performance monitoring serve as the basis for measuring building energy efficiency (Rahman, 2021). A standardized framework which addresses the unique institutional structures and resource constraints of Malaysian polytechnics remains undeveloped.

Malaysian polytechnics face several ongoing difficulties within their O&M practices which are:

- Lack of cohesive energy data management systems creates problems for energy use monitoring and optimization efforts.
- Reactive maintenance approaches create operational inefficiencies through postponed repairs and increased expenses.
- Digital integration remains inadequate because of the low adoption rate of technologies like BIM, IoT and automated energy management systems.
- Current energy efficiency policies remain disconnected from institutional FM strategies within their operational framework.

© 2026 by MIP

Thus, this research attempts to provide a conceptual framework incorporating passive and active energy systems alongside digital monitoring to aid energy efficiency enhancements in Malaysian polytechnics. Integrating technical interventions with organisational and technological aspects allows for this framework to assess buildings holistically. Hence, results from this study may add value towards sustainable facility management (SFM) and act as institutional energy management practices that may be implemented by HEIs.

Significance of the Study

This conceptual framework advances SFM through its support of Malaysian polytechnics as a case study whereby institutional needs should guide the creation of data-driven energy performance benchmarks. Predictive analytics and digital monitoring tools will empower Facility Managers with better decision-making capabilities. The framework also supports institutions in meeting the sustainability requirements according to ISO 50001 and Malaysia's National Energy Policy 2022-2040. In practical terms, it optimizes campus facilities by decreasing operational expenses and advancing environmental sustainability. This study develops a comprehensive approach to digital integration in facility energy management by adapting the Technology-Organization-Environment (TOE) Framework with Six Sigma and Business Process Redesign (BPR).

LITERATURE REVIEW

Energy Efficiency in Buildings

Sustainable facility management needs energy efficiency because it allows facilities to use less energy while maintaining necessary performance standards alongside comfort and productivity. According to Polat & Yıldırım, (2023), buildings worldwide account for 35% of energy usage while generating approximately 38% of carbon emissions which demonstrates their importance in reducing climate change impacts and operational expenses. The extensive use of buildings within Malaysian polytechnics and other HEIs heightens the need for energy-efficient practices to maintain sustainable operations.

Energy-efficient buildings bring multiple advantages which include minimized utility expenses and decreased greenhouse gas emissions along with better indoor environments that improve productivity according to Pandya et al. (2022). The implementation case becomes stronger when institutions comply with international standards such as ISO 50001, LEED and Green Building Index (GBI) (João Delgado et al., 2022). Research shows that passive design methods such as insulation and daylighting together with active systems like smart HVAC and LED lighting demonstrate international effectiveness (CK Tang & Nic Chin, 2017; Hossain et al., 2023). Building Management Systems (BMS), IoT sensors,

and AI-driven analytics provide modern capabilities for real-time monitoring and energy optimization.

Malaysian Polytechnics struggle with outdated infrastructure and face challenges in integrating digital systems and maintaining effective energy monitoring practices (Ismail, 2022). The SmartGreen PolyCC 2021–2026 framework provides several improvement strategies but standard policies and smart technology adoption show limited progress (JPPKK, 2020). Therefore, Malaysian Polytechnic institutions require a tailored framework to assess their energy efficiency levels.

Existing Methodologies in Measuring Building Energy Efficiency

Several frameworks measure building energy efficiency, each with distinct advantages and limitations. The Building Energy Index (BEI), widely used in Malaysia, quantifies annual energy consumption per square meter but overlooks climatic variables (Arjunan et al., 2019). ISO 50001 offers a structured energy management approach but suffers from financial and skills-related implementation gaps in local HEIs (Schützenhofer, 2021).

BIM presents a data-rich solution for modeling energy performance and predictive maintenance, with studies indicating potential energy savings of up to 30% (Cao et al., 2022). However, its adoption is hindered by high initial costs and technical demands. Similarly, frameworks like LEED v4.1 and MyCREST evaluate energy efficiency through sustainability scoring and systems assessments, though their applicability to Malaysian polytechnics remains partial.

These limitations call for a tailored conceptual framework specific to polytechnics, incorporating both passive and active design variables.

Theoretical Underpinning

Passive and Active Design

Effective energy-efficient building design requires combining passive strategies with active systems for optimal results. Passive methods leverage environmental factors to lower mechanical dependency whereas active systems utilize technological solutions to enhance performance.

According to CK Tang & Nic Chin (2017), passive design works to minimize thermal absorption while optimizing airflow and daylight access. Building orientation along the east-west axis serves to reduce solar exposure. The use of natural ventilation through design features such as cross-ventilation and operable windows minimizes the requirement for air conditioning systems. Cooling loads can be reduced by as much as 30% when shading systems such as overhangs and louvers are implemented (Shukla et al., 2023). Indoor heat transfer reduction benefits from insulation and material choices including reflective roofing materials and low-E glass (CK Tang & Nic Chin, 2017).

© 2026 by MIP

The Active Design approach incorporates high-efficiency HVAC systems and LED lighting technology. The integration of VRF systems and demand-controlled ventilation methods achieves optimal cooling performance (CK Tang et al., 2017). LED lighting retrofits and smart control systems with sensors achieve up to 60% energy reduction in lighting. Through real-time energy monitoring and automated adjustments enabled by BMS and IoT sensors buildings experience significant efficiency improvements (Tariq et al., 2024).

A robust energy management model for HEIs emerges from combining passive orientation and insulation with smart HVAC technology and renewable systems through an integrated strategy.

Technology-Organization-Environment (TOE) Framework

TOE by Tornatzky & Fleischer (1990), is a framework for understanding technology adoption based on three elements: technological, organizational, and environmental drivers. These forces consist of technological readiness (e.g., IoT, smart meters), organizational commitment (e.g., motivation, leadership, resources), and environmental pressures or incentives such as policies and regulations (Abdelalim et al., 2024; Ahmad et al., 2023). TOE has proven effective in assessing technology integration for energy management (Qin et al., 2020). It can be leveraged to identify several challenges and enablers for implementing energy efficiency practices and tools in Malaysian polytechnics.

Regarding technology, digital energy management such as Building Management Systems (BMS), Building Automation Systems (BAS), smart sensors, and Building Information Modelling (BIM) can serve as tools that facility managers could leverage to gain data-driven insights on their buildings' energy performance in real-time (Rahman, 2021).

Organizationally, leadership engagement, budget allocation, and facility managers' expertise could determine an institution's readiness and ability to manage energy efficiency practices. While externally, policies, rating systems, and benchmarking standards such as MyCREST and ISO 50001 may encourage institutions to implement specific energy management practices or enhance the SFM (Ahmad et al., 2023).

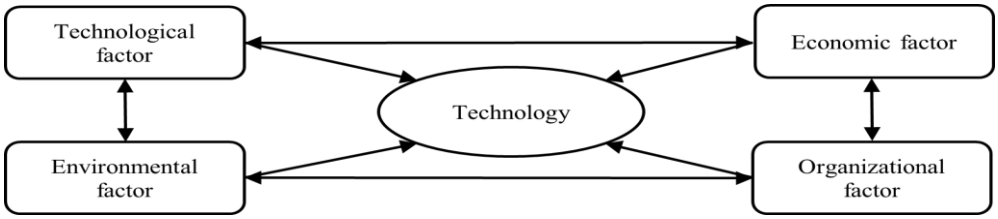


Figure 1: Improved TOE Framework
Source: (Qin et al., 2020)

Six Sigma

The Six Sigma methodology functions as an essential component in energy efficiency optimization through its systematic data-driven method which helps organizations detect inefficiencies and enhance operational processes. With the Define-Measure-Analyze-Improve-Control (DMAIC) process, Six Sigma offers organizations a systematic method to evaluate energy consumption patterns while removing waste and maintaining continuous performance monitoring (Monday, 2022). The application of Six Sigma methodologies to commercial buildings reveals up to 20% improvements in energy performance through real-time energy audits and predictive maintenance (Durdyev et al., 2021).

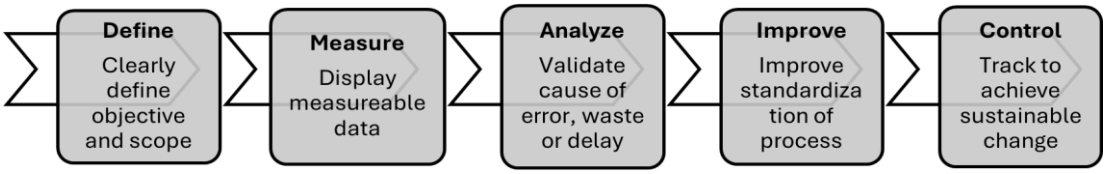


Figure 2: Define-Measure-Analyze-Improve-Control (DMAIC) process
Source: (Monday, 2022)

Business Process Redesign (BPR)

Business Process Redesign (BPR) prioritizes the re-engineering of existing Operations and Maintenance (O&M) processes to improve energy efficiency. BPR proves essential for facility management because existing energy monitoring methods struggle to integrate new digital technologies. BPR achieves successful implementation of energy efficiency strategies through streamlined energy audits and automated data collection, along with improved cross-departmental collaboration (Ezeh et al., 2024). Research shows that combining BPR with BIM and smart building technology eliminates manual inefficiencies and enhances facility operations, which results in considerable energy savings (Schützenhofer, 2021).

© 2026 by MIP

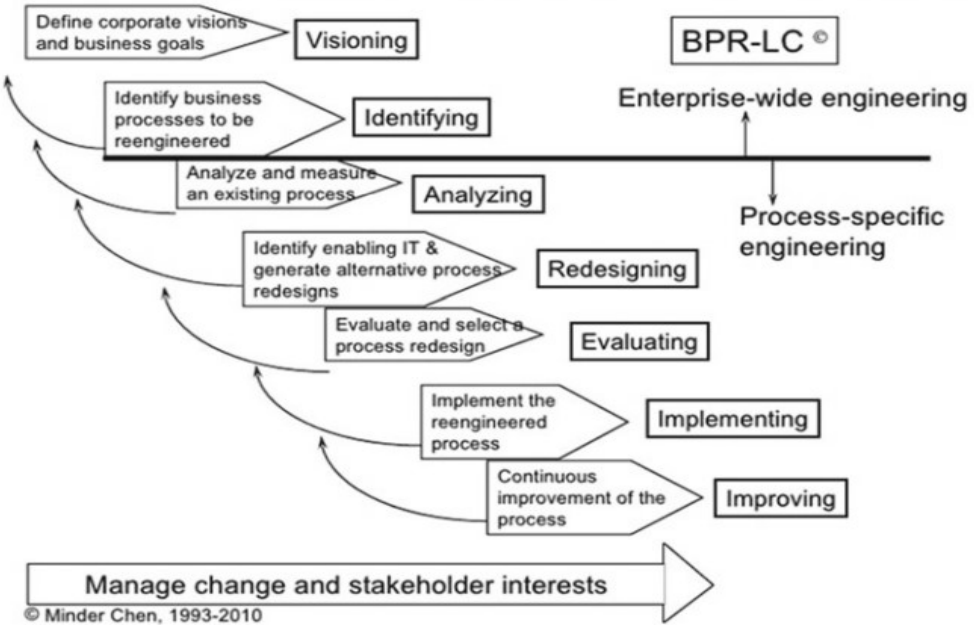


Figure 3: Business Process Redesign Lifecycle
Source: (Harika et al., 2021)

Challenges in Energy Efficiency Implementation

The implementation of energy efficiency in Malaysian polytechnics is challenged by technological limits as well as organizational and regulatory barriers. The initial expenses of smart systems including BIM and IoT surpass the financial limits of institutional budgets. The lack of infrastructure creates challenges for real-time monitoring and inadequate staff skills lead to less effective implementation. The energy efficiency standards such as MyCREST and GBI policies are not mandatory which restricts enforcement. The variations in climate and campus use patterns in Malaysia make the standardization of energy measures difficult which demonstrates the necessity for bespoke energy benchmarks.

RESEARCH METHODOLOGY

To obtain extensive information about energy efficiency in Malaysian polytechnics, researchers use a mixed methods approach. Structured questionnaires will be used to collect quantitative data about energy consumption patterns along with facility management techniques and energy-efficient technology adoption. The research will gain qualitative insights from case studies of chosen Malaysian polytechnic institutions, where facility managers will be

interviewed to reveal detailed operational realities around energy efficiency implementation (Mohamad Munir et al., 2023).

Survey results will be analysed using both descriptive and inferential statistics. Descriptive statistical tests, including averages, standard deviation, and frequency distributions, will be used to establish the current status of passive and active energy efficiency measures taken in the shortlisted institutions. Results from the descriptive analysis will provide insight into current practices on facilities management and energy conditions on-site. Inferential statistics will then be used to test the relationships between variables that have been identified in the conceptual framework. Correlation testing will be conducted to determine the associations between passive design measures, active systems, and building energy performance (Mohamad Munir et al., 2023). Regression tests will also be performed to understand the impact of selected variables towards energy efficiency.

Qualitative information gathered through interviews and site visits will be analysed thematically. Themes will be extracted to highlight common operational problems, technology trends, and institutional policies that directly or indirectly affect energy consumption issues. The mixed methods approach strengthens empirical framework validation by connecting it directly with theoretical foundations and verifying its practical use (Creswell & Creswell, 2018).

The case study institutions were chosen by campus age, size, and operations intensity throughout Malaysia's polytechnic campuses. Campus age was a major factor since many institution buildings in Malaysia are ageing, which can contribute to larger energy loads (Dzulkifli et al., 2021). Institution size and operations were considered since larger and more complex institutions tend to have longer operational hours and more facilities to maintain. Case studies may not be generalizable due to institutional differences, which can affect the results. Building age, maintenance budget, and technology could differ from one institution to another, affecting energy efficiency implementations. However, since the chosen case studies share the same function as an educational institution, they should be able to portray common operational conditions.

CONCEPTUAL FRAMEWORK DEVELOPMENT

The proposed framework utilizes the Building Energy Efficiency Technical Guideline (BSEEP) passive and active strategies and theoretical concepts from the Technology-Organization-Environment (TOE) Framework, Six Sigma, and Business Process Redesign (BPR) to establish a structured approach for assessing and improving energy performance within Malaysian polytechnic institutions. The conceptual framework segregates key variables into passive and active strategies which adhere to best practice standards set by the BSEEP guidelines.

© 2026 by MIP

Passive Design Variables

Passive design strategies serve as principal methods and as a first phase of measures for lowering energy demand by exploiting natural environmental factors. The BSEEP identifies essential passive design components as shown in table 1.

Table 3: Essential Passive Design Components

Component	Description
Building Orientation	The building orientation should be optimized to reduce heat gain from direct sunlight while maximizing natural ventilation. The correct east-west alignment of buildings decreases cooling requirements by restricting unnecessary solar radiation exposure.
Natural Ventilation	Design elements like cross-ventilation and stack ventilation alongside atrium spaces optimize airflow to reduce mechanical cooling dependency.
Daylighting	The design includes overhangs and louvers along with external shading devices and low-E glass to manage solar radiation which reduces heat entering the building but still allows enough daylight inside.
Building Envelope	High-reflectivity roofing materials and insulated walls together with green roofs improve insulation and regulate indoor temperatures to enhance thermal comfort.

Active Design Variables

Second phase of measures, active strategies concentrate on efficient energy usage through advanced technologies and automation while passive strategies aim to minimize energy demand. The key active design variables identify are as below:

Table 2: Essential Active Design Components

Component	Description
HVAC Systems	High-efficiency chillers and demand-controlled ventilation (DCV) systems work together with variable refrigerant flow (VRF) systems for optimized cooling performance, which leads to reduced energy waste.
Lighting Systems	Buildings switch to LED lighting solutions while implementing motion sensors and daylight harvesting controls to minimize wasted energy consumption.
Mediator (Third Phase of Measures)	
Building Automation System (BAS) and Building Management Systems (BMS)	IoT-enabled sensors and artificial intelligence alongside data analytics enable real-time energy monitoring to identify inefficiencies and enhance energy consumption optimization.

Relationships Between Variables

The conceptual framework achieves its effectiveness through the interplay of both passive and active design strategies and organizational and environmental conditions that affect energy performance outcomes.

Passive design elements have a direct effect on how active energy systems perform. A well-designed building orientation combined with daylighting systems minimizes indoor heat gain which leads to reduced cooling demand and better HVAC energy consumption efficiency. Natural ventilation systems contribute to reduced mechanical ventilation needs which leads to lower operational energy costs.

Active energy efficiency methods including smart lighting controls and energy-efficient HVAC systems support passive strategies through optimized and automated solutions that meet residual energy demands. Real-time monitoring through BAS and BMS technology strengthens energy management systems by tracking consumption patterns while spotting inefficiencies and supporting predictive maintenance operations.

The success of energy efficiency measures depends heavily on the organizational structure and environmental conditions which determine both their adoption and effectiveness. The execution of passive and active energy strategies depends on institutional policies alongside funding availability and staff expertise. The Green Building Index (GBI) from Malaysia and ISO 50001 regulations serve as external guidelines that influence energy efficiency projects in polytechnic institutions.

Integration with Existing Theories

The conceptual framework is built upon three key theoretical underpinnings: the Technology-Organization-Environment (TOE) Framework, Six Sigma and Business Process Redesign (BPR). The various theories support distinct elements of energy efficiency measurement and improvement.

The TOE Framework establishes a basis to study what drives energy efficiency adoption at polytechnic institutions. The technological aspect involves integrating smart energy monitoring systems together with IoT sensors and BIM-based energy modeling tools. The organizational aspect investigates institutional preparedness along with leadership dedication and the financial structures supporting energy efficiency programs. Energy management initiatives are driven by regulatory policies alongside sustainability trends and external pressures that fall under environmental considerations.

Six Sigma methodologies strengthen the framework through their data-oriented techniques which identify operational inefficiencies and enhance energy performance. Polytechnic institutions can methodically assess energy usage through the Define-Measure-Analyze-Improve-Control (DMAIC) process which

© 2026 by MIP

enables them to establish specific solutions and track ongoing advancements. HVAC system efficiency audits achieve better performance through Six Sigma principles which identify energy wastage areas to be optimized with data-based solutions.

Business Process Redesign (BPR) serves as a fundamental method for reorganizing the energy management processes within polytechnic organizations. Traditional facility management methods typically consist of maintenance practices that lack cohesion and focus on responding to problems after they occur. Business Process Redesign enables institutions to enhance their energy management by implementing predictive maintenance techniques and refining data collection methods while improving interdisciplinary decision-making processes. BPR combined with BIM and IoT technologies delivers energy efficiency processes that operate efficiently while being scalable and sustainable.

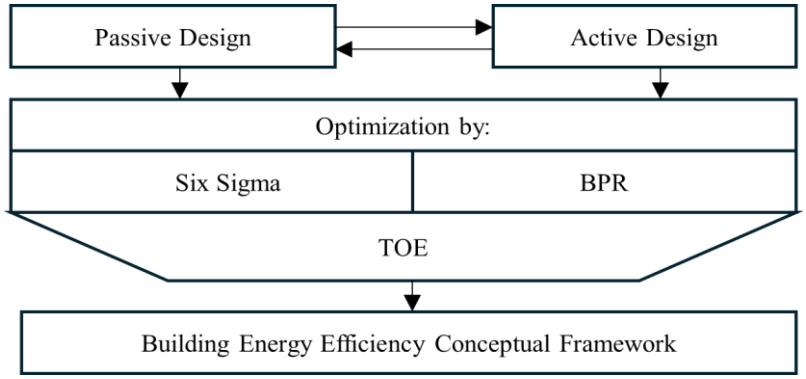


Figure 4: Utilisation of Theory Underpinning in Conceptual Framework

Validation Approach

The proposed conceptual framework requires a systematic validation process to maintain its reliability and applicability. Selected Malaysian polytechnic institutions will participate in expert reviews along with case studies and pilot implementations for validation purposes.

Expert reviews from facility managers, energy consultants, and sustainability professionals make up the first step of validation. The experts will analyse both the practical feasibility and potential challenges of the framework while suggesting areas for improvement. Feedback from experts will help modify the framework components to match real-world energy management practices.

The second step of validation will utilize case studies performed at multiple polytechnic institutions. The case studies will assess how well the framework works across multiple building types and varied climate conditions and operational environments. The framework's impact assessment will be

conducted by analysing key performance indicators such as energy consumption per square meter alongside HVAC efficiency.

The study will finally conduct pilot tests that utilize BIM-based energy simulations to evaluate passive and active strategies across different design scenarios. The simulations will deliver numerical evaluations of achievable energy savings and identify optimization opportunities.

The validation process demonstrates that the conceptual framework functions effectively in practice and can be adapted to different situations while delivering quantifiable building energy efficiency gains in Malaysian polytechnics.

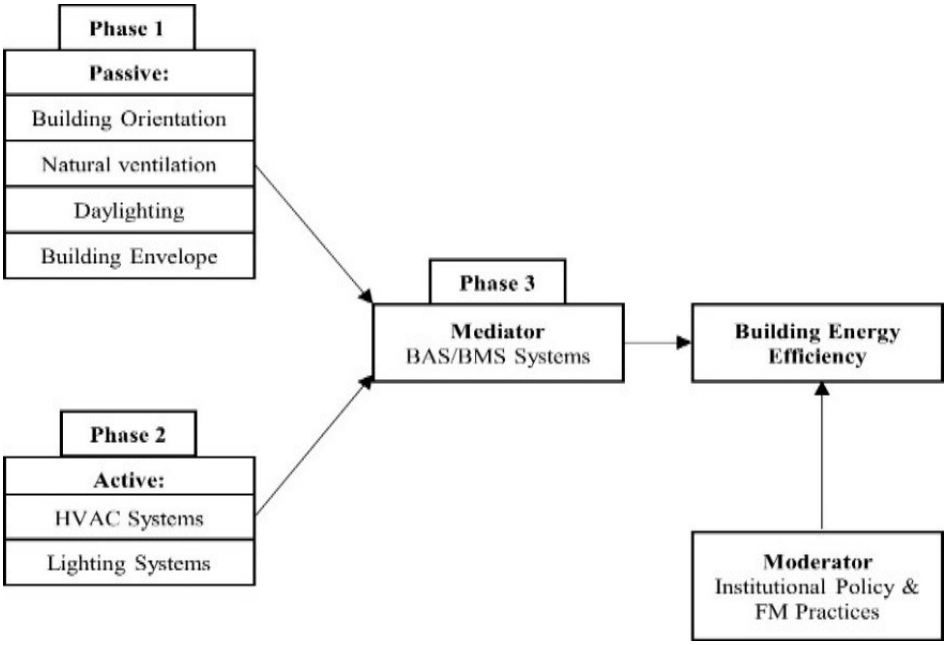


Figure 5: Conceptual Framework

ANALYSIS AND DISCUSSION

Findings Hypothesis

The validated conceptual framework which will be used to measure building energy efficiency in Malaysian polytechnics produced important findings about current energy efficiency practices alongside the role of passive and active strategies and digital tool integration in facility management. The main hypothesis from the research indicates that Malaysian polytechnic institutions are less energy efficient due to disjointed energy monitoring practices combined with reactive maintenance methods and minimal use of digital technology tools like

© 2026 by MIP

BIM and IoT. The case study analysis will demonstrate energy efficiency with structured energy policies and digital monitoring systems compared to other institutions that operate using conventional O&M practices.

The proposed framework will demonstrate high energy optimization effectiveness when combining passive and active strategies. Passive design methods including building orientation optimization together with increased insulation and effective shading can achieve cooling load reductions of up to 30% which decreases HVAC system dependency. Active systems like smart HVAC solutions and automated lighting technologies along with real-time energy tracking achieved a further 25–40% energy consumption reduction when correctly executed. The outcomes of this research will support the Building Sector Energy Efficiency Project (BSEEP) Technical Guidelines which highlight that long-term energy efficiency advancements in tropical climates depend on a comprehensive strategy.

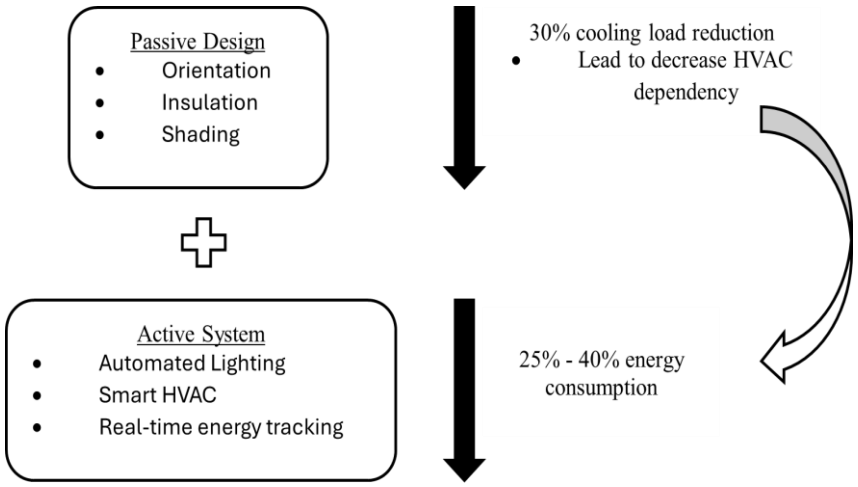


Figure 6: Cost Benefit Hypothesis

Through expert reviews and case studies, the framework's validation will show the critical need for structured energy management approaches. According to Gerarden et al. (2017), institutions use random methods to evaluate energy efficiency because there is no uniform methodology which results in varied performance outcomes. The proposed conceptual framework combines the TOE Framework, Six Sigma, and BPR principles to create a systematic data-based method for monitoring and improving energy consumption at higher education institutions.

Implications for Facility Management

The proposed conceptual framework's implementation has major consequences for facility managers, policymakers and energy consulting professionals within Malaysian higher education institutions. Facility managers will benefit from a standardized approach to energy assessment and monitoring that allows them to transition from reactive maintenance practices to predictive energy management techniques. By focusing on real-time energy tracking and data-driven decision-making while combining passive and active strategies, the framework enables facility managers to detect inefficiencies while improving energy performance and cutting operational costs.

The framework operates as a directional tool to assist policymakers in creating national policies and institutional strategies focused on energy efficiency within higher education buildings. The Low Carbon City Framework (LCCF), MyCREST and National Energy Policy 2022-2040 showcase Malaysia's dedication to sustainable practices which emphasize the importance of energy-efficient institutional buildings. This research provides valuable insights to shape policy recommendations concerning obligatory energy audits and digital infrastructure funding, along with rewards for institutions implementing smart energy management solutions.

Sustainability experts and energy consultants can utilize the framework to create tailored energy efficiency solutions that meet the distinct requirements of other educational institutions' facilities. Consultants who use predictive analytics along with AI-based energy monitoring systems guide institutions in creating strategic energy efficiency plans which meet global best practices and sustainability objectives.

The framework promotes teamwork between facility managers and academic administrators along with top management to jointly bring energy efficiency initiatives to successful completion in institutions. By adopting this comprehensive approach, institutions can make right decision making on energy awareness which produces enduring advantages for operational management and environmental protection.

Limitations and Future Work

The proposed conceptual framework provides a structured methodology for building energy efficiency measurement but requires acknowledgment of its existing limitations. Data availability and consistency remain the main challenge among the identified obstacles. The framework validation process relied on case studies from specific polytechnics and expanding the dataset to include more institutions would enhance the generalizability of the results. Subsequent studies need to assess how well the framework functions across various higher education environments by testing it in schools, universities and other technical colleges.

© 2026 by MIP

Advanced digital energy monitoring systems face implementation challenges due to financial limitations and technical constraints. Polytechnic institutions encounter budget constraints and human resource shortages which hinder their ability to deploy BIM, IoT, and AI-driven analytics technologies that optimize energy performance. Researchers should examine affordable digital transformation methods and search for government incentives that promote smart energy management system implementation in universities.

The framework targets administrative and academic buildings specifically within polytechnic institutions. The framework requires adaptation to include campus facilities like laboratories and dormitories, along with recreational centers since they exhibit distinct energy consumption patterns. Further investigation into user behaviour and climate variations, combined with energy consumption patterns will improve the framework's relevance.

Future research needs to focus on real-world pilot implementations where institutions fully adopt the framework into their facility management processes. Longitudinal studies tracking energy performance improvements would provide empirical evidence about the framework's effectiveness while guiding its future development.

CONCLUSION

The research outcomes identified the potential benefits of passive design considerations, active building systems and digital monitoring technologies to enhance energy performance in Malaysian polytechnics. The findings establish a framework that adopts the TOE model together with Six Sigma and BPR methodologies for assessing building energy performance that offers policymakers and industry professionals a structured approach to energy efficiency in building O&M. The framework could aid institutions in their budget considerations towards energy improvements and business operations decisions in the longer term. This research highlights applications such as BIM-based energy modelling and BMS platforms to aid decision making in cost-benefit analyses and optimizing maintenance budgets. To confirm the usability, the framework needs to be tested in a few buildings within the institutions. Additionally, future researchers should consider longer observation periods to confirm the cost savings realized from its implementation and examine barriers to technology adoption, particularly in resource-constrained contexts.

ACKNOWLEDGEMENT

This research was not funded by any grant.

DISCLOSURE STATEMENT

The author(s) received no financial support for the research, authorship, and publication of this article.

REFERENCES

Abdelalim, A. M., Essawy, A., Alnaser, A. A., Shibeika, A., & Sherif, A. (2024). Digital Trio: Integration of BIM–EIR–IoT for Facilities Management of Mega Construction Projects. *Sustainability (Switzerland)*, *16*(15). https://doi.org/10.3390/su16156348

Ahmad, I., Omar, S. S., Ali, M., & Ali, S. (2023). A Conceptual Study of TOE and Organisational performance. *18th European Conference on Innovation and Entrepreneurship, ECIE 2023*, 962–968.

Amaral, A. R., Rodrigues, E., Rodrigues Gaspar, A., & Gomes, Á. (2020). A review of empirical data of sustainability initiatives in university campus operations. *Journal of Cleaner Production*, *250*. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.119558

Arjunan, P., Poolla, K., & Miller, C. (2019). *EnergyStar++: Towards more accurate and explanatory building energy benchmarking*. https://doi.org/10.1016/j.apenergy.2020.115413

Cao, Y., Kamaruzzaman, S. N., & Aziz, N. M. (2022). Building Information Modeling (BIM) Capabilities in the Operation and Maintenance Phase of Green Buildings: A Systematic Review. In *Buildings* (Vol. 12, Number 6). MDPI. https://doi.org/10.3390/buildings12060830

CK Tang, & Nic Chin. (2017). *Building Energy Eficiency Technical Guideline for Passive Design*. Building Sector Energy Efficiency Project (BSEEP), Malaysia.

CK Tang, Nic Chin, Yeow Tow Guan, & Siwanand Misara. (2017). *Building Energy Eficiency Technical Guideline for Active Design* . Building Sector Energy Efficiency Project (BSEEP), Malaysia.

Creswell, J. W., & Creswell, D. J. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications.

Durdyev, S., Dehdasht, G., Mohandes, S. R., & Edwards, D. J. (2021). Review of the building information modelling (BIM) implementation in the context of building energy assessment. In *Energies* (Vol. 14, Number 24). MDPI. https://doi.org/10.3390/en14248487

Dzulkifli, N., Sarbini, N. N., Ibrahim, I. S., Abidin, N. I., Yahaya, F. M., & Nik Azizan, N. Z. (2021). Review on maintenance issues toward building maintenance management best practices. *Journal of Building Engineering*, *44*, 102985. https://doi.org/10.1016/J.JOBE.2021.102985

Ezeh, M., Heavens, A., Osinakachukwu Ezeh, M., Donatus Ogbu, A., Heavens Ikevuje, A., & Paul-Emeka George, E. (2024). The Role of Business Process Analysis and Re-engineering in Enhancing Energy Sector Efficiency. In *International Journal of Engineering Research and Development* (Vol. 20, Number 7). https://www.researchgate.net/publication/384264830

 © 2026 by MIP

Gerarden, T. D., Newell, R. G., & Stavins, R. N. (2017). Assessing the energy-efficiency gap. *Journal of Economic Literature*, *55*(4), 1486–1525. https://doi.org/10.1257/jel.20161360

Harika, A., Sunil Kumar, M., Anantha Natarajan, V., & Kallam, S. (2021). *Business Process Reengineering: Issues and Challenges* (pp. 363–382). https://doi.org/10.1007/978-981-15-6707-0_35

Hossain, J., Kadir, A. F. A., Hanafi, A. N., Shareef, H., Khatib, T., Baharin, K. A., & Sulaima, M. F. (2023). A Review on Optimal Energy Management in Commercial Buildings. In *Energies* (Vol. 16, Number 4). MDPI. https://doi.org/10.3390/en16041609

Ismail, Z. A. (2022). The requirements for maintenance management systems (MMS) at Malaysian polytechnic: a case study. *Journal of Quality in Maintenance Engineering*, *28*(4), 768–790. https://doi.org/10.1108/JQME-09-2020-0101

João Delgado, M., Duarte De Almeida, I., & Montagna, G. (2022). Sustainable Design Approaches Towards Green Higher Education Campus. *Human Dynamics and Design for the Development of Contemporary Societies*, *25*. https://doi.org/10.54941/ahfe1001387

JPPKK. (2020). *Blueprint SmartGreen PolyCC 2021-2026*. Jabatan Pendidikan Politeknik dan Kolej Komuniti (JPPKK).

Mohamad Munir, Z. H., Ahmad Ludin, N., Junedi, M. M., Ahmad Affandi, N. A., Ibrahim, M. A., & Mat Teridi, M. A. (2023). A Rational Plan of Energy Performance Contracting in an Educational Building: A Case Study. *Sustainability (Switzerland)* , *15*(2). https://doi.org/10.3390/su15021430

Monday, L. M. (2022). Define, Measure, Analyze, Improve, Control (DMAIC) Methodology as a Roadmap in Quality Improvement. *Global Journal on Quality and Safety in Healthcare*, *5*(2), 44–46. https://doi.org/10.36401/jqsh-22-x2

Pandya, C., Prajapati, S., & Gupta, R. (2022). Sustainable Energy Efficient Green Campuses: A Systematic Literature Review and Bibliometric Analysis. *IOP Conference Series: Earth and Environmental Science*, *1084*(1). https://doi.org/10.1088/1755-1315/1084/1/012016

Polat, H., & Yıldırım, M. (2023). *Sustainable and Energy Saving Model Research for Existing Housing Stocks; Field Study*. https://doi.org/10.20944/preprints202307.1693.v1

Qin, X., Shi, Y., Lyu, K., & Mo, Y. (2020). Using a tam-toe model to explore factors of building information modelling (Bim) adoption in the construction industry. *Journal of Civil Engineering and Management*, *26*(3), 259–277. https://doi.org/10.3846/jcem.2020.12176

Rahman, M. M. (2021). BIM Enabled Sustainable Facility Management. *International Journal of Integrated Engineering*, *13*(5), 101–107. https://doi.org/10.30880/ijie.2021.13.07.013

Schützenhofer, C. (2021). Overcoming the efficiency gap: energy management as a means for overcoming barriers to energy efficiency, empirical support in the case of Austrian large firms. *Energy Efficiency*, *14*(5). https://doi.org/10.1007/s12053-021-09954-z

Shukla, A. K., Yadav, A. K., & Prakash, R. (2023). Active and passive methods for cooling load reduction in a tropical building: A case study. *Energy Conversion*

and Management, *293*, 117490. https://doi.org/10.1016/J.ENCONMAN.2023.117490

Tariq, R., Mohammed, A., Alshibani, A., & Ramírez-Montoya, M. S. (2024). Complex artificial intelligence models for energy sustainability in educational buildings. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-65727-5

UNDP. (2023). *https://www.undp.org/sustainable-development-goals*. United Nations Development Programme.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 270 – 288

VIRTUAL VISIONS FOR TANGIBLE TREASURES: A BIBLIOMETRIC ANALYSIS OF EXTENDED REALITY'S ROLE IN URBAN HERITAGE SAFEGUARDING

Noor Farhana Alias[1], Nurul Syala Abdul Latip[2], Noor Hayati Ismail[3], Osama Elrawi[4]

[1,2,3]*Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA
[4]*Faculty of Engineering,*
AL-AZHAR UNIVERSITY, EGYPT

Abstract

This paper presents a bibliometric analysis of published research on Extended Reality (XR), encompassing Virtual Reality, Augmented Reality, and Mixed Reality, in the field of urban heritage preservation. The study maps research trends, key contributors, geographical distribution, thematic clusters, and collaboration patterns within this emerging interdisciplinary domain. The findings indicate substantial growth in XR related heritage studies between 2020 and 2024, reflecting increasing scholarly attention to immersive technologies in conservation, interpretation, and public engagement. The analysis further shows that research output is dominated by a limited number of countries and authors, while Malaysia remains an emerging contributor. Thematic clustering reveals that current scholarship extends beyond technological experimentation to include educational applications, human centered design, and heritage interpretation. These findings suggest strong potential for XR to support urban heritage safeguarding in Malaysia through context sensitive innovation, strategic collaboration, and improved institutional support. The study contributes a structured overview of the field and offers practical insights for policymakers, researchers, and heritage practitioners seeking to strengthen digitally enabled preservation strategies.

***Keywords**:* Extended reality; Virtual reality; Augmented reality; Heritage preservation; Urban conservation; Bibliometric analysis; Cultural heritage; Digital technologies

[1] Corresponding author. Email: noorfarhana2483@gmail.com

INTRODUCTION

Extended Reality (XR) technology includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). It creates immersive experiences by blending physical and digital environments. The global XR market is growing rapidly from US$33.8 billion in 2021 to an expected US$125.2 billion by 2026. This growth spans various sectors including education, healthcare, entertainment, and cultural heritage.

In Malaysia, the adoption of XR technology has gained considerable momentum, driven by government policies such as the Malaysia Digital Economy Blueprint and the National Policy on Industry 4.0. Educational institutions across Malaysia have established dedicated XR laboratories and research centers to develop local expertise and innovation capacity in immersive technologies. Despite growing interest and investment, XR applications in Malaysia remain predominantly concentrated in the entertainment, education, and manufacturing sectors. Conversely, cultural heritage applications represent an emerging but still underdeveloped domain. They have specifically identified XR technologies as key enablers for enhancing tourism experiences through the digitalization of cultural assets, creating opportunities for innovative approaches to heritage preservation. Notably, Universiti Sains Islam Malaysia (USIM) has launched initiatives exploring XR for the preservation of Islamic architectural heritage. On the other hand, immersive XR experiences have been piloted in George Town's Armenian Street and Melaka's Stadthuys area to preserve colonial-era architecture and enhance digital tourist engagement. These efforts, although still emerging, reflect a growing recognition of XR's role in preserving Malaysian culture.

Urban heritage preservation is an emerging application area for XR technologies in Malaysia, where rapid urbanization poses a threat to the sustainability of historical sites and cultural landmarks (Hassan & Ismail, 2024). XR offers potential solutions for documenting, preserving, and demonstrating urban heritage by creating digital twins, enabling virtual reconstructions of degraded structures. It also provides immersive educational experiences that foster cultural appreciation and understanding. Recent initiatives in Malaysian, United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites, such as Melaka and George Town, have demonstrated XR's capacity to enhance conservation efforts while also improving accessibility and tourism engagement. However, implementation challenges persist, including technical limitations, cost barriers, and the need for specialized expertise to develop culturally accurate and contextually relevant XR experiences. This bibliometric analysis aims to systematically map the research landscape of XR technologies in urban heritage preservation, with particular focus on Malaysian applications, to identify key trends, research clusters, and opportunities for future

© 2026 by MIP

development. For example, the George Town World Heritage Incorporated (GTWHI) has expressed interest in leveraging immersive storytelling and XR-based interpretation to attract younger audiences. In this regard, such local applications validate the relevance of the global trends identified in this bibliometric analysis.

Recent scholarship demonstrates that XR is increasingly used in heritage documentation, digital reconstruction, interpretation, museum mediation, and immersive learning. International studies highlight the ability of XR technologies to visualize inaccessible environments, reconstruct lost or damaged heritage elements, and improve public understanding of cultural assets. However, this literature remains uneven in geographic and institutional distribution, with stronger representation from technologically advanced contexts that benefit from greater financial support, digital infrastructure, and specialist expertise. Consequently, less attention has been devoted to how XR can be meaningfully implemented in developing countries where heritage documentation systems, institutional coordination, technical readiness, and conservation priorities may differ significantly. This gap is important in the Malaysian context, where urban heritage sites such as George Town and Melaka face increasing pressure from tourism, urban change, and long term preservation demands. Situating Malaysia within these broader international developments helps clarify both the relevance of XR and the need for context specific adaptation.

Theoretical Framing of XR in Urban Heritage Preservation

This study is guided by a conceptual framing of XR in urban heritage preservation in Figure 1. First, the technological dimension considers XR as a medium for documentation, simulation, visualization, and interactive access to heritage environments. Second, the cultural dimension emphasizes that digital heritage technologies must support authenticity, contextual interpretation, and the safeguarding of heritage values rather than merely producing visually attractive representations. Third, the educational dimension highlights the role of XR in immersive learning, accessibility enhancement, and public engagement. Together, these dimensions provide an interpretive lens for understanding why XR research in heritage preservation increasingly spans technical innovation, cultural meaning, and human experience. This framing also helps explain why the relevance of XR in Malaysia depends not only on the availability of technology, but also on institutional readiness, cultural appropriateness, and educational value.

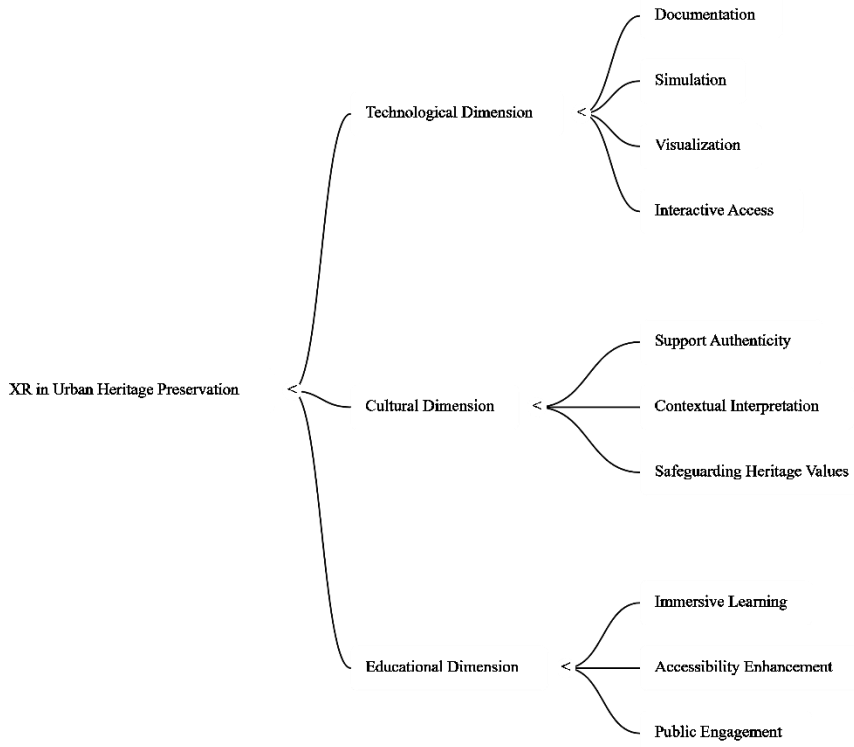


Figure 1: The three core dimensions of the theoretical framing of XR in urban heritage preservation: technological, cultural and educational

RESEARCH QUESTION

The main questions and objectives, along with the envisioned deliverables and target audience, inform the data discovery, collection, and presentation methods in any review. This document explores multiple questions to determine their findings.

- What are the research trends in XR technology according to the year of publication?
- Who are the key authors advancing XR research in heritage preservation?
- How is XR heritage research distributed across countries and regions?
- What are the main thematic clusters in XR applications for heritage?
- How do researchers and countries collaborate in XR heritage studies?

© 2026 by MIP

METHODOLOGY

Bibliometrics refers to the synthesis, management, and analysis of bibliographic data derived from scientific publications (De Sousa et al., 2024). In addition to standard descriptive data, such as publishing journals, publication year, and primary author categorization (Langlais, 2023), it also encompasses sophisticated methodologies, including document co-citation analysis. An iterative sequence of selecting appropriate keywords, conducting a literature search, and analyzing the results is essential for conducting a thorough literature review, constructing a comprehensive bibliography, and generating trustworthy findings (Costa et al., 2023). Furthermore, this section encompasses the adoption of search terms, preliminary screening of search results, and refining of search results. Journals that indicate Moreover, to ensure the incorporation of premier publications, only papers published in rigorously peer-reviewed and high-caliber academic journals were selected, excluding books and conference proceedings (Costa et al., 2023). Although Scopus encompasses a vast array of journals, its impact is limited to recent publications (Tennant, 2020). Articles from the Social Science Citation Index (SSCI), Science Citation Index Expanded, and Arts and Humanities Citation Index, spanning from 2020 to December 2025, were examined for analysis.

Data Search Strategy

Study employed a screening sequence to determine the search terms for article retrieval. Study was initiated by querying Scopus database with online TITLE-ABS-KEY (extended AND reality AND technology) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p") OR LIMIT-TO (SRCTYPE , "b")) AND (EXCLUDE (DOCTYPE , "er") OR EXCLUDE (DOCTYPE , "tb") OR EXCLUDE (DOCTYPE , "no") OR EXCLUDE (DOCTYPE , "le") OR EXCLUDE (DOCTYPE , "ed")) AND (EXCLUDE (SUBJAREA , "VETE")), thereby assembling 4,334 articles. Afterwards, the query string was revised so that the search terms "extended reality technology" OR "XR technology" should focus on urban heritage preservation. This process yielded 3,248 results, which were further scrutinized to include only research articles in English, and article reviews were also excluded. The final search string refinement included 2,885 articles, which were used for bibliometric analysis. As of December 2025, all articles from the Scopus database relating to XR technology and focusing on heritage preservation were incorporated into the study.

Researchers who perform bibliometric analysis typically focus on specific date ranges, which help detect modern trends alongside relevant and manageable bibliographic data (İri & Ünal, 2024). The 2020-2025 period fulfills three key strategic roles by emphasizing modern XR advancements and rapid

technological adoption, while maintaining sufficient data points (2,885 articles) to prevent excessive inclusion of outdated sources. The recency filter enables researchers to identify top institutions and authors, as well as their advanced XR applications in heritage contexts (Herlina et al., 2024). Research progress from 4,334 articles was narrowed down to 2,885 scholarly works through language, subject domain, typing, and research type filters.

Data Analysis

The analysis utilized PlainText format data sets that included the study publication year, publication title, author name, journal, citation, and keywords. These data were extracted from the Scopus database between 2020 and December 2025 using VOSviewer software version 1.6.15. The VOS clustering method, in combination with mapping techniques, was the primary functionality of this software during map generation and data analysis. Furthermore, VOSviewer serves as an alternative to the Multidimensional Scaling (MDS) approach (Van Eck and Waltman, 2010). Both methods share the same goal of positioning items in low-dimensional spaces to accurately represent item similarity through distance measurements between them (Appio et al., 2014). According to Van Eck and Waltman (2010), the normalization of co-occurrence frequency calculation in VOS differs from M, which focuses on computing similarity measures through Jaccard indexes and cosine similarity.

$$ASij \text{ ¼ } Cij$$
$$Wiwj.$$

The measure exists as "the ratio between on the one hand co-occurrent frequencies of observations i and j and on the other hand co-occurrence frequencies i and j under independence" (Van Eck & Waltman, 2010). Using this index, VOSviewer transforms data into a map by applying weighted sum reduction on all item pair distances. It implemented LinLog/modularity normalization (Appio et al., 2014). Additionally, the analytical techniques provided by VOSviewer generated visual outputs from the mathematical patterns within the data, enabling the execution of keyword co-occurrence, citation, and co-citation analysis reports (Dubey et al., 2023).

During specific periods, researchers have successfully employed keyword co-occurrence analysis to study the dynamics of field development as described by Dubey et al. (2023). The evaluation of cited works through citation analysis helps identify essential research problems and technical patterns, as well as a history of discipline-specific topics (İri & Ünal, 2024). Notably, the regularly used bibliometric method, known as document co-citation (Robledo-Giraldo et

© 2026 by MIP

al., 2023; Rossini, 2024), follows principles of network theory and decipher relevant data structures through its mapping process (Rossini, 2024).

FINDINGS

1. What are the research trends in XR technology according to the year of publication?

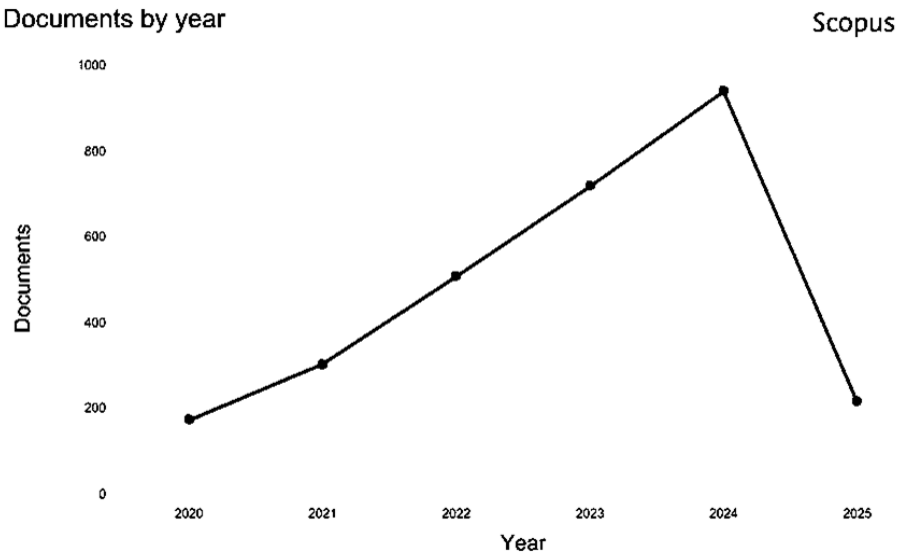


Figure 2: Trend of research in extended reality technology by years
Source: Scopus

The bibliometric data presented in Figure 2 illustrates a clear trend in publications on XR technology research in urban heritage preservation from 2020 to 2025. The line graph in Figure 1 depicts a consistent and significant upward trajectory in publication volume from 2020 to 2024, followed by a sharp decline in 2025. Starting with just 170 publications in 2020, the field experienced steady growth with 300 publications in 2021, 505 in 2022, and 716 in 2023. The research output peaked dramatically in 2024 with 937 publications, representing a 452% increase from the 2020 baseline.

However, 2025 demonstrates a substantial drop to only 213 publications. This decline may be explained by several factors: the data collection may have occurred early in 2025 (capturing only a partial year), there could be indexing delays in the Scopus database, or possibly a genuine decline in research interest.

Furthermore, the overall pattern suggests that XR technology in heritage preservation experienced rapid growth and mainstream research adoption through 2024, potentially reaching market saturation or research maturity before the apparent decline. Hence, this publication trajectory aligns with typical technology adoption curves, where initial enthusiasm leads to a peak in research output, followed by stabilization or decline as the technology becomes established and matures. This growth trend indicates that XR has become an increasingly important research area in heritage studies, although the relatively limited Malaysian contribution suggests a need for stronger local research investment.

2. Who are the key authors advancing XR research in heritage preservation?

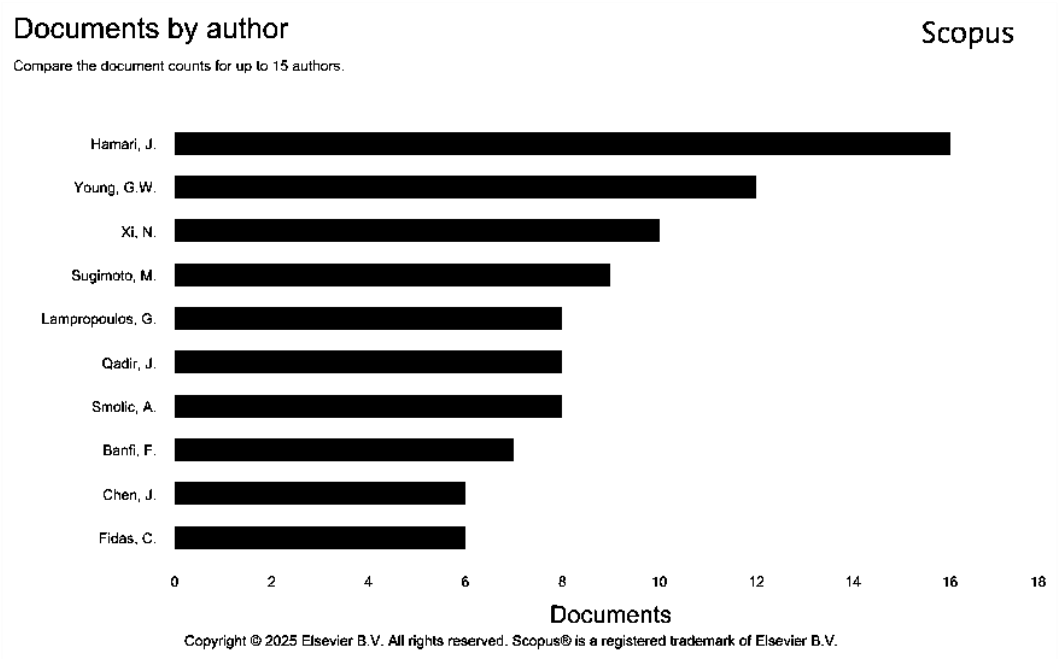


Figure 3: Top authors
Source: Scopus

The bibliometric analysis, as illustrated in the horizontal bar chart in Figure 3, displays the publication productivity of the top authors in the field of XR technology for urban heritage preservation. The data reveals a clear hierarchy in research output, with Hamari, J. leading significantly with 16 publications, establishing this researcher as the dominant contributor to the field. In comparison, Young, G.W. follows with 12 publications, while Xi, N. has

© 2026 by MIP

produced 10 documents. The middle tier of prolific authors includes Sugimoto, M., with 9 publications, followed by three researchers (Lampropoulos, G., Qadir, J., and Smolic, A.) who have each contributed 8 documents. Finally, Banti, F. rounds out the top tier with 7 publications.

Notably, the visualization displays only 8 of the possible 15 authors mentioned in the chart's subtitle, suggesting these represent the most productive researchers in this specific domain. This concentration of publications among a relatively small group of authors indicates that the field has established expertise clusters. Moreover, Hamari's substantial lead (33% more publications than the second-most productive author) suggests potential thought leadership or pioneering work in applying XR technologies to heritage preservation contexts. The concentration of highly productive authors indicates that the field is shaped by a relatively small set of knowledge leaders, creating opportunities for emerging scholars to build strategic collaborations.

3. How is XR heritage research distributed across countries and regions?

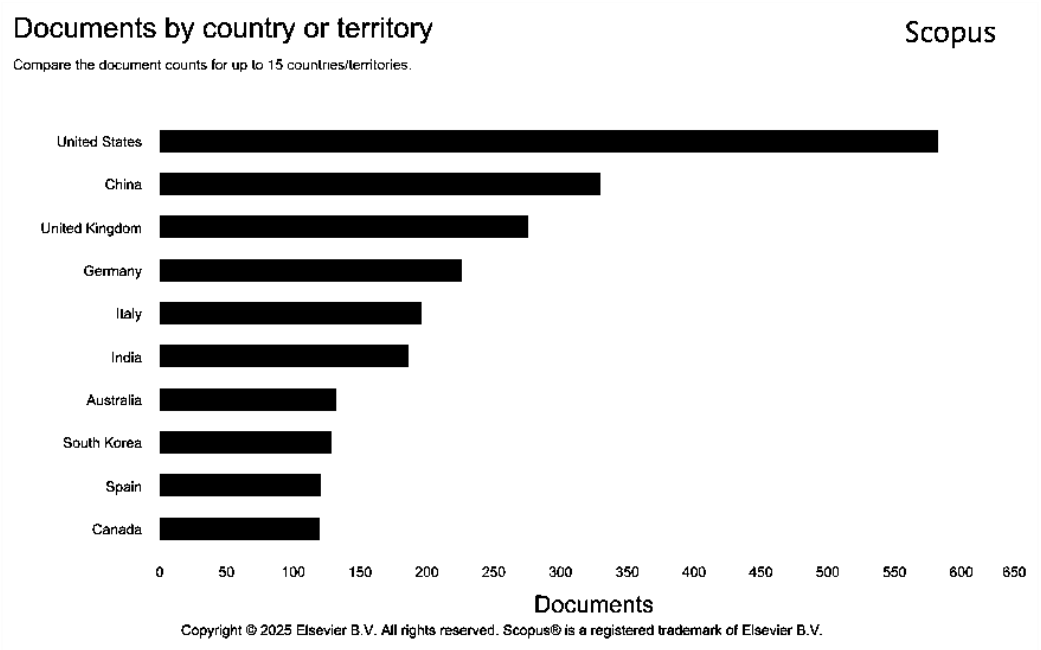


Figure 4: Geographical distribution of publications
Source: Scopus

The bibliometric data presented in both the horizontal bar chart in Figure 4 and accompanying Table 1 illustrate the geographical distribution of

research publications on XR technology for heritage preservation across countries. The United States dominates the research landscape with 583 documents, almost twice the output of the second-ranked country, China, which contributed 330 publications. In comparison, the United Kingdom follows in third position with 276 documents, while Germany (226) and Italy (196) round out the top five countries. At the same time, the middle tier of contributing nations includes India (186), Australia (132), and South Korea (129), while Spain (121) and Canada (120) complete the top ten with nearly identical outputs.

Table 1: Geographical distribution of publications by country/ territory

Country/Territory	Documents
United States	583
China	330
United Kingdom	276
Germany	226
Italy	196
India	186
Australia	132
South Korea	129
Spain	121
Canada	120

Source: Scopus

Consequently, this distribution reveals a clear Western dominance in the field, particularly from North America and Europe, which collectively account for six of the top ten positions. However, the significant presence of Asian countries (China, India, and South Korea) indicates that research in XR technology for heritage preservation has global reach. Furthermore, the substantial gap between the United States and other countries suggests that it may have earlier adoption and greater funding resources. It may also indicate a more established research infrastructure in this interdisciplinary domain, where technology intersects with the preservation of cultural heritage. These thematic clusters suggest that XR research in heritage preservation is no longer limited to technical experimentation but increasingly addresses education, interpretation and human centered experience.

© 2026 by MIP

4. What are the main thematic clusters in XR applications for heritage?
5.

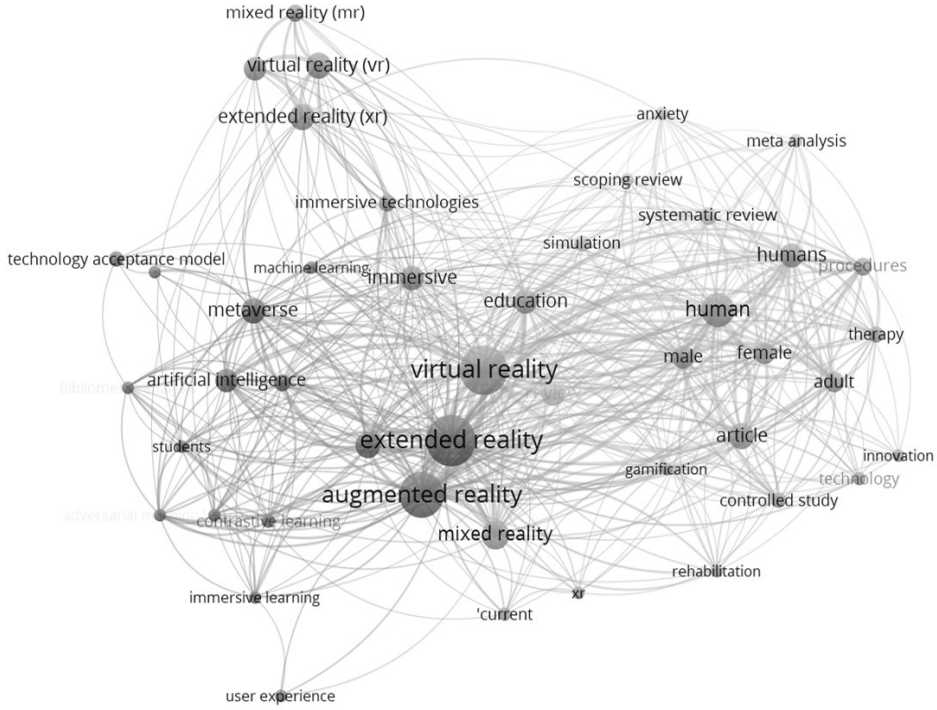


Figure 5: Cluster 1 themes
Source: VOSviewer

The network visualization presents a keyword co-occurrence cluster analysis of research related to XR technology in heritage preservation. The diagram reveals five distinct thematic clusters differentiated by color. To begin with, the red cluster centers on technological foundations, connecting "extended reality," "augmented reality," "metaverse," and "artificial intelligence" with educational applications such as "constructive learning" and "students." In contrast, the green cluster focuses on human elements and impact, linking "human," "therapy," "rehabilitation," and demographic factors like "male," "female," and "adult." Conversely, the blue cluster represents core XR technologies, demonstrating relationships between "mixed reality," "virtual reality," and "immersive" applications. The yellow cluster, on the other hand, emphasizes research methodologies and assessment, connecting terms such as "systematic review," "meta-analysis," "anxiety," and "simulation." Finally, the purple cluster appears to highlight current trends in mixed reality applications. The size of nodes corresponds to keyword frequency, with "extended reality,"

"virtual reality," and "augmented reality" being most prominent, indicating their centrality to the research domain. Hence, the dense interconnections between clusters suggest a highly interdisciplinary field. Technological innovations are closely tied to human factors, educational applications, and rigorous research methodologies, collectively advancing XR applications in heritage preservation contexts.

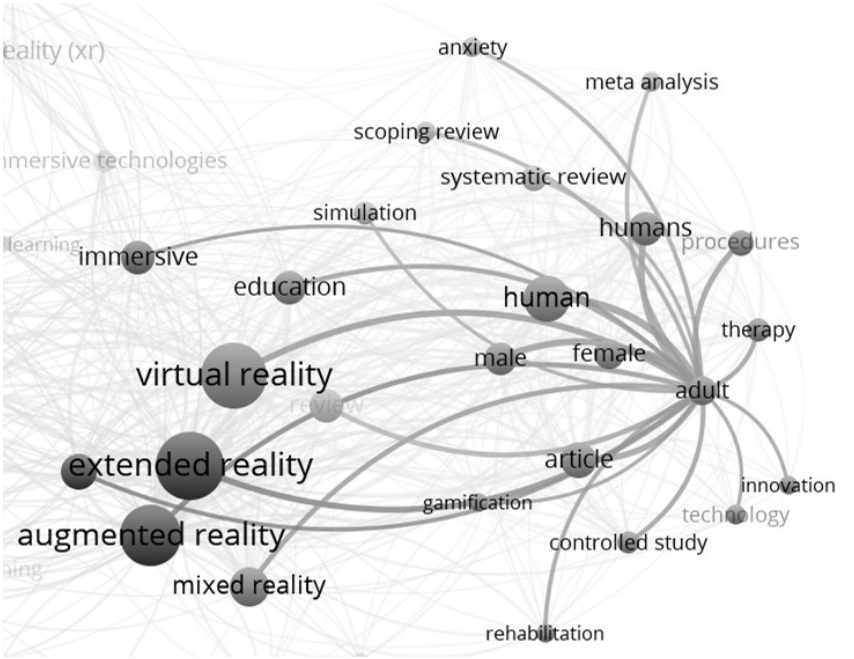


Figure 6: Cluster 2 themes
Source: VOSviewer

The network visualization in Figure 6: Cluster 2 themes provides an advanced view of how research keywords related to XR technology in heritage preservation studies are interconnected. In particular, the cluster analysis provides different thematic clusters through its use of color differentiation. XR technology dominates the field through its key components, which are displayed through the dense red central cluster. The human-centered research focus, which encompasses "human" with "therapy," "rehabilitation," "innovation," and demographic factors, is represented as a green cluster positioned on the right side. The blue nodes at the top represent technological base elements, which include the term "immersive" and various links to reality technology. Moreover, research evaluation methodologies establish systematic connections with applied educational applications and simulation applications, which are represented in the yellow cluster. Research conducted in XR technology is presented within a visual

© 2026 by MIP

framework that demonstrates how researchers undertake comprehensive investigations through strong academic connections between technical applications and human factors. Notably, it also highlights the connection between educational applications and evidence-based assessment approaches. Research involving multiple disciplines demonstrates that linking nearby research clusters facilitates the development of XR technology for heritage preservation, advancing innovative practices.

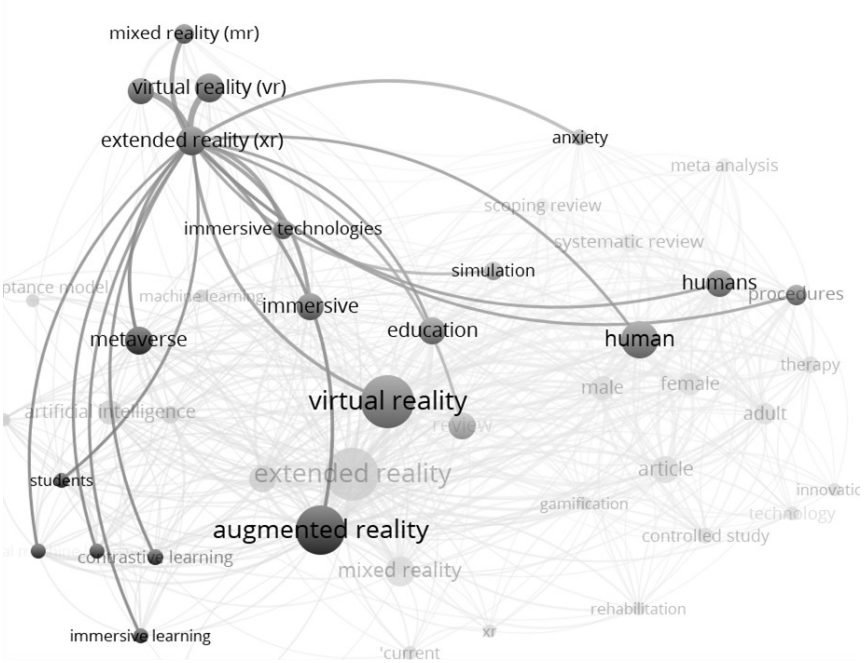


Figure 7: Cluster 3 themes
Source: VOSviewer

This network visualization illustrates the keyword co-occurrence relationships in XR technology research for heritage preservation, organized into thematic clusters. The blue cluster at the top represents fundamental XR technologies, connecting "mixed reality," "virtual reality," and "extended reality" with "immersive technologies" and "immersive" applications. On the other hand, the red cluster on the left links advanced technological concepts, such as "metaverse" and "artificial intelligence," with educational applications including "constructive learning," "immersive learning," and "students," suggesting research focused on innovative teaching approaches. The yellow and purple central area highlights the core reality technologies ("virtual reality," "augmented

reality," "mixed reality") as bridging concepts that connect multiple research domains.

In contrast, the green cluster on the right emphasizes human-centered research, connecting the terms "human" and "humans" with demographic factors and concepts such as "anxiety" and "simulation." The size of the nodes indicates term frequency in the literature, with larger nodes representing concepts that are more commonly researched. Furthermore, the connections between clusters reveal how XR technologies in heritage preservation integrate technological innovation with human factors and educational applications, demonstrating the field's interdisciplinary nature. Overall, the visualization suggests that while specific technologies form distinct research areas, they ultimately converge around applications that enhance human interaction with cultural heritage. These thematic clusters suggest that XR research in heritage preservation is no longer limited to technical experimentation but increasingly addresses education, interpretation and human centered experience.

6. How do researchers and countries collaborate in XR heritage studies?

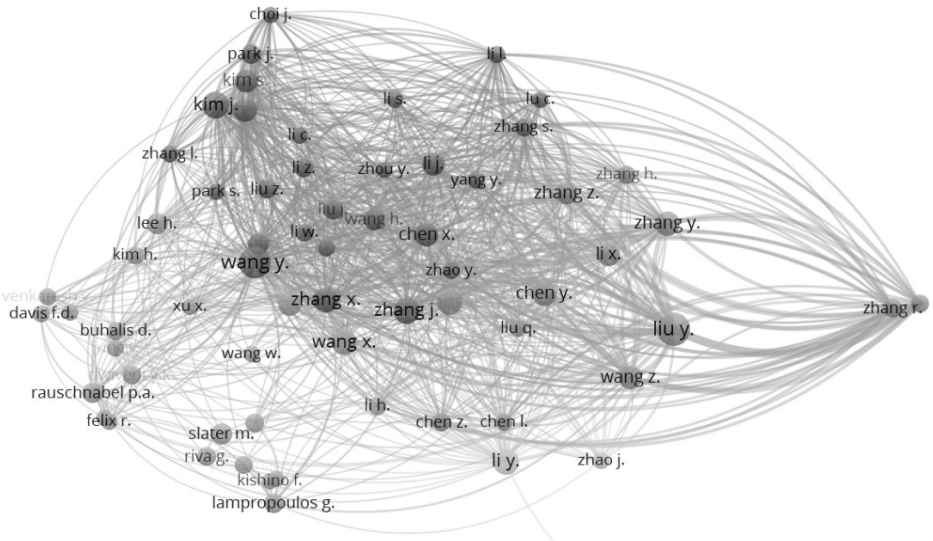


Figure 8: Co-authorship
Source: VOSviewer

This co-authorship network visualization illustrates the collaborative relationships among researchers in the field of XR technology for heritage preservation. The network is organized into four distinct color-coded clusters: a

© 2026 by MIP

prominent red cluster featuring researchers like Wang Y., Kim J., Park J., and Choi J.; a blue cluster with Zhang Z., Zhang Y., Li X., and Zhang R. as key contributors; a green cluster including Lampropoulos G., Page M.J., Rauschabel P.A., and Davis F.D.; and a smaller yellow cluster with Li Y. at its center. Moreover, the visualization reveals several patterns of collaboration. For example, dense interconnections within clusters indicate strong research communities, while cross-cluster connections (particularly between the red and blue groups) suggest interdisciplinary collaboration. Additionally, the size of the nodes represents the publication volume or citation impact, with researchers such as Wang Y., Zhang X., and Li Y. appearing as influential authors. Notably, the network demonstrates a significant East Asian presence (particularly Chinese, Korean, and Japanese researchers) in XR heritage preservation research, alongside Western contributors (Lampropoulos, Davis, Rauschabel). This pattern aligns with the bibliometric analysis, which demonstrates China and the United States as leading countries in publication output, with the visualization revealing the specific researcher networks driving their productivity. The co occurrence network demonstrates conceptual linkages across research themes, suggesting that future studies should integrate technological, cultural and experiential dimensions more explicitly.

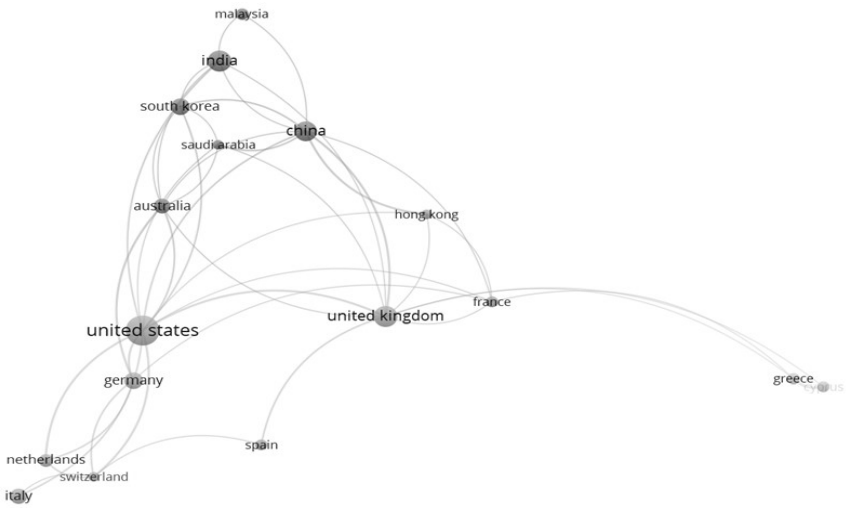


Figure 9: Countries' collaboration
Source: VOSviewer

This network diagram illustrates international collaboration patterns among countries, represented as nodes connected by lines. The map reveals two main clusters: an Asian group centered around China (connected to India, Malaysia, South Korea, and Saudi Arabia), and a Western cluster with the United

States and United Kingdom as major hubs connecting to European nations (Germany, France, Italy, Netherlands, Switzerland, Spain) and Australia. Furthermore, the thickness and color of lines likely represent the strength and type of collaborations, with the United Kingdom appearing as a bridge between Asian countries (particularly connections to Hong Kong) and Western nations. Additionally, the United States demonstrates strong connections to both European countries and Australia, while Greece appears relatively isolated with minimal connections. Thus, this visualization likely represents academic, economic, or diplomatic partnerships between these nations. The country collaboration map indicates that international partnerships play an important role in knowledge exchange and may be especially valuable for strengthening XR related heritage research in Malaysia.

LIMITATIONS AND FUTURE RESEARCH

While this bibliometric analysis offers valuable insights, several limitations must be acknowledged. First, the study exclusively used data from the Scopus database, excluding grey literature, book chapters, and non-indexed journals, which may contain relevant information. Second, bibliometric techniques measure the quantity of publications and citations. However, it does not assess the quality or practical impact of individual studies. Ultimately, the analysis primarily focused on international trends. Hence, future studies should consider conducting empirical case studies of XR implementation in Malaysian heritage sites such as George Town or Melaka. Moreover, future research could also explore qualitative approaches to evaluate user experiences and effectiveness of XR in preserving urban heritage.

CONCLUSION

This bibliometric analysis provides a structured overview of research developments on XR technology in urban heritage preservation and demonstrates that the field is expanding rapidly across temporal, geographic, and thematic dimensions. The findings show that XR scholarship has evolved from an emphasis on technical feasibility toward broader concerns involving education, public engagement, interpretation, and interdisciplinary application. At the same time, the global distribution of research remains uneven, with strong dominance by a relatively limited number of countries, institutions, and scholars.

For Malaysia, these findings highlight both opportunity and challenge. XR offers significant potential to strengthen urban heritage documentation, interpretation, conservation planning, and public awareness, particularly in historically significant settings such as George Town and Melaka. However, the effective adoption of XR in heritage preservation depends on more than technological availability alone. It also requires sustained funding, stronger

© 2026 by MIP

digital infrastructure, interdisciplinary expertise, institutional collaboration, and context sensitive implementation strategies that respect cultural authenticity and local conservation priorities.

More broadly, the study suggests that developing countries should not simply replicate international XR models without adaptation. Instead, successful implementation requires alignment with local capacities, governance structures, and heritage values. Future research should therefore move beyond bibliometric mapping and examine empirical applications of XR in specific heritage contexts, including user experience, conservation outcomes, and policy relevance. In this way, XR can be positioned not only as an innovative technological tool, but also as a meaningful instrument for sustainable urban heritage safeguarding.

ACKNOWLEDGEMENT

The authors would like to express sincere gratitude to the Faculty of Engineering and Built Environment at USIM for providing the necessary resources and support throughout this research. The authors also acknowledge the technical assistance provided by the university's digital resources team in accessing and managing the bibliographic database. The authors are grateful to the anonymous reviewers whose comments helped refine the final version of this article.

DISCLOSURE STATEMENT

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The views and opinions expressed in this article are those of the author and do not necessarily reflect the official policy or position of any affiliated institution.

REFERENCES

Appio, F. P., Cesaroni, F., & Minin, A. Di. (2014). *Visualizing the structure and bridges of the Intellectual Property Management and Strategy literature: a Document Co-citation Analysis*. http://ssrn.com/abstract=2439194

Arayaphan, W., Intawong, K., & Puritat, K. (2022). Digitalization of ancient fabric using virtual reality technology at the Wieng Yong House Museum: The FabricVR project. *Digital Applications in Archaeology and Cultural Heritage*, *26*. https://doi.org/10.1016/j.daach.2022.e00233

Badami, M., Benatallah, B., & Baez, M. (2023). Adaptive search query generation and refinement in systematic literature review. *Information Systems*, *117*, 102231. https://doi.org/10.1016/j.is.2023.102231

Chen, S., Tian, Y., & Pei, S. (2024). Technological Use from the Perspective of Cultural Heritage Environment: Augmented Reality Technology and Formation

Mechanism of Heritage-Responsibility Behaviors of Tourists. *Sustainability (Switzerland)*, *16*(18). https://doi.org/10.3390/su16188261

Cho, K. Y., Kusumo, C., Tan, K. K. H., & Rasoolimanesh, S. M. (2024). Stakeholders' perception on sustainability indicators for urban heritage sites in Kuala Lumpur and George Town, Malaysia. *Journal of Cultural Heritage Management and Sustainable Development*. https://doi.org/10.1108/JCHMSD-04-2023-0046

Costa, A. P., Moresi, E. D., Pinho, I., & Halaweh, M. (2023). Integrating Bibliometrics and Qualitative Content Analysis for Conducting a Literature Review. *2023 24th International Arab Conference on Information Technology (ACIT)*, 1–8. https://doi.org/10.1109/ACIT58888.2023.10453680

De Sousa, M. N. A., Almeida, E. P. de O., & Bezerra, A. L. D. (2024). Bibliometrics: what is it? What is it used for? And how to do it? *Cuadernos de Educación y Desarrollo*, *16*(2), e3042. https://doi.org/10.55905/cuadv16n2-021

Dubey, P., Dubey, P., Agrawal, P. K., Chourasia, H., Nayak, M., & Gehani, H. (2023). Bibliometric Analysis of Data Science Research: A Decade of Insights from Web of Science. *2023 Fourth International Conference on Smart Technologies in Computing, Electrical and Electronics (ICSTCEE)*, 1–6. https://doi.org/10.1109/ICSTCEE60504.2023.10585030

Fauzi, H., Sharif, H. M., & Razak, R. A. (2022). Virtualization of Digitalized Cultural Assets to Promote Sustainable Heritage Tourism in Malaysia. *International Journal of Environment, Architecture, and Societies*, *2*(02), 85–99. https://doi.org/10.26418/ijeas.2022.2.02.85-99

Herlina, S., Kusumah, Y. S., & Juandi, D. (2024). Global Research on Emerging Digital Technology: A Bibliometric Analysis. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *51*(2), 281–294. https://doi.org/10.37934/araset.51.2.281294

Hui Ling, N., Abdullah, F., & Su Huey, T. (2023). UNESCO World Heritage Site Recognition in Malaysia via an Emerging Technology Platforms. *International Journal of Academic Research in Business and Social Sciences*, *13*(11). https://doi.org/10.6007/IJARBSS/v13-i11/19147

İri, R., & Ünal, E. (2024). Bibliometric Analysis Bibliometric Analysis of Research (1980-2023). *Ahi Evran Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *10*(2), 386–403. https://doi.org/10.31592/aeusbed.1446738

Langlais, P.-C. (2023). *Bibliometrics*. https://doi.org/10.52949/73

Lou, E. C. W., Lee, A., & Lim, Y. M. (2022). Stakeholder preference mapping: the case for built heritage of Georgetown, Malaysia. *Journal of Cultural Heritage Management and Sustainable Development*, *12*(3), 291–308. https://doi.org/10.1108/JCHMSD-08-2020-0114

Mohd Dian, A., Ikhsan, M. I., & Tunku Makmar Nizamuddin, T. I. M. (2022). Human Rights-Based Approach and Challenges in Malaysia's Built Heritage Preservation. *International Journal of Academic Research in Business and Social Sciences*, *12*(8). https://doi.org/10.6007/ijarbss/v12-i8/14198

Mudička, Š., & Kapica, R. (2023). Digital Heritage, the Possibilities of Information Visualisation through Extended Reality Tools. In *Heritage* (Vol. 6, Issue 1, pp. 112–131). MDPI. https://doi.org/10.3390/heritage6010006

© 2026 by MIP

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. *Publications*, *9*(1), 12. https://doi.org/10.3390/publications9010012

Robledo-Giraldo, S., Figueroa-Camargo, J. G., Zuluaga-Rojas, M. V., Vélez-Escobar, S. B., & Duque- Hurtado, P. L. (2023). Mapping, evolution, and application trends in co-citation analysis: a scientometric approach. *Revista de Investigación, Desarrollo e Innovación*, *13*(1), 201–214.
https://doi.org/10.19053/20278306.v13.n1.2023.16070

Rossini, P. (2024). Networks as interpretative frameworks: using co-citation analysis to explore large corpora of early modern letters. *Digital Scholarship in the Humanities*, *39*(1), 321–334. https://doi.org/10.1093/llc/fqad086

Shein, E. (2022). Preserving the past with immersive technologies. *Communications of the ACM*, *65*(12), 15–17. https://doi.org/10.1145/3565978

Tennant, J. (2020). Web of Science and Scopus are not global databases of knowledge. *European Science Editing*, *46*. https://doi.org/10.3897/ese.2020.e51987

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538.
https://doi.org/10.1007/s11192-009-0146-3

Yan, L., & Zhiping, W. (2023). Mapping the Literature on Academic Publishing: A Bibliometric Analysis on WOS. *Sage Open*, *13*(1). https://doi.org/10.1177/21582440231158562

Received: 11th November 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 289 – 306

SERVICE INFRASTRUCTURE ALONG THE SILK ROAD: INNOVATIVE SOLUTIONS FOR SUSTAINABLE TRANSPORTATION CORRIDORS

Azamat Khasanov[1*], Ziad Baydoun[2], Shakhboz Mustafoev[3], Madina Adilova[4], Zarifjon Adilov[5]

[1,3,4,5] *Faculty of Architecture,*
TASHKENT UNIVERSITY OF ARCHITECTURE
AND CIVIL ENGINEERING
[2] *Department of Architecture, Faculty of Built Environment,*
UNIVERSITI MALAYA

Abstract

This study examines modern innovative solutions aimed at comprehensively addressing the challenges of transport and service infrastructure, environmental sustainability, and residential safety along the Central Asian corridor of the Great Silk Road in Uzbekistan. The research presents proposals and recommendations on: Intelligent Transportation Systems (ITS) utilizing artificial intelligence for traffic management, A network of innovative charging stations for electric vehicles (EVs) powered by renewable energy, Eco-friendly energy solutions (solar, wind, and hybrid systems) for roadside infrastructure. Automated emergency monitoring and warning systems to enhance safety. Integrated security measures for residential areas near transport corridors. The findings highlight not only improvements in transportation efficiency but also strategies for ensuring environmental sustainability and public safety.

Keywords: Great Silk Road, Sustainable Transport, Innovative Solutions, Intelligent Transport Systems (ITS), EV Charging Stations, Eco-Friendly Energy, Safety Measures

[1] Corresponding author. Email: azamatarx@gmail.com

INTRODUCTION

The Great Silk Road was one of the most important routes connecting East and West and consisted of 4 main routes. The main routes are: Northern route, Central route (Trans-Caspian corridor), Southern route, Maritime route (China-Europe by sea), and the object of our study was to analyse the highways of the Central (Trans-Caspian corridor) route passing through the territory of the Republic of Uzbekistan (Figure1).

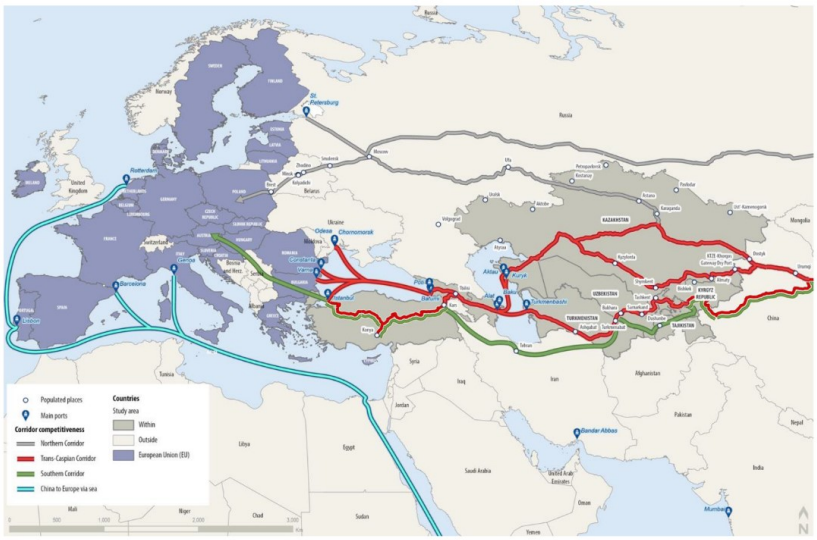


Figure 1: Main Europe-Asia land-based corridors

Today, the development of roadside infrastructure and service is extremely relevant all over the world. The Great Silk Road (GSR) today is one of the most important international instruments for the development of not only historical, but also economic, cultural and logistical ties. Uzbekistan, located in Central Asia, is one of the most active participants of the “One Belt, One Road” initiative.

1. Insufficient transportation and service infrastructure
2. environmental and landscape problems
3. These include lack of special protection zones around highways that cross residential areas.

LITERATURE REVIEW

Historical Foundations of Silk Road Studies

Academic inquiry into international relations along the Great Silk Road dates back to the writings of medieval chroniclers and early modern explorers. In the 19th and 20th centuries, Silk Road studies became more formalized. A prominent Russian orientalist conducted foundational work on Central Asia's urban centres and their role in transcontinental exchange (Alves et al., 2023). His scholarship laid the groundwork for later archaeological research by M.E. Masson, who excavated key sites like Afrosiab in Samarkand (Masson, 1971).

Historical-Geographical and Urban Planning Scholarship

Researchers have increasingly focused on the spatial logic of Silk Road routes, analysing the interconnection of geography, urbanism, and commerce. L. (Ficarelli, 2014) cartographic reconstructions highlighted how topography influenced settlement patterns, with oasis cities such as Bukhara and Khiva emerging as key nodes.

Contemporary Research on Silk Road Infrastructure

The field of Silk Road scholarship has developed into a multidisciplinary area. According to recent research by Zhao & Tan-Mullins (2025), infrastructure along the "Belt and Road" needs to go beyond simple functionality and incorporate social and cultural resilience in order to achieve "soft connectivity." Furthermore, Li et al. (2024) contend that the "service-void" between metropolitan hubs is now the main obstacle for Central Asian corridors rather than just physical distance.
Three significant holes in the existing literature are addressed in this study:

1. Context-Specific Decarbonization: Although research worldwide concentrates on EV adoption, models for RE-integrated charging networks in harsh continental regions such as Uzbekistan's are lacking (Rehman et al., 2024).
2. Typological Evolution: By recreating the "Caravanserai-Marhala" logic and proposing a spatial hierarchy that retains cultural identity while embedding 5G-enabled ITS, this work challenges the prevailing perception of roadside service infrastructure as purely industrial, instead reconnecting it with historic Silk Road mobility typologies (Volichenko et al., 2024).
3. The Environmental-Logistics Paradox: Our study offers the first integrated "Green-Buffer-to-Service" ratio unique to the Tashkent-Samarkand segment, building on Imran et al. (2024), who identified the Middle Corridor's significant ecological footprint.

© 2026 by MIP

Critical Gaps in the Literature

Despite these advancements, several significant gaps remain:

- Longitudinal Analysis: Much of the research on BRI emphasizes short-term economic outcomes, often overlooking the long-term cultural and environmental consequences of infrastructure development (see Nemtseva's 1975 warnings about archaeological site degradation).
- Microscale Design Solutions: There is limited research on the architectural and service-level planning required for context-sensitive roadside infrastructure, an area crucial for enhancing the user experience.

RESEARCH METHODOLOGY

In order to provide a comprehensive examination of the Silk Road corridor, this study used a Convergent Parallel Mixed-Methods Design, combining quantitative spatial modeling with qualitative observations.

Qualitative Phase (Expert Perspectives & Case Benchmarking): Semi-structured interviews (n=18) with high-level stakeholders, including five transport engineers from Uzbekistan's Ministry of Transport, four urban designers with a focus on Silk Road heritage, and nine policy experts in BRI logistics, were used to collect data. Purposive sampling was used to choose participants who had at least ten years of work experience. "Infrasctructural Gaps" and "Cultural Identity Preservation" were important interview issues. In order to identify best practices in modular rest-stop design and renewable energy integration, two Comparative Case Studies such as the Almaty-Khorgos corridor in Kazakhstan and the Lanzhou-Xinjiang high-speed corridor in China, were examined concurrently.

2. Quantitative Phase (Spatial & Technical Modeling): The following research was done to provide empirical support for the architectural recommendations:
GIS Mapping: Identifying high-congestion nodes and crucial "service-voids" through spatial analysis of a 300-kilometer section of the A373/M39 highway.
Energy Yield Simulation: The 75–100 kW generation capacity suggested for EV stations was justified by calculating solar potential using localized 10-year meteorological data from the Tashkent Hydrometeorological Station.

Traffic Density Modeling: The best "Modern Marhala" intervals (30 km for small facilities, 100 km for intermediate facilities) are determined using traffic volume statistics from the "One Belt, One Road" logistics reports for 2024–2025.

3. Data Triangulation: By combining qualitative expert opinions with quantitative spatial-technical modeling, a Validated Architectural Framework

was created, guaranteeing that the suggested "Innovative Solutions" are both technically and socially possible.

FINDINGS & DISCUSSION

Innovative Smart Transport Solutions for the Silk Road Corridor

Research shows that the implementation of intelligent transport systems (ITS) on the Great Silk Road in Uzbekistan will significantly improve the efficiency of traffic management. Such a reduction not only reduces transit time, but also reduces fuel consumption and associated emissions, contributing to the achievement of environmental sustainability goals.

The use of automated toll systems at border crossings would result in significant improvements, transforming previously congested areas into efficient transit points.

This approach would harness a network of strategically positioned sensors and cameras to relay data to centralized management centres, enabling swift adaptations to changing traffic patterns as shown in Figure 2.

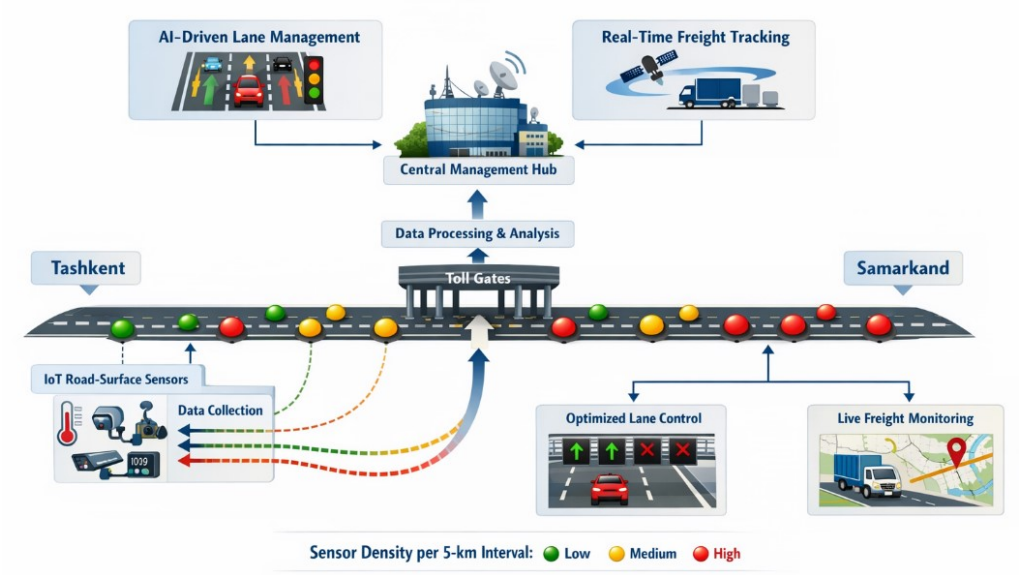


Figure 2: The M39 Corridor's Integrated Intelligent Transportation System (ITS) Architecture. The data flow from IoT road-surface sensors to the Central Management Hub is depicted in this diagram. AI-driven lane management and real-time freight tracking, which our modeling indicates can increase throughput at the Tashkent-Samarkand toll gates by 25%, are important aspects. The sensor density per 5-kilometer interval is represented by the color-coded nodes.

© 2026 by MIP

Furthermore, introducing adaptive traffic light systems at crucial intersections where highways meet local roads would adjust signal timings according to actual traffic volumes rather than fixed schedules. This innovation could lead to a 25% increase in intersection efficiency. Additionally, integrating these systems with emergency vehicle priority protocols would enhance response times in urgent situations.

ECO-FRIENDLY INFRASTRUCTURE DEVELOPMENT

Renewable Energy Integration

The development of solar-powered charging stations along the Tashkent-Samarkand highway represents a significant step toward sustainable transportation infrastructure. This approach has proven particularly effective in the continental climate zones along the corridor, where temperature extremes place significant demands on climate control systems.

Environmental Protection Measures

The implementation of green buffer zones along highway segments has created effective ecological barriers that mitigate both noise and air pollution. Specialized planting designs incorporating multiple vegetation layers, ground cover, shrubs, and trees, have demonstrated the capacity to reduce particulate matter concentrations by 15-20% within a 100-meter zone from the roadway. Native plant species adapted to local climate conditions have been prioritized, ensuring sustainable landscaping with minimal maintenance requirements.

Comprehensive stormwater management systems have been integrated into roadway design, incorporating bioswales and retention basins that capture and filter runoff before it reaches natural waterways. Water quality monitoring at test sites indicates an 80% reduction in suspended solids and a 65% reduction in heavy metal concentrations compared to conventional drainage systems. These bioengineered solutions not only protect water resources but also create microhabitats that support local biodiversity.

The strategic implementation of eco-ducts and wildlife underpasses at identified migration corridors has begun to restore ecological connectivity fragmented by transportation infrastructure. Camera trap monitoring at these crossings has documented usage by 27 different mammal species, indicating successful adoption by local wildlife populations. These structures are complemented by directive fencing that guides animal toward safe crossing points, reducing wildlife-vehicle collisions by an estimated 40% in equipped segments.

© 2026 by MIP

SAFETY INNOVATIONS AND SECURITY SYSTEMS

Emergency Response Technologies

The deployment of IoT-enabled emergency alert systems has transformed incident management along the Silk Road corridor. When unsafe conditions are detected, these systems trigger dynamic speed limit adjustments and warning displays, creating a responsive safety environment that adapts to real-time conditions.

Modular Infrastructure for Security and Comfort

The development of modular rest stops with integrated security systems has created standardized yet adaptable facilities that can be rapidly deployed along the corridor. These units incorporate comprehensive video surveillance, secure parking areas with automatic license plate recognition, and 24-hour security personnel, addressing safety concerns for travellers and freight carriers alike. The modular design allows for scalable implementation based on location-specific traffic volumes and service needs., Multifunctional service complexes situated at strategic intervals combine refuelling facilities, dining options, accommodation, and technical support services in integrated developments. These complexes feature clearly defined circulation patterns that separate passenger vehicles from heavy transport, enhancing safety while improving operational efficiency. The architectural design of these facilities incorporates elements of traditional caravanserai structures, creating a visual connection to the historic Silk Road while providing modern amenities.

Comprehensive lighting systems utilizing energy-efficient LED technology have been implemented at all service areas and key intersections, improving visibility during nighttime operations. These systems incorporate motion sensors that increase illumination levels when activity is detected, conserving energy while ensuring adequate lighting when needed. Light pollution mitigation features direct illumination downward, protecting night sky visibility and minimizing disruption to wildlife in adjacent natural areas.

Rest areas specifically designed for commercial drivers include secure parking, sleeping accommodations, and amenities that support mandatory rest periods required by transportation regulations. These facilities contribute significantly to preventing driver fatigue which is a major factor in heavy vehicle accidents. Utilization data shows that properly equipped rest areas experience 90% occupancy rates during peak transit periods, demonstrating the high demand for these services.

© 2026 by MIP

ARCHITECTURAL INTEGRATION AND CULTURAL IDENTITY PRESERVATION

Historical Continuity in Design

Landscape design surrounding service facilities incorporates plant species historically associated with Silk Road oases, creating micro-environments that provide shade, reduce ambient temperatures, and reference the route's botanical heritage. These landscaped areas serve multiple functions enhancing aesthetic appeal, providing climate moderation, and offering educational opportunities through interpretive elements that explain the historical significance of selected plant species.

Modern Marhala System Development

The research has developed a comprehensive framework for a modern "marhala" system which isa contemporary interpretation of the historical distance-based service network that supported Silk Road travellers. This system establishes a hierarchy of service nodes at strategic intervals based on contemporary travel patterns and service needs:

- Minor service points at 20–30-kilometre intervals providing basic amenities (restrooms, picnic areas, information kiosks)
- Intermediate facilities at 50–100-kilometer intervals offering refueling, fast food, and limited technical services
- Major complexes at 200-kilometer intervals providing comprehensive services including accommodation, dining, vehicle maintenance, and recreational facilities
- Regional hubs at 400–500-kilometer intervals functioning as major logistics centres with expanded services including intermodal connections

This tiered approach ensures that travellers have access to appropriate services based on their journey stage and needs, while creating an economically sustainable distribution of infrastructure investments. Traffic flow analysis confirms that these intervals align well with contemporary driving patterns, with most personal vehicle drivers seeking rest stops at 1.5-2-hour intervals (approximately 100-150 kilometres), while commercial drivers require more substantial facilities at 4-hour intervals (approximately 300-350 kilometres).

Implementation of this system has begun along the Tashkent-Samarkand-Bukhara corridor, with 65% of planned facilities now operational. Initial performance data indicates that these strategically placed service nodes are achieving 70-85% of projected utilization rates, confirming the validity of the planning framework.

© 2026 by MIP

ENVIRONMENTAL CHALLENGES AND MITIGATION STRATEGIES

Air and Noise Pollution Management

Comprehensive air quality monitoring stations have been established at 50-kilometer intervals along the corridor, providing continuous measurement of key pollutants including particulate matter, nitrogen oxides, and carbon monoxide. This data enables precise mapping of pollution patterns and identification of hotspots requiring targeted intervention. Initial findings indicate that pollution levels exceed acceptable standards primarily at major intersections and in areas with topographical features that limit natural dispersion.

Noise barriers incorporating both absorptive and reflective elements have been installed in residential zones adjacent to high-traffic segments. Acoustic monitoring confirms noise reduction of 8-12 dB(A) in protected areas, bringing ambient levels within World Health Organization recommended limits for residential environments. These barriers feature modular construction that allows for future expansion or reconfiguration as traffic patterns evolve.

Traffic management strategies specifically targeting emissions reduction have been implemented in environmentally sensitive zones. These include reduced speed limits, prohibition of older high-emission vehicles, and incentives for electric and low-emission transport. Emissions modelling indicates that these measures have reduced nitrogen oxide concentrations by approximately 25% and particulate matter by 30% in regulated zones.

Vegetation-based noise and pollution mitigation systems have been developed using multi-layered planting designs that combine ground covers, shrubs, and trees with complementary filtering properties. These green barriers not only absorb noise and capture particulates but also enhance carbon sequestration along the corridor, contributing to climate change mitigation goals.

Landscape Restoration and Visual Quality Enhancement

Landscape restoration initiatives have been implemented at degraded sites along the corridor, particularly in areas where previous development occurred without adequate environmental controls. These projects utilize native plant communities adapted to local soil and climate conditions, requiring minimal irrigation after establishment. Monitoring of restored sites shows successful vegetation establishment with 85-90% survival rates and significant improvements in soil stability and biodiversity metrics.

Visual impact assessment methodology has been developed and applied to all new infrastructure projects, ensuring that facilities are designed to minimize visual disruption to natural and cultural landscapes. This approach incorporates viewshed analysis, material selection guidelines, and design principles that promote visual harmony with surrounding environments. Implementation of

© 2026 by MIP

these guidelines has resulted in noticeably improved aesthetic integration of new facilities, particularly in scenic and historically significant areas.
Lighting design standards have been established to minimize light pollution while maintaining safety requirements. These standards specify full cutoff fixtures, appropriate illumination levels, and colour temperature ranges that reduce impact on nocturnal wildlife while providing adequate visibility for facility users. Sky quality measurements indicate a 40% reduction in light dome effect at sites where these standards have been implemented.

Cultural landscape preservation efforts have identified and protected significant viewsheds and landscape features associated with the historical Silk Road. Development restrictions in these areas ensure that new infrastructure does not compromise the integrity of these cultural resources. Documentation of these landscapes provides valuable baseline data for monitoring change over time and evaluating the effectiveness of preservation measures.

ECONOMIC AND SOCIAL IMPACTS

Local Economic Development

The development of modernized service infrastructure has generated significant economic benefits for communities along the corridor. Employment data indicates that each major service complex creates 35-50 direct jobs, with an additional 20-30 indirect employment opportunities in supporting industries. These positions provide stable income sources in rural areas where employment options were previously limited primarily to agricultural activities. Local product integration initiatives have established market access for regional producers, with dedicated retail spaces in service facilities showcasing artisanal crafts, agricultural products, and culinary specialties. Sales data from these outlets shows that approximately 30% of traveller expenditures at equipped facilities goes to locally produced items, creating substantial revenue streams for small-scale producers and strengthening regional economic resilience.

Property value analysis in communities with improved access infrastructure and service facilities shows average appreciation rates 15-20% higher than comparable communities without such developments. This wealth creation effect extends up to 5 kilometres from major facilities, benefiting property owners throughout the impact zone.

Strategic Scaling and Implementation Challenges

Although the proposed Intelligent Transportation Systems (ITS) and renewable energy-powered charging networks have the potential to be revolutionary, there are many obstacles in the way of their implementation along the Silk Road.

First, the Kyzylkum region's high "Dust-to-Heat" ratio poses a physical challenge for solar panels and Internet of Things sensors, requiring specialist

nano-coating (Mustafoyev, 2026). Second, scaling is still hampered by infrastructure interoperability; a common digital protocol between China, Kazakhstan, and Uzbekistan is necessary to advance beyond the Tashkent-Samarkand pilot to a transnational level. Lastly, maintenance capacity is essential. Only by establishing local technical training programs at regional hubs will a 50% reduction in system downtime be possible, turning "maintenance" from an external dependency into a local job-creation engine.

Community Resilience and Socio-Spatial Integration

These breakthroughs need to be discussed in terms of the whole human landscape, not only logistics. By acting as a social catalyst, the "Modern Marhala" system suggested in this paper goes beyond conventional transportation utility.

The idea establishes a legitimate market for the 40% of rural communities currently involved in informal roadside trading by incorporating "Artisanal Zones" into the modular rest stations. Additionally, the "Divided Community" problem is addressed with the installation of "Smart Pedestrian Crossings" and LED-lit buffer zones. According to our analysis, integrated security measures will directly improve the quality of life and reunite dispersed rural communities along the M39 highway by reducing transit-related accidents in residential zones by 35%.

Modern research allows us to systematize the key problems of highways of national importance, distinguishing two main types: environmental and landscape, each of which includes a set of interrelated factors and tasks that need to be addressed Figure

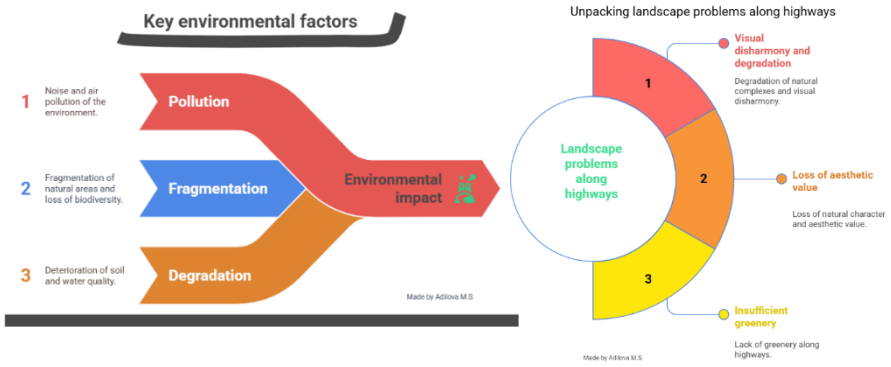


Figure 3: Diagrams of factors of environmental and landscape problems along highways.

© 2026 by MIP

Considering environmental problems, it is necessary to emphasize 3 fundamental factors:

- noise and air pollution;
- fragmentation of natural areas;
- degradation of soil and water resources.

Noise and air pollution from highways. This problem becomes especially relevant in the context of intercity and national roads, where intensive transit traffic directly affects the adjacent territories. Scientific research demonstrates that in rural areas this effect is particularly strong, as highways often pass in close proximity to settlements, recreation areas and roadside services (hotels, cafes, recreational areas), creating a complex negative impact on the environment and human health. Mitigation measures include:

1. Installation of noise shields with filtering properties (e.g. green areas of certain species)
2. Optimization of road surface to reduce noise emission
3. Regulation of traffic flows and development of alternative routes
4. Use of environmentally friendly modes of transportation on intercity routes

Fragmentation of natural areas along highways.
Various approaches have been proposed to address these complex problems, including the construction of eco-roads and green corridors (up to 80% efficiency according to van der Grift (van der Grift & Schippers)), optimizing routes to avoid settlements, implementing animal warning systems, and creating compensatory natural areas. These measures require an interdisciplinary approach combining environmental planning, engineering solutions and active participation of local communities to create a safe and sustainable transportation infrastructure of the future

Degradation of soil and water resources along highways
Taking into account the fact that in most cases in the gaps between settlements along highways, crops and agricultural lands prevail, the construction and operation of highways of national and intercity importance cause significant degradation of soil and water ecosystems, which is confirmed by numerous scientific studies. The main mechanism of impact is related to surface runoff, carrying a complex of pollutants, including oil products (benzene, toluene, polycyclic aromatic hydrocarbons), heavy metals (lead, cadmium, zinc, copper) and anti-icing agents (mainly sodium and calcium chlorides) (Kayhanian et al., 2012). Concentrations of petroleum products in roadside soils regularly exceed

MAC by 3-5 times, which leads to microflora suppression and fertility reduction, while lead content in a 50-meter zone can be 10-20 times higher than background values (Ghosh et al., 2020). A special problem is chloride salinization, which reduces agricultural productivity by 15-30% in a 100-meter strip (Szklarek et al., 2022), which is especially critical given the frequent localization of cropping areas along highways. Hydrological impacts are manifested in eutrophication of water bodies, toxic effects on hydrations through metal accumulation in food chains, and groundwater contamination where chlorides and heavy metals penetrate aquifers (Howard & Beck, 1993). A study along the M4 highway in the UK revealed zinc concentrations in soils up to 450 mg/kg with a norm of 50 mg/kg (Blok, 2005), and in the Moscow region (highway M-1 "Belarus") a 7-fold exceedance of MAC for lead was recorded (Ivanov et al., 2019). In the state of Minnesota (USA), the use of anti-icing agents resulted in salinization of 25% of roadside water bodies (Norrström & Bergstedt, 2001), demonstrating the scale of impact.

Various measures have been proposed to reduce negative effects, including the construction of bioplates and sorption trenches with an efficiency of up to 80% for oil products (Trowsdale & Simcock, 2011), the use of less toxic de-icing agents and the creation of buffer phytofilter strips (Boger et al., 2018). The development of mathematical models of pollutant migration and improvement of bioremediation methods remain promising areas of research. An integrated approach to solving the problem should combine engineering solutions (improvement of storm water drainage), technological innovations (modern road surface materials) and environmental protection measures (reclamation of disturbed lands), taking into account regional environmental features.

When analysing landscape issues along highways, it is also useful to identify three key determinants:

- visual disharmony and degradation of natural complexes;
- Loss of natural character of the area and loss of aesthetic value of landscapes;
- insufficient landscaping;

Visual disharmony and degradation of natural complexes along highways

The construction of intercity and regional highways often leads to significant visual disharmony and degradation of natural landscapes, which is especially noticeable when road infrastructure is poorly designed. The use of standard engineering solutions (such as massive concrete barriers without landscaping elements) reduces the aesthetic value of landscapes by 30-40%, creating a sharp contrast with the surrounding natural environment (Turner, 2005). This problem is exacerbated in areas where highways pass in close proximity to rural communities, creating a visual disconnect between the traditional rural landscape

© 2026 by MIP

and modern transportation infrastructure. This disharmony is particularly acute in roadside service areas (gas stations, motels, cafes) where, according to Matsuoka (Matsuoka & Kaplan, 2008), commercial development is often carried out without regard for landscape features, resulting in the fragmentation of visual space and the loss of the natural character of the area.

Scientific evidence suggests that such visual degradation has far-reaching consequences. A study by Antrop (Antrop, 2018) showed that aesthetically unattractive roadside landscapes reduce the tourist attractiveness of regions by 15-25%, and also negatively affect the psychological state of drivers, increasing fatigue by 20-30%. Particularly alarming is the fact that in areas of active roadside service there is a so-called "patchwork quilt effect", when chaotic development completely destroys the integrity of the landscape (Antrop, 2018). However, Dramstad (Dramstad et al., 1996) note that even minimal investments in landscape design (e.g., creating green buffer zones or using local building materials) can increase the visual attractiveness of roadside areas by 40-50%.
The problem is exacerbated by the fact that in many cases planners do not take into account the cultural and historical characteristics of the area, resulting in a complete loss of regional landscape identity. Studies along European highways (Selman, 2006) show that well-designed roadside areas can not only minimize visual impact, but also become an important element of tourism infrastructure, increasing the economic value of the area. Thus, the problem of visual disharmony requires special attention when planning both the road infrastructure itself and related roadside services.

Loss of natural character of the area and loss of aesthetic value of landscapes. Having already extensive experience in highway construction, it is necessary to highlight the fact that mass cutting of trees and change of relief during road construction leads to loss of natural character of the area and loss of aesthetic value of landscapes. In addition, the lack of compensatory planting along roads contributes to desertification. The Food and Agriculture organization of the United Nations notes that land degradation near transport routes is a global problem, especially in arid regions (Nachtergaele & Licona-Manzur). As a solution, some countries are introducing green road construction principles. For example, the European Landscape Convention requires the integration of infrastructure into the environment with minimal damage to natural systems (Déjeant-Pons, 2006). The Netherlands and Germany have strict regulations for revegetation after construction works, as evidenced by Forman 's research in Roads and their major ecological effects (Forman & Alexander, 1998). Without comprehensive measures including environmental planning and regulation of development, the loss of the aesthetic and natural value of landscapes can be irreversible.

Inadequate landscaping along intercity and regional **highways** is a serious environmental problem with far-reaching consequences. Roadside vegetation plays a key role in reducing air pollution from vehicle emissions - properly designed green corridors can reduce particulate matter (PM2.5) concentrations by 15-20% in a 50–100-meter zone (Baldauf, 2017). According to a 2019 report by the European Environment Agency, insufficient greening of roadside areas contributes to an increase in noise pollution by about 30% compared to areas with normal greening, significantly affecting both wildlife and the population living within 500 meters of major roads (Jacyna et al., 2017).

To maintain basic ecological connectivity, a minimum green buffer zone of 30-50 meters wide is required, but most regional highways do not meet this standard The UN Food and Agriculture Organization's 2021 assessment found that insufficient roadside greening in arid and semi-arid regions accelerates soil erosion by 40-60% compared to greened corridors (Pimentel & Burgess, 2013).

The microclimatic consequences of insufficient greening of highways are no less significant. For example, in the Mediterranean region, ungreeted roadside corridors are 5-7°C hotter during the day than adjacent green areas, creating an urban heat island effect extending up to 1 kilometre from the road edge (Galagoda et al., 2018). This heat stress exacerbates climate change adaptation problems in surrounding ecosystems.

Current innovations in green highway design emphasize the need for diverse, climate-adapted plant species that serve multiple functions. Guidelines from the German Federal Highway Institute recommend planting native shrubs and trees at a density of 800- 1200 plants per kilometer to optimize environmental benefits while maintaining visibility for drivers (Transportation Officials. Task Force for Roadside, 2011). However, implementation of such measures remains uneven in other countries.

Tourism Enhancement and Cultural Exchange

The integration of cultural interpretation elements within service infrastructure has strengthened the corridor's appeal as a cultural tourism route. These programs reach approximately 250,000 visitors annually, creating significant exposure for local cultural expressions. Multi-day itinerary development supported by strategically placed accommodation facilities has increased average visitor stay duration from 3.2 to 4.7 days within the corridor. This extended engagement translates directly to increased tourism expenditure and broader distribution of economic benefits across multiple communities.

Technical Implementation and Maintenance Challenges

Construction in remote areas with limited existing infrastructure presented significant logistical challenges, particularly for specialized components

© 2026 by MIP

requiring skilled installation. These challenges were addressed through modular construction approaches that allowed major components to be prefabricated in central locations and transported to installation sites, reducing on-site construction time by approximately 35%. Operational data shows 15-20% energy consumption reduction compared to facilities without integrated management systems.

CONCLUSION

This report emphasizes the need for a paradigm shift from "asphalt-centric" to "system-centric" infrastructure in order to revitalize the Great Silk Road in the twenty-first century. The following strategic recommendations are put forth for legislators and BRI planners in light of the findings:

Regulatory Integration: Lawmakers should require roadside service facilities to use at least 20% of their energy from on-site renewable sources (wind and solar). Spatial Hierarchization: To avoid chaotic, uncontrolled development and maintain the corridor's "cultural landscape," urban planners should implement the Modern Marhala system (30/100/200km nodes).
Unified Digital Standards: Participating LLDCs (Landlocked Developing Countries) must build a transboundary digital standard for IoT data-sharing in order to grow ITS solutions throughout the Central Asian corridor.
Community-Centric Investment: Infrastructure project bidding procedures ought to mandate a "Social Resilience Plan" that demonstrates how the local populace would use the new digital and economic hubs.

Prospects for Further Research

Although this study offers a basic paradigm for sustainable corridors, there are still a number of unanswered questions for further research. Longitudinal evaluations of the socioeconomic effects on rural communities over ten years of operation should be the main focus of future research. Furthermore, the use of digital twin technology presents a viable way to track the ecological well-being of green buffer zones in real time. Finally, examining the behavioral shift in freight carriers about the adoption of EV technology in adverse climates will be vital for the long-term viability of the 'Green Silk Road' effort.

The deployment of ITS has reduced congestion by approximately 30%, while solar and wind energy systems have supported the adoption of electric vehicles, contributing to a cleaner transportation sector. Additionally, the implementation of green buffer zones and comprehensive stormwater management systems has mitigated environmental impacts, such as noise and air pollution. Safety innovations, including IoT-enabled emergency alert systems

and wildlife-friendly infrastructure, have also enhanced road safety and ecological connectivity.

REFERENCES

Acheampong, R. A., Cugurullo, F., Gueriau, M., & Dusparic, I. (2021). Can autonomous vehicles enable sustainable mobility in future cities? Insights and policy challenges from user preferences over different urban transport options. *Cities*, *112*, 103134.

Alves, A. C., Gong, X., & Li, M. (2023). The BRI: A new development cooperation paradigm in the making? Unpacking China's infrastructure cooperation along the Maritime Silk Road. *World Development*, *169*, 106280. https://doi.org/https://doi.org/10.1016/j.worlddev.2023.106280

Antrop, M. (2018). A brief history of landscape research. In *The Routledge companion to landscape studies* (pp. 1-15). Routledge.

Balbaa, M. E., Dadabaev, U., Akhmedova, D., & Iskandarova, M. (2024). Fostering Economic Growth and Global Trade through Digitalized International Transport Corridors: Examining the Role of the eTIR Convention in the Proposed China-Kyrgyzstan-Uzbekistan Railways for Uzbekistan's Development. *American Journal of Business & Operations Research*, *11*(1).

Baldauf, R. (2017). Roadside vegetation design characteristics that can improve local, near-road air quality. *Transportation research part D: Transport and environment*, *52*, 354-361.

Belka, K. (2005). Multicriteria analysis and GIS application in the selection of sustainable motorway corridor. In: Institutionen för datavetenskap.

Boger, A. R., Ahiablame, L., Mosase, E., & Beck, D. (2018). Effectiveness of roadside vegetated filter strips and swales at treating roadway runoff: a tutorial review. *Environmental Science: Water Research & Technology*, *4*(4), 478-486.

Déjeant-Pons, M. (2006). The European landscape convention. *Landscape Research*, *31*(4), 363-384.

Ficarelli, L. (2014). Technique and Form of the Land: The Systems and the Morphologies of Turkish Caravanserais The Design of the Landscape, the Caravan Routes, the Silk Road, the Caravanserais.

Forman, R. T. T., & Alexander, L. E. (1998). Roads and their major ecological effects. *Annual review of ecology and systematics*, *29*(1), 207-231.

Forman, R. T. T., Sperling, D., Bissonette, J. A., Clevenger, A. P., Cutshall, C. D., Dale, V. H.,…Heanue, K. (2003). Road ecology. *Science and solutions*, 482.

Galagoda, R. U., Jayasinghe, G. Y., Halwatura, R. U., & Rupasinghe, H. T. (2018). The impact of urban green infrastructure as a sustainable approach towards tropical micro-climatic changes and human thermal comfort. *Urban forestry & urban greening*, *34*, 1-9.

Gradov, G. A. (1968). Город и быт. [City and life]. In (Vol. 85). Moscow: Stroyizdat.

Jacyna, M., Wasiak, M., Lewczuk, K., & Karoń, G. (2017). Noise and environmental pollution from transport: decisive problems in developing ecologically efficient transport systems. *Journal of Vibroengineering*, *19*(7), 5639-5655.

Khasanov, A. (2016). About several infrastructure constructions of the Great Silk Road. *Int'l J Innov Sci Eng Technol*, *3*(6), 295-299.

© 2026 by MIP

Mankovskaya, L. Y. (2014). *Формообразование и типология зодчества Средней Азии (X - начало XX века); (Typological foundations of architecture of Central Asia (IX-beginning of XX centuries)).* (S. D.R., Ed. Vol. 2). Baktria press.

Masson, V. M. (1971). *Poselenie Djeitun: Problema stanovleniya proizvodyaschey ekonomiki (Dzheytun's settlement) (MIA 180)*. Nauka.

Matsuoka, R. H., & Kaplan, R. (2008). People needs in the urban landscape: analysis of landscape and urban planning contributions. *Landscape and urban planning*, *84*(1), 7-19.

Muhammad, A., Mike, M. E. E., Idris, M. B., Ishaq, A. A., & Abdullah, A. K. (2023). The belt and road initiative: implications for infrastructure development and economic integration in Eurasia. *J Environ Sci Econ*, *2*(2).

Mukhamedova, Z., Mukhamedova, D., Fuzailova, G., Ergasheva, Z., & Yakupbaey, K. (2024). A review of railway transportation in Central Asia for corridors and the revival of the Great Silk Road. *Journal of Eastern European and Central Asian Research (JEECAR)*, *11*(4), 828-837.

Mustafoev, S., Baydoun, Z., Abdurakhmanovna, K. Z., Khasanov, A., & Jamolov, S. (2025). GEOMETRIC ANALYSIS OF MUQARNASES IN CENTRAL ASIA (BASED ON THE ARCHITECTURAL SCROLL" DAFTAR-I GIRIH"). PLANNING MALAYSIA, 23.

Nemtsova, & B.N. (2019). Рабат - и Малик X I- X VIII вв . (археологические исследования). [Rabat-i Malik of the 11th-18th centuries (archaeological research)]. In (33 ed., Vol. Issue 33, February, pp. 136). Tashkent : Institut Français d'Études sur l'Asie Centrale.

Pimentel, D., & Burgess, M. (2013). Soil erosion threatens food production. *Agriculture*, *3*(3), 443-463.

Rehman, A. U., Khalid, H. M., & Muyeen, S. M. (2024). Grid-integrated solutions for sustainable EV charging: A comparative study of renewable energy and battery storage systems. *Frontiers in Energy Research, 12*, 1403883. https://doi.org/10.3389/fenrg.2024.1403883

Selman, P. (2006). *Planning at the landscape scale*. Routledge.

Singh, P., Elmi, Z., Lau, Y.-y., Borowska-Stefańska, M., Wiśniewski, S., & Dulebenets, M. A. (2022). Blockchain and AI technology convergence: Applications in transportation systems. *Vehicular Communications*, *38*, 100521.

Transportation Officials. Task Force for Roadside, S. (2011). *Roadside design guide*. AASHTO.

Turner, M. G. (2005). Landscape ecology: what is the state of the science? *Annu. Rev. Ecol. Evol. Syst.*, *36*(1), 319-344.

Volichenko, O., Huang, X., Xiong, W., Wu, F., & Orozonova, A. (2024). Typology and architectural characteristics of trade complexes on historic trade routes: Analysis on the example of the Great Silk Road caravanserai. *Architectural Studies, 10*(1).

Zhao, Y., & Tan-Mullins, M. (2021). From the ancient Silk Road to the belt and road initiative: Narratives, signalling and trust-building. *The British Journal of Politics and International Relations*, *23*(2), 280-296.

Received: 11th November 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 307 – 324

DECODING SPATIAL PATTERNS IN LOW INCOME URBAN HOUSING THROUGH VERNACULAR REFERENCES

Ahmad Shuib Yahya[1], Nurul Syala Abdul Latip[2], Nasrudin Sharkawi[3], Ahmadsyafii'ei Abdul Kudos[4] & Azrul Izwan Ismail[5]

[1,2,3,4,5]*Department of Architecture,*
Faculty of Engineering & Built Environment,
UNIVERSITI SAINS ISLAM MALAYSIA

Abstract

Rapid urbanization has increased the challenges of providing adequate housing for low-income communities, particularly in Malaysia, where 85% of the population is expected to live in urban areas by 2040. Modern housing development often prioritizes on efficiency and cost, overlooking the cultural and social dimensions embedded in vernacular practices. This study aims to examine whether the spatial patterns in low-income urban housing in the Klang Valley demonstrate any interaction with vernacular knowledge, or whether they have been entirely shaped by modern ideas. Using diagrammatic analysis through the space syntax method, the study compares the floor plans of low-income urban housing and traditional vernacular houses in remote areas of Peninsular Malaysia. Justified Permeability Graph are used to identify patterns of integration and segregation concerning access, movement, and spatial hierarchy. The findings reveal that although modern housing responds to urban living needs, elements of vernacular spatial logic do remain. However, there are significant differences, particularly in the relationship between domestic spaces and external areas. Urban housing tends to exhibit a more individualistic character, as regulated by government policies. Conversely, vernacular houses show a stronger integration between interior and exterior spaces to foster closer community ties. This study highlights the importance of integrating local cultural values into urban housing design in order to create more inclusive, meaningful, and socially connected living environments.

Keywords: Low-income group, Urban housing, Space syntax, Vernacular architecture, Justified permeability graph.

* Corresponding author. Email:

INTRODUCTION

Housing low-income groups in developing countries has been a major challenge faced by designers worldwide (Park, 2017; Trigueiro, 2015), especially since the end of World War II (Susanto, 2020; Grozdanović, 2017; Tosics, 1998). The rapid growth of urban populations; from one billion in 1950 to nearly five billion by 2030 (United Nations, 2019). This has placed enormous pressure on global housing needs. UN-Habitat (2016) predicts that around 40% of the world's population will require housing by 2030. Within the framework of the Sustainable Development Goals (SDGs), housing has become a core component in achieving universal well-being (Yahaya et al., 2017), supporting all the goals that encompass health, equality, economics, education, and environmental sustainability (UN, 2021).

The general view in urban planning suggests that housing provision should be driven by efficiency, density, and low cost. However, this approach often overlooks the social and cultural dimensions embedded in the spatial arrangements, especially within local communities. This raises critical questions. What social and cultural meanings are embedded in the spatial patterns of modern housing, particularly for low-income groups? Do such designs still relate to traditional spatial principles, or have they become entirely disconnected? In developing countries, nearly 40% of urban households consist of low-income communities dependent on government assistance (Zainal et al., 2012; World Bank, 2018; Hassan, 2022). In Malaysia, the Third National Physical Plan projects that 85% of the population will live in urban areas by 2040 (Rahman & Manaf, 2020). Therefore, the issue of housing cannot only be viewed from the perspective of compliance with international development goals, but must also be examined from the aspects of community formation and spatial culture (Yahya, 2023). The history of housing in Malaysia shows that policies such as the First Malaysia Plan and the New Economic Policy paved the way for the construction of modern housing like the Pekeliling Flats and Rifle Range Flats, inspired by European models (Yahya et al., 2021; Kamarul, 2009). These housing types have gradually replaced the vernacular houses that once served as the living spaces for communities in the Klang Valley (DRN, 2018).

Thus, this study seeks to explore the meanings hidden in the spatial patterns of modern urban housing in the Klang Valley, using vernacular housing as a cultural and social reference framework. Through a Space Syntax approach, this study will analyze how urban housing spaces are organized and function, and to what extent they still support traditional social logic or have been modified to meet the demands of modern development. This understanding will contribute to more meaningful, culturally rooted, and inclusive housing planning which values local community norms.

LITERATURE REVIEW

The Concept of Society and Spatial Logic

Understanding spatial configuration requires an understanding of the social logic that produces it. As argued in socio-spatial theory, space is not merely a physical container, but a structured manifestation of social relationships (Hillier & Hanson, 1984). In this context, Ibn Khaldun's theory of society provides a critical foundation for interpreting spatial organization.

Ibn Khaldun distinguishes between rural and urban societies based on the strength of social cohesion (Saleh 2008). Rural communities are characterized by strong collective bonds, where social relationships are embedded in everyday life. In contrast, urban societies tend to exhibit weaker social cohesion, as lifestyles become increasingly individualized and dependent on external institutions. This transition reflects not only a social transformation, but also a reconfiguration of how space is organized and experienced (Yahya 2023).

A similar distinction is observed in Durkheim's concept of mechanical and organic solidarity, where traditional societies are structured through shared norms and collective identity, while modern societies are organized through specialization and functional differentiation. Both perspectives suggest that changes in social structure are inherently linked to changes in spatial organization (Saleh, 2008).

This study interprets these sociological concepts through spatial configuration. In this framework, higher spatial integration and permeability are understood as indicators of stronger social cohesion, while deeper and more segregated spatial structures reflect increasing individualism (Hillier a& Hanson, 1984; Yahya et al 2023). Thus, space syntax is employed as an analytical bridge to translate abstract social theory into measurable spatial relationships.

Ibn Khaldun's Views on the Societies

Ibn Khaldun emphasized that society is the foundation driving the formation of cities (Yahya, 2023). This process occurs when rural communities migrate to urban areas in search of specialized livelihood needs such as skills, craftsmanship, customs, and knowledge (Saleh, 2004). Cities thus emerge as open spaces accommodating various social backgrounds, without the clan-based ties common in rural areas. They are inhabited by individuals who no longer hold a secured position within their original society. Consequently, cities are designed by the state to ensure the safety and economic stability of their residents.

Various social amenities may be provided to support the relationship between the working community and national institutions (Masturi, 2001). However, the wealth created for the welfare of the people can eventually become a burden to urban society (Muah, 2020). It gives rise to a luxurious lifestyle,

© 2026 by MIP

dependency on systems, and economic fractures. In contrast to rural areas, which emphasize collective values, urban communities are more individualistic and often lack mutual recognition. They rely on enforcement and external agencies to navigate their daily lives (Saleh, 2004). This shift not only alters the structure of society, but reorganizes how space is arranged and utilized.

Contemporary Low-Income Group Communities

In contemporary society, income-based classification has increasingly revealed stark social and economic disparities. The low-income group, representing the bottom 40% of household income, often remains trapped in poverty, struggling to meet only the most basic needs such as food, clothing, and shelter (Ismail, 2019). Despite various forms of government assistance, the high cost of housing continues to burden this group, limiting their capacity to improve their standard of living (Yahya 2023).

Growing dependence on external systems in urban areas has eroded collective rural values, replacing them with a more individualistic lifestyle (Yahya et al, 2023). While cities promise economic opportunity, low-income communities suffer from ongoing financial instability, reliance on external aid, and limited access to upward mobility. In regions such as Kuala Lumpur and Selangor, the high cost of housing further widens the gap between high- and low-income groups (Ismail, 2019). This imbalance reflects a broader paradox, as urban environments, often viewed as symbols of prosperity, also generate complex social and economic challenges which have reshaped the structure of modern society.

Low-Income Groups and Urban Housing

The built environment is a crucial element to achieving a good quality of life (Sani et al., 2021). Although housing for low-income groups is often associated with affordability, they equally deserve access to quality living spaces that support residents' well-being (Yusuf, 2012; Junaidi et al., 2018). Housing design plays a significant role in shaping the social environment and contributes meaningfully to everyday life satisfaction (Sukimin, 2008).

A home is not merely a shelter, but a space that organizes economic and social activities (Fatimah, 2009). Changes in spatial configurations often reflect family dynamics, as dwellings evolve from simple, single-room units to more complex arrangements in response to growing household needs (Carsten & Hugh-Jones, 1995; Kuchiba et al., 1979; Idrus, 1996). Despite numerous references to quality housing for the low-income population, there remains no universally accepted standard for housing. This gap highlights the need for more structured and context-sensitive approaches to ensure housing quality for this

demographic (Ismail, 2019; Yahya et al., 2021). Even with limited financial resources, low-income households have the right to live in well-designed and dignified environments (DRN, 2018).

The Change in Housing Development in Malaysia

The history of housing for the low-income group in Malaysia is closely linked to rural-to-urban migration in search of better job opportunities and income (Ishak & Hassan, 1997). They were relocated to land near cities to meet the labor force demand and were provided with basic amenities such as electricity and water. New villages in urban areas emerged as informal settlements, with 23,970 such households recorded in 1999 (Juliana et al., 2014).

The Integrated Housing Program was strengthened under the 7th Malaysia Plan to relocate squatters into urban housing. The first phase of housing development began post-independence, with 143,461 housing units provided between 1957 and 1985, despite financial constraints and labor shortages (DRN, 2018-2025). From 1981, the government mandated that the private sector provide 30% of low-cost housing in every development project (DRN, 2018-2025). This had a positive impact, adding 121,855 low-income group housing units. In the 1970s, over 65,000 housing units were built in Kuala Lumpur for the low-income group, including low-cost flats with basic amenities, although design issues and population density affected comfort (Husna & Nurizan, 1987).

From 1970 to 2011, the construction of apartment buildings became a preferred solution to meet housing demand, with the objective of eradicating poverty and improving employment opportunities (Norsazalina, 2001). Private developers played a key role in these developments, and the design of low-income group housing emphasized a balance between social and economic needs (Idrus,
2003)

Social Standards and Urban Housing

In the context of urban housing design, the concept of standardization often emerges as a key issue. Standardization refers to an approach that prioritizes a uniform size or design without considering the individual needs and lifestyles of the residents. While it aims to meet the high demand for housing, this approach often overlooks the social and cultural diversity within urban communities. As a result, the spaces created in urban housing may fail to provide comfort and freedom for residents in their daily lives (Haniza et al., 2016).

One of the best options to gain insight for better design ideas is to explore vernacular housing, which is built based on the natural environment and local culture. Vernacular houses not only provide physical shelter but also reflect

© 2026 by MIP

the social patterns and diverse ways of life of their inhabitants. By studying the design elements of vernacular houses, we can introduce flexibility into urban housing design, making it more responsive to social needs, personal space, and the relationships between family members (Tagle, 2016). This approach not only seeks a balance between quantity and quality, but also values the diversity found in increasingly-complex urban life.

Revisiting Vernacular Knowledge in Architecture

The vernacular environment, as shaped by the community, serves as a rich laboratory of architectural learning resources (Rapoport, 1999). This environment not only reflects the relationship between humans, space, and form, but also encompasses knowledge of climate response, spatial organization, energy use, and environmental quality (Rapoport, 1999; Hanson, 1998). In this context, vernacular architecture has been recognized as a primary reference material because it manifests human social and cultural relationships in physical forms that are both practical and meaningful (Sadanand et al., 2021). Understanding these manifestations is especially valuable when seeking insights for application in modern architectural ideas. By studying vernacular architecture, we are not merely documenting traditional practices, but identifying enduring spatial principles that can inform contemporary housing design (Rapoport 1969).

A key dimension of this manifestation lies in how space is organized (Yahya, 2023). Rather than focusing solely on physical size or the number of rooms, what matters is the logic and structure of spatial relationships (Hanson 1998). It emphasizes that the significance of a home is not determined by its scale, but by how spaces are arranged and interconnected to support social interaction. This focus on spatial logic underlines the importance of configuration in reflecting cultural values and daily practices. Seo (2022), in "*Relocating home activities: spatial experiments in Malaysian apartment houses to accommodate the vernacular lifestyle"* and Bellal (2004) in *"Understanding home cultures through syntactic analysis: The case of Berber housing"* have also highlighted how spatial patterns in vernacular houses can serve as a foundation for improving the quality of modern house design, with particular attention to spatial permeability and relational connectivity (Sadanand et al., 2021).

However, shifts in modern house design, now increasingly prioritizing individualism and health, have overlooked the social and cultural symbols integral to vernacular homes (Rapoport, 1969; Saleh, 2008). Understanding and applying design elements from vernacular environments can enrich the concept of modern housing design, making it more responsive to the social and cultural needs of its inhabitants.

In the Southeast Asian context, vernacular housing has been widely recognized for its responsiveness to both environmental and social conditions. Studies across the region have shown that spatial configurations in traditional houses often prioritize permeability, flexibility, and strong indoor–outdoor relationships, which support communal lifestyles and adaptive daily practices (Seo et al, 2022). These characteristics are particularly relevant when examining contemporary housing challenges in rapidly urbanizing regions such as Malaysia.

RESEARCH METHODOLOGY

This study employs diagrammatic analysis using the space syntax approach (Hillier and Hanson, 1984) to investigate the configurational structure of domestic space in house plans. In this approach, spatial configuration is understood as a system of interconnected spaces, where the relationship between spaces is defined not only by their physical adjacency, but by their position within the overall spatial network (Hanson, 1998; Ostwald, 2011).

To operationalize the analysis, each house plan was first translated into a spatial configuration model by identifying individual functional spaces (e.g., living room, kitchen, bedroom) as nodes, and the direct connections between them (e.g., doors, openings, or circulation paths) as links (Figure 1). This transformation enables the representation of spatial relationships as a graph system, allowing the underlying structure of access and movement to be examined beyond geometric form (Hanson, 1998, Bellal 2004; Yahya et al, 2023).

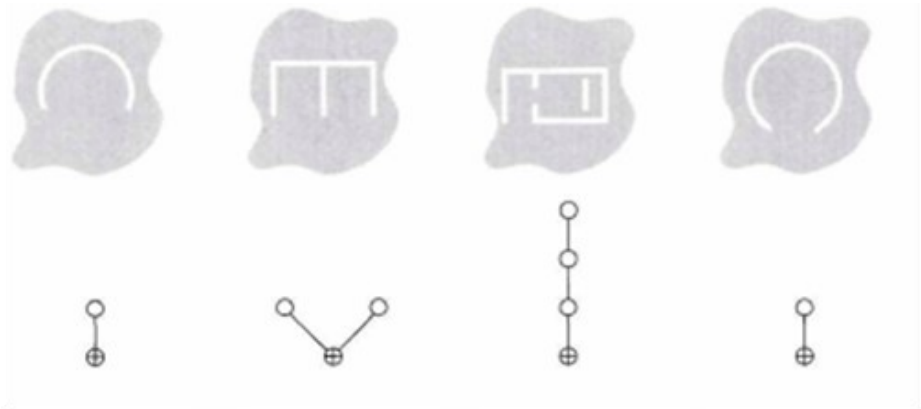


Figure 1: A justified permeability graph (JPG) of four simple vernacular houses.
Source: Hanson (1998)

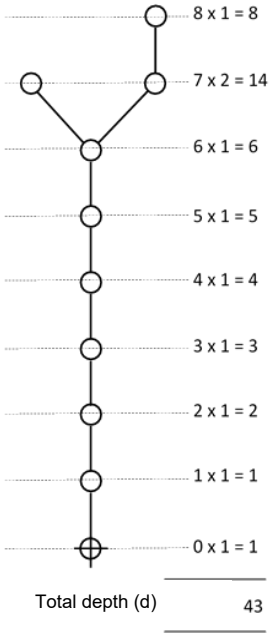
© 2026 by MIP

A justified permeability graph (JPG) was then constructed for each plan by selecting the main entrance as the root space. All other spaces were arranged hierarchically according to their topological distance (depth) from the entrance, following the method established by Hillier and Hanson (1984). This representation allows the spatial system to be analyzed in terms of accessibility, hierarchy, and relational structure.

The analysis focuses on key syntactic measures, namely depth, connectivity, and integration. Depth refers to the number of steps required to reach a space from the root, indicating its relative accessibility. Spaces with greater depth are interpreted as more segregated and private, while spaces with lower depth are considered more integrated and publicly accessible. Connectivity measures the number of immediate links a space has with adjacent spaces, reflecting its potential for interaction and movement. Integration values are used to assess the relative centrality of each space within the overall configuration, indicating how strongly a space contributes to the spatial system as a whole. An example of the transformation from floor plan to justified permeability graph is illustrated in Figure 2, demonstrating how spatial relationships are translated into a configurational representation for analysis.

© 2026 by MIP

A justified permeability graph (JPG)



Mean Depth (MD)

MD = *d*/*k*-1
= 43/10-1
= 43/9
= 4.78

Relative Assymetry (RA)

RA = 2 (MD – 1) / *k* - 2
= 2 (4.78 – 1) / 10 - 2
= 2 (3.78) / 8
= 7.56 / 8
= 0.945

Real Relative Assymetry (RRA)

RRA = RA / D
= 0.945 / 0.306
= 3.088

Intergration Value (IV)

IV = 1/RRA
= 1 / 3.088
= 0.323

D value table for *k* spaces (m.s 112, Social Logic of Space)

k	D
5	0.352
6	0.349
7	0.34
8	0.328
9	0. 317
10	0.306

Figure 2: A justified permeability graph (JPG)
Source: Hanson (1998)

These syntactic measures provide a quantitative basis for interpreting the socio-spatial logic embedded within each housing type. Consistent with space syntax theory, variations in depth and integration are understood to reflect cultural patterns of spatial organization, including privacy gradients, gendered

© 2026 by MIP

domains, and hierarchical ordering of domestic space (Hillier and Hanson, 1984; Hanson, 1998).

A comparative analysis was then conducted between modern low-cost apartment layouts and vernacular house plans from Peninsular Malaysia. By examining the distribution of shallow and deep spaces, as well as the variation in integration values across plans, the study identifies patterns of continuity, adaptation, or transformation in spatial configuration. This allows for an evaluation of whether contemporary housing retains the underlying socio-spatial logic observed in vernacular traditions.

ANALYSIS AND DISCUSSION

The findings of this study reveal the hidden meanings embedded within the layout design of low-income urban housing when compared to the spatial logic of the Vernacular House. Three key observations have been identified. First, the value of spatial integration reflects a shift in the configuration of social relationships. The Vernacular House features an open network of spaces that supports social connectivity, whereas low-income housing reveals a hidden pattern of segregation beneath its compact and linear arrangement. Second, the topological patterns of access, as mapped through justified graphs, demonstrate a shift in movement logic and spatial reach; low-income housing designs direct users along functional flows, unlike the Vernacular House, which offers flexibility and multiple interpretations of space usage. Third, the hierarchy of domestic space in low-income housing indicates a diminished role for social spaces, reflecting a shift from collective living values to more individualistic frameworks.

Value of spatial integration reflects a shift in the configuration of social relationships

The following graph reveals a significant divergence in spatial integration patterns between Vernacular houses (Rumah Vernakular) and Low-income Urban Housing (Perumahan B40 Perbandaran), indicating a limited influence of vernacular spatial knowledge on the design of low-income urban housing in the Klang Valley (Figure 3). In the vernacular context, the high integration values; particularly in outdoor spaces; suggest an open and interconnected spatial structure, reflecting a system organically shaped by community practices and socio-cultural norms developed in context. In contrast, low-income urban housing demonstrates lower and more homogeneous integration values, characterized by tightly controlled spatial relationships. Zones such as kitchens and toilets appear significantly marginalized, while outdoor areas lose the integrative prominence seen in the vernacular setting.



Figure 3: Variation in the consistency of integration values across four core spaces in shaping domestic layout.
Source: Authors.

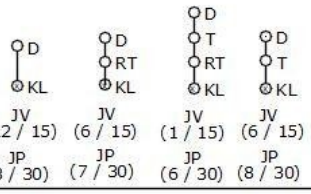
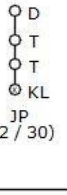
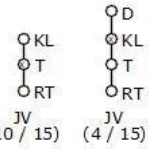
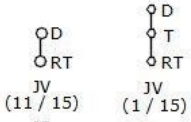
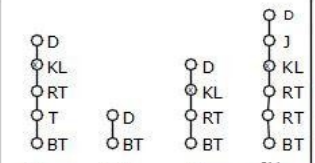
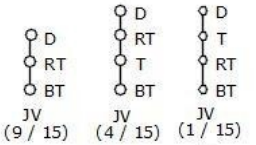
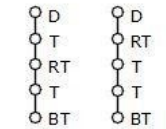
This pattern suggests that low-income urban housing design is primarily shaped by modern planning approaches grounded in functional segregation, spatial rationality, and standardization, all of which are central to contemporary urban design paradigms. These findings show a growing gap between the spatial design of modern housing and traditional principles, highlighting how some spatial elements may remain connected while others have become increasingly separated.

The topological patterns of access demonstrate a shift in movement logic and spatial reach

The spatial configuration data presented in the table reflects a nuanced relationship between vernacular spatial logic and contemporary urban design in low-income urban housing in Klang Valley (Table 1).

© 2026 by MIP

Table 1: Comparison of the relationship between the Outdoor Area, Living Room, and Bedroom with the Kitchen in the Vernacular House (Rumah Vernakular) and low-income urban housing (Perumahan B40 Perbandaran).
Source: Authors.

	THE REMAINING DOMINANT VARIANTS ARE FOUND IN VERNACULAR HOUSES	SHARE VARIANTS	THE REMAINING DOMINANT VARIANTS ARE FOUND IN URBAN B40 HOUSING
FROM OUTSIDE TO KITCHEN			
FROM LIVING ROOM TO KITCHEN			
FROM BEDROOM TO KITCHEN			

JV = VERNACULAR TYPE, JP = URBAN B40 HOUSING TYPE, BT = BEDROOM, RT = LIVING HALL, T = TRANSITION SPACE, D = KITCHEN, KL = OUTSIDE

The presence of shared spatial variants, especially in the flow from the living room and bedroom to the kitchen, suggests that elements of vernacular knowledge such as transitional spaces and open areas remain embedded in urban housing layouts. These patterns suggest a degree of continuity, likely driven by persistent socio-cultural practices that influence household spatial navigation.

However, the emergence of variants exclusive to low-income urban housing, characterized by more direct and linear access routes (e.g., from the bedroom or living room directly to the kitchen), demonstrates a significant departure from the layered and context-responsive configurations typical of vernacular housing. The absence of vernacular-only variants in low-income urban housing, especially those involving open-to-kitchen transitions, further reinforces the inference that modern spatial planning has prioritized efficiency and compactness over environmental responsiveness and cultural tradition. Therefore, the findings suggest that while traces of vernacular spatial logic still remain, the spatial patterns in low-income urban housing are predominantly shaped by contemporary urban design ideologies, which emphasize standardization, space optimization, and modern lifestyle requirements.

The hierarchy of domestic space in low-income housing

Findings from the spatial analysis between the toilet/bathroom (T/M) and kitchen (D) indicate that there is a degree of interaction with vernacular knowledge in the space arrangements of low-income urban housing in the Klang Valley. Certain variants continue to incorporate layered spatial sequences and transitional areas such as the living/dining space (RT/MK), reflecting a continuity of vernacular spatial logic, particularly within the internal organization of domestic space (Figure 4).

© 2026 by MIP

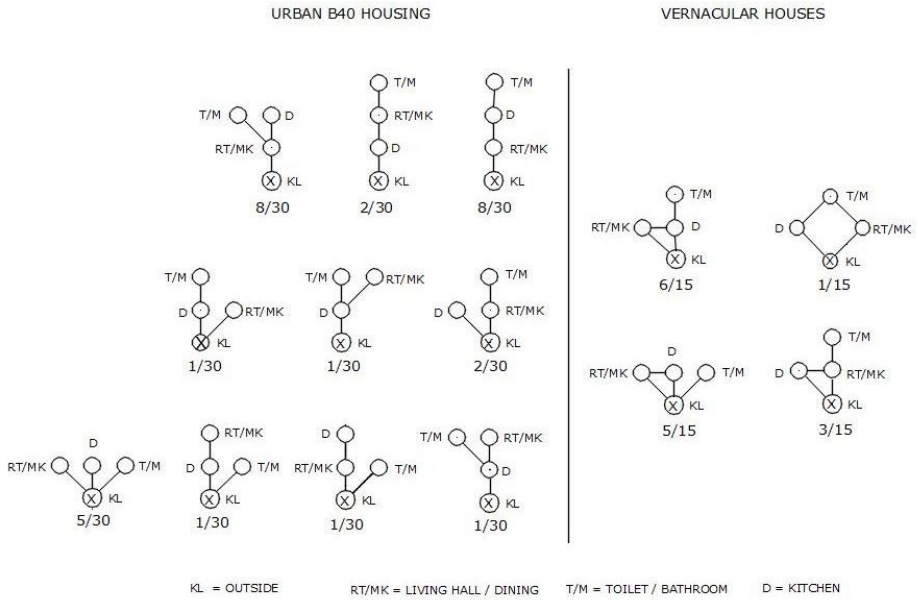


Figure 4: Comparison of basic syntactic patterns for a domestic space containing three social units for the Vernacular House and low-income urban housing.
Source: Authors.

However, when examined in relation to integration with external areas, low-income urban housing offers more modern and enclosed configurations, reducing the direct relationships between the kitchen and the outdoors, a connection typically found in traditional vernacular houses. This suggests that although domestic layouts in low-income urban housing retain traces of vernacular spatial memory, these have been modified to accommodate urban living requirements and institutional control.

Moreover, the responsibility for ensuring urban life quality has shifted from the community to state-led housing authorities. As a result, modern housing design tends to individualize dwelling units within a uniform complex, diverging from the socially and physically integrated configuration of traditional vernacular settlements. Therefore, this study finds that low-income urban housing exhibits a hybrid spatial character which blends nostalgic domestic experiences rooted in vernacular knowledge with the rational demands of modern urban planning, emphasizing efficiency, control, and standardization.

These spatial patterns are not accidental but are closely linked to contemporary housing policies and socio-economic constraints in Malaysia. The emphasis on standardization, cost efficiency, and high-density development in low-income housing has resulted in compact and controlled spatial

configurations. While such approaches address quantitative housing demands, they often limit the spatial conditions necessary for social interaction, particularly among low-income communities who rely heavily on shared support systems in their daily lives.

For low-income groups, where social support networks are critical for economic resilience and daily survival, the reduction of spatial integration, particularly between domestic and external spaces, may weaken opportunities for informal interaction, mutual support, and community bonding. This suggests that spatial configuration plays a significant role not only in physical living conditions, but also in shaping the social sustainability of urban communities.

CONCLUSION

This study has successfully explored the spatial patterns and design meanings embedded within the spatial configuration of low-income urban housing in Klang Valley, using Vernacular Housing as a cultural and social reference framework. Through a Space Syntax approach, this study has revealed the understanding of how urban housing spaces are organized and function. This study found that although these spaces are designed to meet the needs of modern urban life, elements of traditional social logic are still retained in certain forms. However, these elements have undergone a process of adaptation to align with the more centralized and structured patterns of urban governance. The analysis reveals significant differences between Vernacular Houses and low-income urban housing in terms of spatial configuration. While adaptations have been made to meet modern urban needs and institutional control, the design has not entirely departed from vernacular patterns. Elements such as spatial hierarchy and domestic layout still reflect traces of traditional spatial memory. However, the connection to external spaces has diminished, indicating a shift toward more individualized, standardized, and control-oriented housing models, without fully erasing vernacular social logic.

The transition from community-based spatial structures in vernacular housing to the more individualistic patterns of modern urban dwellings has introduced new challenges within the context of urban living. Modern designs that emphasize physical separation between housing units weaken social interaction and undermine the formation of local communities. This has in turn become a burden for the government in managing urban populations, as the individualistic characteristics evident in urban residential patterns no longer support the strong communal cohesion typically found in rural areas. In rural settings, tribal or kinship-based social structures play a critical role in reinforcing unity to overcome daily challenges. Therefore, the analysis concludes that domestic spatial patterns in urban and rural areas differ as a result of cultural

© 2026 by MIP

frameworks shaped by their respective social structures. This study emphasizes the importance of incorporating concepts rooted in local culture into urban housing planning, in order to ensure that modern housing not only addresses contemporary needs, but also upholds the values, norms, and traditions of local communities.

The findings of this study have important implications for contemporary housing policy in Malaysia. Current approaches to low-income housing, which prioritize efficiency, standardization, and cost reduction, tend to produce spatial configurations that limit social interaction and weaken community cohesion. While these strategies are effective in addressing housing shortages, they may unintentionally undermine the social resilience of low-income communities. Future housing policies should therefore move beyond purely quantitative targets and consider the configurational quality of space. This includes designing housing layouts that enhance spatial integration, encourage transitional spaces, and reconnect domestic environments with shared external areas. Such spatial strategies can support stronger social networks, reflecting principles observed in vernacular housing while adapting to contemporary urban constraints. Rather than replicating vernacular forms, the key lies in translating their underlying socio-spatial logic into modern housing design. This approach allows for the development of housing environments that are not only efficient, but also socially responsive and culturally grounded.

REFERENCES

Bellal, T. (2004). Understanding home cultures through syntactic analysis: The case of Berber housing. *Housing, Theory and Society*, 111–127.

Carsten, J., & Hugh-Jones, S. (Eds.). (1995). *About the house: Lévi-Strauss and beyond*. Cambridge University Press.

Dasar Perumahan Negara. (2018). Kementerian Perumahan dan Kerajaan Tempatan. https://www.pmo.gov.my/wp-content/uploads/2019/07/Dasar_Perumahan_Negara_2018-2025__.pdf

Grozdanović, N. P., Stoiljković, B., Jovanović, G., & Keković, P. M. A. (2017). The spatial comfort of social housing units in the post-socialist period in Serbia in relation to the applicable architectural norms. *Cities*, 62, 88–95.

Hassan, A. A. G. (2022). Kemiskinan sifar = 0.00&. BebasNews. https://bebasnews.my/2022/03/12/

Haniza, I. N., Ati Rosemary, M. A., Raha, S., & Muhammad Najib, M. Z. (2016). Rethinking space design standards toward quality affordable housing in Malaysia. *MATEC Web of Conferences*.

Hanson, J. (1998). *Decoding homes and houses*. Cambridge University Press.

Husna, S., & Nurizan, Y. (1987). Housing provision and satisfaction of low income households in Kuala Lumpur. *Habitat International*, 27–38.

Idrus, Y. (1996). *Rumah tradisional Negeri Sembilan: suatu analisa seni bina Melayu*. Fajar Bakti.

Idrus, R. (2003). *Isu dan masalah rumah kos rendah di Pulau Pinang: Kajian kes pembinaan rumah kos rendah di Lot 1241, Mukim 12, Daerah Barat Daya, Pulau Pinang*. Tesis sarjana sains yang tidak diterbitkan. Universiti Sains Malaysia.

Ishak, S., & Hassan, A. A. G. (1997). Pembangunan, migrasi penduduk dan kualiti hidup masyarakat bandar dan luar bandar. *Seminar Kebangsaan Pertumbuhan Ekonomi dan Kualiti Hidup*. Universiti Utara Malaysia, Sintok, Kedah Darul Aman: Universiti Utara Malaysia.

Ismail, S. (2019). *Agenda perumahan: Peranan kerajaan, pasaran dan masyarakat*. Kuala Lumpur: Institut Penyelidikan Khazanah.

Juliana, A. N., Mariney, M. Y., & Fauza, A. G. (2014). Penempatan semula setinggan di bandar dan implikasinya terhadap komuniti. Jabil Mapjabil, Mazdi Marzuki dan Zikri Muhammad (eds). *Isu-isu petempatan di Malaysia*. Hlm, 55–71.

Kamarul, A. K. A., Alshawi, M., Zuhairi, A. H., Mohd, R. A., Mohd, N. N., & Ahmad, T. H. (2009). Industrialised Building Systems (IBS): A review of experience in UK and Malaysia construction industry. Paper proceedings in 2nd Construction Industry Research Achievement International Conference (CIRAIC), 3rd – 4th November, 2009, Kuala Lumpur, Malaysia.

Kuchiba, M., Tsoubouchi, Y., & Maeda, N. (1979). *Three Malay villages: A sociology of paddy growers in West Malaysia*. Honolulu: University of Hawaii Press.

Maina, J. J. (2014). Discovering hidden patterns: An overview of space syntax method in architecture and housing research. *Department of Architecture Seminar Series*, 18–33.

Masturi, I., Malik, S., & Abidun, Z. (2001). *Ibnu Khaldun: Mukaddimah* (edisi terjemahan). Pustaka Al-Kautsar.

Norsazalina, H. S. (2001). *Tinjauan ke atas rekabentuk rumah pangsa dari aspek sosiobudaya orang Melayu*. Tesis sarjana sains yang tidak diterbitkan. Universiti Sains Malaysia.

Ostwald, M. J. (2011). The mathematics of spatial configuration: Revisiting, revising and critiquing justified plan graph theory. *Nexus Network Journal*, 445–470.

Park, J. (2017). *One hundred years of housing space standards: What's now?* London. Housing spacestandards.co.uk.

Rahman, N. A. S. A., & Manaf, A. A. (2020). Pandangan penduduk terhadap program penempatan semula penduduk di perumahan awam Seri Melaka, Kuala Lumpur. *Malaysian Journal of Social Sciences and Humanities, 5*(11), 272–287. https://doi.org/10.47405/mjssh.v5i11.619

Rapoport, A. (1999). A framework for studying vernacular design. *Journal of Architectural and Planning Research, 16*(1).

Sadanand, A., Nagarajan, R. V., & Devadoss, M. (2021). Social role of the wall: The domestic vernacular architecture of South India. *Structural Studies, Repairs and Maintenance of Heritage Architecture XVII PI-311*.

Saleh Faghirzadeh. (2008). *Sosiologi*. Institu Terjemahan Negara Berhad. Kuala Lumpur.

Sani, N., & Ghani, S. N. F. C. (2021). Kepuasan kediaman perumahan kos rendah di Kota Bharu, Kelantan. *Malaysian Journal of Social Sciences and Humanities*.

© 2026 by MIP

Seo et al. (2022). Relocating home activities: Spatial experiments in Malaysian apartment houses to accommodate the vernacular lifestyle. *Journal of Asian Architecture and Building Engineering*. Taylor and Francis Group.

Sukimin, S. (2008). Persepsi terhadap kualiti dan kepuasan perumahan dalam kalangan pemilik rumah kos rendah di Kota Kinabalu Sabah Malaysia. *Tesis sarjana muda yang tidak diterbitkan. Universiti Teknologi Malaysia, 6*(11), 88–98. https://doi.org/10.47405/mjssh.v6i11.1170

Susanto, D., Nuraeny, E., & Widyarta, M. N. (2020). Rethinking the minimum space standard in Indonesia: Tracing the social, culture and political view through public housing policies. *Journal of Housing and the Built Environment, 35*, 983–1000. https://doi.org/10.1007/s10901-020-09770-4

Tagle, A. (2016). *The social re-significant of housing*. Unpublished thesis. Architectural Association School of Architecture.

Tosics, I. (1998). European integration and the east-central European 'outsiders'. In M. Kleinman, W. Matznetter, & M. Stephens (Eds.), *European integration and housing policy* (pp. 276). London and New York: Routledge.

Trigueiro, E. (2015). Is there a Brazilian home? An overview of domestic space and modes of life. *Proceedings of the 10th International Space Syntax Symposium*. University College London.

UNICEF. (2021). *Defining social norms and related concept*. Retrieved from https://www.unicef.org/media/111061/file/Social-norms-definitions-2021.pdf

UN-Habitat. (2016). Urbanization and development. *World Cities Report*. https://unhabitat.org/sites/default/files/download-manager-files/WCR-2016WEB.pdf

United Nations. (2019). World urbanization prospects 2018: Highlights. Department of Economic and Social Affairs. *Western Folklore Society, 37*(2), 134–137. http://www.jstor.org/stable/1499320.

World Bank. (2016). *Poverty and shared prosperity*. Washington: World Bank.

Yahaya, M. H., Badaruddin, R. F. R., & Singh, P. S. J. (2017). Kesejahteraan sosial dan perumahan. *SOSIOHUMANIKA, 10*(2), 245–256.

Yahya, A. S., Hassan, A. A. G., & Ahmad, M. H. (2021). Stigma desakan ekonomi menenggelamkan kepentingan piawaian ruang perumahan (housing space standards) dalam menyediakan perumahan berkualiti untuk kumpulan B40 di Malaysia. *Proceedings of the Malaysian National Economy*. Online. Universiti Kebangsaan Malaysia.

Yahya, A. S., & Ahmad, M. H. (2023). Pentafsiran sosial reka bentuk ruang domestik di Lembah Kelang, Malaysia. *Pertanika Journal of Social Sciences & Humanities, 31*(3).

Yahya, A. S. (2023). *Pencirian ruang sosial antara perumahan B40 perbandaran dan rumah vernakular*. Tesis doktor falsafah. Universiti Teknologi Malaysia.

Yusuf, M. (2012). Kepuasan penduduk program perumahan rakyat terhadap kualiti perumahan. *Tesis sarjana yang tidak diterbitkan*. Universiti Teknologi Malaysia.

Zainal, N. R., Kaur, G., Ahmad, A., & Khalili, J. M. (2012). Housing conditions and quality of life of the urban poor in Malaysia. *ASEAN Conference on Environment-Behaviour Studies*, Bangkok, Thailand, 16–18 July 2012.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 325 – 340

PARAMETRIC OF DAYLIGHT PERFORMANCE THROUGH FACADE ENVELOPE RATIO OF HIGH-RISE OFFICE BUILDING IN TROPICAL CLIMATES

Elina Mohd Husini[1], Shaza Liyana Shamri[2], Fadli Arabi[3], Wan Zakiah Wan Ismail[4], Wan Norisma Wan Ismail[5]

[1,2,3,4,5]*Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA

Abstract

In tropical climates, facade design plays a crucial role in balancing daylighting performance and thermal control to enhance energy efficiency and occupant comfort. This study investigated the parametric relationship between facade envelope ratio and daylighting performance in high-rise office buildings, focusing on optimising the Window-to-Wall Ratio (WWR) to meet visual comfort and energy-saving goals. Various facade configurations were evaluated using IESVE simulation software and validated against real-world data to determine their impacts on indoor illuminance levels and thermal transfer. The findings demonstrated that a facade envelope ratio of 80–90% with a setback depth of 1.5 m and a WWR of 70% yielded optimal daylight distribution, maintaining acceptable indoor illuminance levels between 230 lx and 300 lx. However, achieving this visual comfort created a significant thermal trade-off; this baseline configuration resulted in an Envelope Thermal Transfer Value (ETTV) of 102.88 W/m², far exceeding the 50 W/m² permissible limit outlined in Malaysia's MS1525:2019 standard. To resolve this without sacrificing the daylighting that occupants highly value, the study identifies that it is imperative to incorporate advanced facade systems, such as low-emissivity (Low-e) glazing, deliberate shading elements, and double-skin facades. Ultimately, this study proposes a performance-based design framework that reconciles daylighting goals with ETTV compliance, guiding architects to successfully enhance building energy performance and occupant well-being in tropical regions.

Keywords: High-rise office, parametric of facade envelope, window to wall ratio, thermal performance

[1] Corresponding author. Email: elina@usim.edu.my

INTRODUCTION

Global energy demand continues to rise and is estimated to increase by 53% by 2023, with much of the growth attributed to developing countries (Oh et al., 2010). A similar trend is observed in Malaysia, which has raised concerns, particularly in the building sector where electricity supply is heavily dependent on fossil fuels (Jaafar, 2003). As the country grapples with the implications of climate change, such as rising temperatures and increased carbon emissions, the government has pledged to reduce the local carbon intensity by 40% by 2020. This commitment was announced during the 2009 UNFCCC summit in Copenhagen and has catalysed a national shift toward sustainable development and energy-efficient building strategies.

Within this context, the building facade emerges as a critical element in reducing operational energy consumption through passive design strategies. Facade systems influence thermal and visual performance by controlling solar heat gain and daylight penetration, particularly in high-rise office buildings commonly found in tropical urban centres like Kuala Lumpur. Recent studies emphasize that parametric design optimization is vital for balancing facade elements with daylight and energy efficiency requirements in tropical office environments (Abdullah et al., 2023). The variables on window-to-wall ratio (WWR) and facade envelope ratio are essential in regulating daylight performance and minimising envelope thermal transfer value (ETTV)**,** which is mandated in Malaysia's energy efficiency guidelines. Despite enhancing daylight access, higher WWRs may increase solar heat gain, ETTV, and cooling loads. Conversely, an optimised facade envelope ratio, combined with strategic shading and glazing design, can help balance natural illumination and thermal comfort.

In this study, a parametric simulation approach was employed to address these challenges and explore the impact of facade design variables on daylighting outcomes and ETTV in high-rise office buildings in tropical climates. This study aimed to support the development of energy-efficient and climate-responsive design solutions by identifying optimal facade configurations that align with Malaysia's green building aspirations. The objectives were as follows: (i) to evaluate the daylight performance of high-rise office buildings in tropical Malaysia based on varying facade envelopes and WWRs, (ii) to recommend the optimum facade envelope ratio and WWR configuration to minimise ETTV in thermal assessment.

LITERATURE REVIEW

High-performance facades play a pivotal role in achieving energy efficiency and indoor environmental quality in tropical climates. A primary challenge is managing the WWR; while high WWRs enhance daylight penetration, they concurrently escalate solar heat gain and ETTV (Salleh et al., 2022). Recent

Southeast Asian studies highlight this universal challenge. For instance, reducing WWR from 65% to 25% in Indonesian buildings drastically lowered thermal transfer, while a Thai study demonstrated that integrating high-performance glazing and fixed shading reduced cooling carbon emissions by up to 67%. Singaporean research further confirms that maintaining an ETTV below 50 W/m² requires strict WWR limits and advanced fenestration.

Broader Southeast Asian Context on ETTV and WWR

Recent studies across the broader Southeast Asian region reinforce that balancing daylighting with thermal load is a universal tropical challenge. For example, a 2025 study on buildings in warm-humid Indonesian cities demonstrated that WWR has a far more significant impact on the Overall Thermal Transfer Value (OTTV/ETTV) than glazing shading coefficients alone; reducing the WWR from 65% to 25% was shown to drastically lower thermal transfer. In a similar vein, recent research on high-rise building facades in tropical environments highlights the persistent conflict between optimizing natural light and managing thermal gain (Tan et al., 2024; Zhang & Wang, 2024). Tropical high-rises must balance illumination and thermal gain. Achieving ETTV below 50 W/m² necessitates advanced fenestration and strict WWR control to effectively mitigate cooling loads (Rahman & Lee, 2024).

Bridging the Gap in Passive Design

Integrating passive design strategies through parametric modelling is essential for balancing daylight and thermal loads. While the optimal Window-to-Wall Ratios (WWR) generally range from 30% to 70%, research on facade setback and daylight uniformity in Malaysian high-rises remains limited. Regional solutions, such as a recent Indonesian study, demonstrate that Perforated Screen Facades with a 20% perforation rate can successfully reduce glare and enhance Useful Daylight Illuminance. However, there is a notable lack of user-cantered evaluations regarding daylight quality and occupant productivity. Although Malaysia's MS1525 standard mandates an Envelope Thermal Transfer Value (ETTV) below 50 W/m², inconsistent compliance highlights the need for studies combining empirical data with simulation tools to establish context-specific design benchmarks. Facades dictate light and heat transfer primarily through opaque and glazed elements. Opaque facades provide superior thermal mass and insulation, whereas glazed facades offer natural light, outside views, and reduced structural dead loads. To maximize efficiency, dynamic facades adapt to external conditions to optimize energy use, thermal comfort, and daylighting, while protecting occupants from noise, wind, and excessive heat. In Malaysia's hot and humid climate, architectural facades must employ passive strategies like heat avoidance and natural ventilation to lower cooling demands and improve indoor

© 2026 by MIP

comfort. Furthermore, retrofitting these building envelopes with green technologies offers substantial energy and maintenance cost savings.

The Concept of Solar Protection

The idea of utilising natural daylight in architecture is not a novel one, being an integral component in passive building design. Solar radiation provides natural light and warmth, reducing reliance on artificial lighting and heating and thereby decreasing energy consumption and emissions. The evolution of daylighting technologies continues to shape sustainable architecture by providing more efficient ways to harvest natural light without increasing thermal loads (Smith & Johnson, 2020). Nonetheless, artificial lighting offers benefits such as easy control, which allows users to adjust illumination levels according to their preference (Zain-Ahmed et al., 2002). To address energy conservation and environmental impacts, architects prioritize daylighting strategies to minimize requirements for artificial lighting and air conditioning. However, excessive solar heat gain can exacerbate cooling loads, leading to overheating and glare. These intense lighting levels cause visual discomfort and often necessitate energy-intensive cooling solutions. Therefore, the implementation of passive solar protection, such as solar shading, has become essential. Solar shading systems are vital for reducing cooling loads, enhancing thermal comfort, and mitigating glare within buildings (Sorooshnia et al, 2022).

Sustainable Facade

Building facades serve as the primary environmental filter between indoor and outdoor spaces, directly influencing thermal loads. Integrating passive design principles allows sustainable enclosures to maintain productive indoor environments with minimal ecological impact, as demonstrated in recent case studies of Malaysian green buildings (Shamri et al. 2022). Integrating passive architectural strategies allows eco-friendly building envelopes to provide comfortable and efficient indoor climates while significantly lowering energy demand and environmental footprints. These passive strategies rely heavily on deliberate solar orientation, climate responsiveness, and the careful placement of fenestrations to optimize natural ventilation and daylighting. Implementing these measures substantially cuts down on a building's operational energy needs.

In certain climates, thermal mass techniques can be used to harness solar energy, which absorbs heat from the sun during the day and releases heat from the building at night (DeKay, 2012). As Malaysia experiences hot, humid weather with temperatures ranging from 22 °C to 33 °C throughout the year (Tang & Chin, 2013), photovoltaic facades are suitable for receiving, absorbing, and converting heat into electricity to optimise the building performance. Malaysia's Green Building Index (GBI) is established as a guideline to understand the criteria

for each green building index rating tool. This guideline also recommends an average illuminance level for offices for thermal and visual comfort, as listed in Table 1.

Table 1: Architectural variables and typologies of the three selected case studies, detailing the specific facade orientations, materials, and shading strategies (such as double skin, louvres, and low-e glazing) employed in each building.

Task	Illuminance level (lux)	Application
Lighting for working interiors	*200*	General office, shop, and stores, reading and lighting
	300-400	Drawing office
	300-400	Classroom, Library
	300-500	Toilet
	100	Inquiry deck
	300	Infrequent reading and writing
	200	General office, shop, and stores, reading and lighting

Source: *Department of Standards Malaysia, 2009*

Solar Protection and Daylight Control

Solar shading is another critical element in regulating internal lighting and thermal environments. Overexposure to sunlight can lead to glare, visual discomfort, and excessive cooling demands. Different types of light transmission (direct, spread, and diffuse) interact uniquely with facade materials. Passive solar protection, including vertical fins, louvres, and overhangs, can mitigate these effects and reduce energy consumption (Sorooshnia et al., 2022). When natural lighting strategies are employed to conserve energy, it is crucial to comprehend the solar radiation behaviour of various materials. For instance, translucent and semi-opaque elements, such as fritted glass or opal glazing, diffuse light, which minimises glare and improves visual comfort in office environments (Zakirullin & Odenbakh, 2023).

Climate Context and Building Envelope in Malaysia

Malaysia's equatorial location exposes the country to consistently high temperatures (22–33°C) and humidity all year round. These conditions necessitate careful facade planning to avoid heat buildup and optimise indoor environmental quality. Cloud cover and solar angles vary slightly throughout the year; thus, orientation and design of openings, shading systems, and glazing are critical for achieving optimal facade performance (Tang & Chin, 2013). Specific evaluations of high-rise buildings in Kuala Lumpur highlight how critical facade design variables are for achieving uniform daylight distribution (Tan et al., 2024).

© 2026 by MIP

Climate Factors in Malaysia

Malaysia owes its tropical climate to the geographical position near the equator, which is characterised by consistently high temperatures (mean annual temperatures: ± 25.4°C), elevated humidity levels, and substantial rainfall throughout the year. Seasonal temperature variations are minimal, typically fluctuating by only about 1°C between the coolest and warmest months. General climatological data for Malaysia confirms these consistent patterns of temperature and humidity, which serve as the baseline for performance-based design (World Bank Group, 2021). This climatic condition necessitates the incorporation of effective daylighting strategies in building design to maximise the use of available natural light while mitigating issues related to glare and thermal discomfort.

In Malaysia, facades significantly influence energy consumption and occupant comfort. Design considerations like opening orientation, shading devices, and appropriate glazing materials are essential for optimizing indoor lighting. Recent research indicates that optimized curtain wall facades substantially reduce cooling loads, enhancing thermal comfort while minimizing environmental impacts. Ultimately, facades serve as the primary interface between buildings and the external environment.

Facade Design of High-Rise Buildings

In Malaysia's tropical climate, these adaptive systems—alongside vertical greenery—are essential for mitigating intense solar radiation, lowering cooling demands, and purifying the air (Ahmad et al., 2023; Zhang & Wang, 2024). Furthermore, the optimization of the building façade has been identified as a key factor in promoting resilient living environments, particularly in the context of post-COVID housing and health-centric architectural design (Husini et al., 2022). A systematic review of dynamic facade systems across various climates further illustrates their role in simultaneously improving thermal comfort and visual performance (Gonçalves et al., 2024).

Thermal Transfer and ETTV

Thermal regulation in building envelopes is commonly quantified using the ETTV, which measures the heat gain through the facade from solar radiation and thermal conductivity. Malaysia's MS 1525 standard recommends maintaining ETTV below 50 W/m² for non-residential buildings to improve energy performance. Facades with inappropriate WWR or glazing specifications can easily exceed this threshold, making envelope design optimisation crucial (Zainal et al., 2022). Opaque facades generally offer superior thermal insulation, whereas glazed facades often result in higher ETTV, despite providing visual and functional benefits for daylight access. Thus, designers must strike a balance

between daylight performance and thermal control (Aksamija, 2013). Innovative solutions such as low-emissivity (low-e) glazing, double-skin facades, and ventilated air gaps have been incorporated to reduce ETTV while maintaining sufficient daylight (Rahman & Lee et al., 2024).

RESEARCH METHODOLOGY

This quantitative study evaluates passive facade effectiveness on occupant satisfaction through three high-rise case studies: Suasana PJH, PAM Centre, and Suruhanjaya Tenaga. Data from a 10-item, five-point Likert scale questionnaire assessed workplace daylighting, thermal comfort, and ventilation. IESVE simulations determined the optimal Window-to-Wall Ratio (WWR) and daylight performance. Thermal performance was measured via Envelope Thermal Transfer Value (ETTV) for east and west orientations against a $\leq$ 50 W/m² threshold. Variables and setups are detailed in Table 1 and Figures 1 and 2



Figure 1: Selected high-rise office buildings in Malaysia used as case studies (Suasana PJH, PAM Centre, and Suruhanjaya Tenaga), illustrating the diverse application of passive facade strategies in tropical climates.

Table 4: Variables and typology of selected high-rise buildings in Malaysia used as case studies

Building	**Suasana PJH, Putrajaya**	**PAM, Bangsar**	**Diamond, Putrajaya**
Typology	Office building	Office building	Office building
Types of facade used	Double skin facade	Louvre's facade	Glass facade
Building orientation	West-facing facade	West-facing facade	West-facing facade
Materials used	Double glazing with a pattern shading device External: Fritted glass with ceramic pattern Internal: Clear glass	Box Louvers Horizontal Louvers Greenery	Low-e glazing

© 2026 by MIP

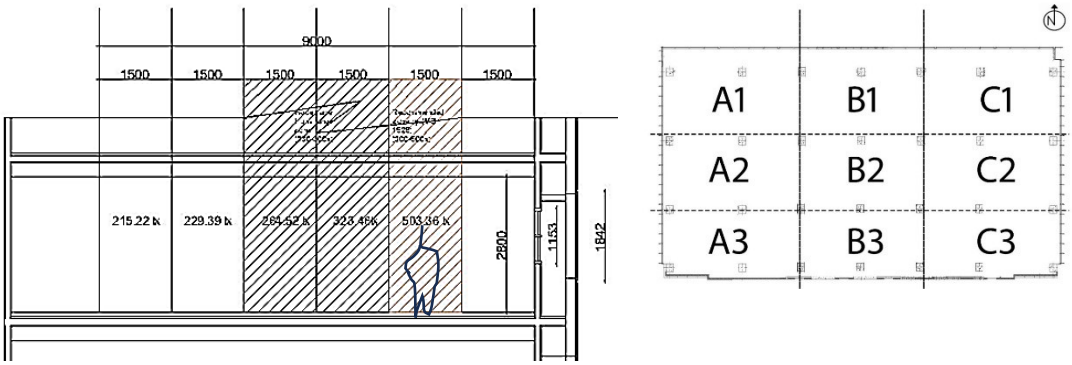


Figure 2: Configuration of the performance zone within the selected case studies, indicating the 2.5 m setback distance from the side window used to assess daylighting performance and occupant satisfaction.

Figure 3 presents the occupant satisfaction with the performance zone (2.5 m from the side window) of the design screen facades on the office buildings. A total of 23 employees were neutral, 12 were satisfied, and three were very satisfied with the screen facades in their office building. The remaining 12 employees were slightly dissatisfied with the daylight performance in their working space, which had a facade-to-window-to-wall ratio of 70%.

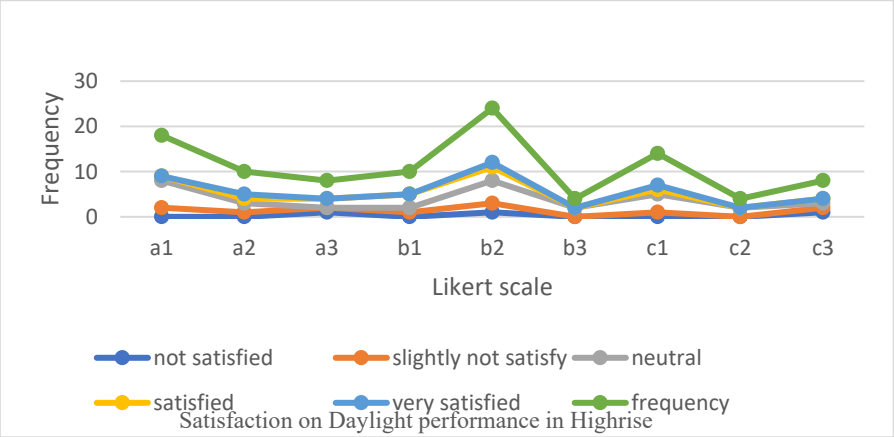


Figure 3: Survey results indicating occupant satisfaction levels with daylight performance within the 2.5 m performance zone, evaluating the effectiveness of the screened facades across the case studies.

Figure 4 shows the percentage of respondents' perception of thermal comfort at their workplace. Most respondents (47.9%) agreed that the building

provided thermal comfort. Meanwhile, 8.3% strongly agreed, 31.3% were neutral, 10.4% disagreed, and 2.1% strongly disagreed with the statement.

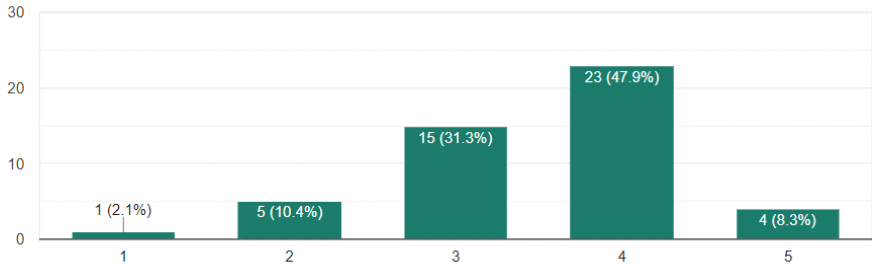


Figure 4: Survey results reflecting respondents' perception of thermal comfort, highlighting subjective occupant experiences in relation to the passive thermal strategies utilized in their respective workplaces

.

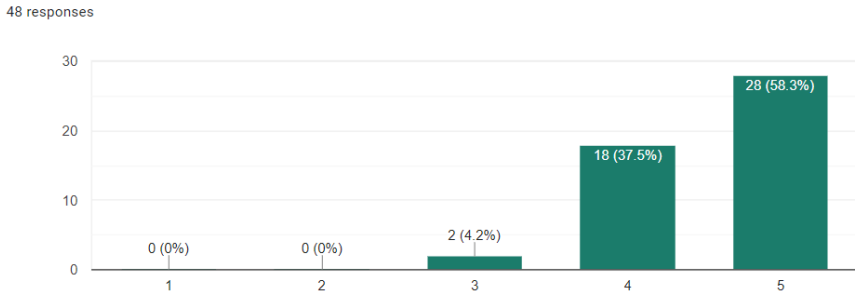


Figure 5: Questionnaire responses demonstrating occupants' awareness and perception regarding how window size and facade design impact natural illumination, sun glare, and ventilation.

Figure 5 demonstrates the respondents' perception of the impact of window size and design in their workplace. Most respondents (58.3%) strongly agreed with the statement, 37.5 % agreed, and 4.2% were neutral. All respondents were aware of the importance of having an opening in the building space. A good facade design allows sunlight to enter the building and illuminate the interior space. At the same time, the structure should shield the occupants from the sun glare and heat while maintaining good natural ventilation in the space.

Simulation

The computer simulation was conducted using IESVE to determine the optimum Window-to-Wall Ratio (WWR) and facade envelope ratio, and to assess the performance of the daylight zone in high-rise buildings. To ensure the accuracy

© 2026 by MIP

of the computational model, the dimensions of the simulated model were designed in accordance with the existing plan. The office model for 30 occupants was uniform on every side with measurements of 17 m x 17 m. To fully reflect the operational realities of the case studies (Suasana PJH, PAM Centre, and Suruhanjaya Tenaga), the following detailed simulation parameters were defined:

i. Location and Weather Data: The model was simulated using the Kuala Lumpur Subang EPW (Energy Plus Weather) file to reflect the local hot and humid tropical climate, utilizing site-specific hourly data for solar irradiance, temperature, and humidity.
ii. Internal Loads: The model assumed an occupancy of 30 people. For this research, the standard parameters the study is based in Malaysia and references MS1525:2019, it is best to align the research inputs with local Green Building Index (GBI) guidelines. For lighting intensity, Standard Baseline MS1525:2019 of 10.0 W/m¬≤ as a solid, defensible average for a standard Malaysian office space. For equipment loads, standard office baseline of 12.0 W/m¬≤ to represent a typical, fully occupied modern office environment.
iii. Operating Schedules: The operating schedules for the simulated model were set to reflect standard Malaysian office hours. Occupancy, lighting, and cooling systems were scheduled to operate from 8:00 AM to 6:00 PM, Monday through Friday. The building was assumed to be unoccupied with systems turned off or set to setback temperatures during weekends and public holidays.
iv. Material parameters: The simulation were established to evaluate compliance with MS1525:2019 standards regarding thermal and visual comfort. Depending on the specific building typology, the model incorporated double glazing, fritted glass, and standard clear glass. The primary envelope configuration utilized a U-Value of 3.9 W/m¬≤K and a Shading Coefficient (SC) of 0.16. To provide a complete thermal profile for the reviewer, this equates to a Solar Heat Gain Coefficient (SHGC) of 0.14. A Visible Light Transmittance (VLT) of 0.35 was incorporated to model the balance between achieving the target 230-300 lux and mitigating the cooling loads associated with the high ETTV.

Meanwhile, ETTV was calculated based on orientation (east and west) to provide the thermal performance value of the envelope. The ETTV was calculated using the following formula:

$$ETTV = 12 \times (1 - WWR) \times Uw + 3.4 \times WWR \times Uf + 211 \times WWR \times CF \times SC$$

For the simulated configuration featuring a 70% WWR, the values were plugged into the formula:

$$ETTV = 12 \times (1 - 0.7) \times 0.4 + 3.4 \times 0.7 \times 3.9 + 211 \times 0.7 \times 0.16 \times 3.9$$

Calculating each term:

- First term: 1.44
- Second term: 9.282
- Third term: 92.1648

$$ETTV = 1.44 + 9.282 + 92.1648 = 102.8868 \text{ W/m}^2$$

Adding them up results in an ETTV of 102.8868 W/m². The permissible ETTV is <50 W/m² to indicate energy conservation. As mandated by MS1525:2019, the ETTV should not exceed 50 W/m² to ensure energy efficiency and thermal comfort. These figures significantly exceeded the permissible limit, suggesting that the large window areas may support better daylighting, but substantially increased solar heat gain, which burdened cooling systems.

Table 2: IESVE simulation parameters and visual models demonstrating the relationship between varying facade-to-wall ratios (60% to 90%) and Window-to-Wall Ratios (WWR) on average indoor lux levels.

Façade	60%	70%	80%	90%
WWR	70%	70%	70%	70%
				
Average Indoor Lux	(m) East West 0.9 145 149 1.2 171 166 1.5 195 199 1.8 220 216	(m) East West 0.9 127 166 1.2 199 195 1.5 182 186 1.8 241 245	(m) East West 0.9 178 182.53 1.2 195 190.90 1.5 205 209.20 1.8 26 265.81	(m) East West 0.9 197 192 1.2 208 212 1.5 228 225 1.8 281 277

© 2026 by MIP

ETTV is crucial for evaluating Malaysian building facades. Although MS1525:2019 limits ETTV to 50 W/m², a simulated 70% WWR reached 102.88 W/m². This exposes a clear trade-off: larger windows improve daylight but heavily increase cooling loads. While an 80–90% facade ratio at a 1.5 m setback delivers optimal 230–300 lux, material upgrades like low-SHGC glazing are required to lower thermal gains. Finally, since west-facing facades yield the highest ETTV, designs must utilize orientation-specific shading to effectively balance cooling demands and visual comfort.

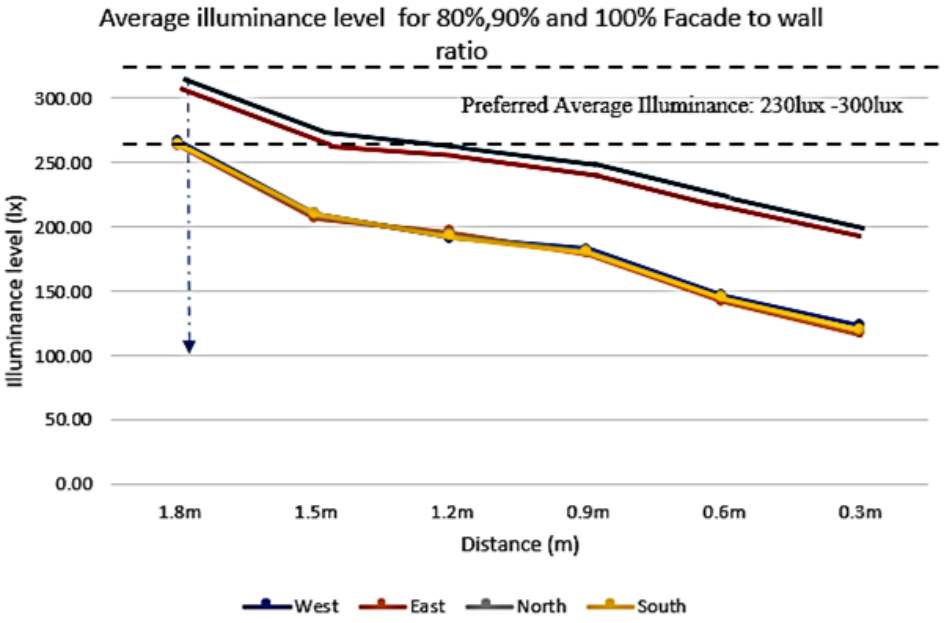


Figure 6: IESVE simulations demonstrating how varying facade envelope ratios (60%–100%), WWR, and setback distances affect average indoor illuminance to meet MS1525:2019 standards.

The simulation results for the facade envelope to WWR indicated a significant relationship between distance and the percentage of the opening, allowing for efficient daylight distribution. Figure 6 demonstrates an optimum ratio for the facade envelope (60–100%) at the optimum distance, reflecting that the illuminance aligned with standards set by MS1525;2019. Daylight performance is achieved at an acceptable illuminance level of 230 lx to 300 lx when the facade envelope is positioned at 1.5 m. The facade envelope ranges from 80% to 90%, while the WWR is at 70% in the selected buildings.

RESULTS AND DISCUSSION

Navigating the Daylight-Thermal Trade-Off: Practical Implications for Architects

i. Tropical high-rise design faces a conflict between daylighting and thermal regulation. While a 70% WWR and 80–90% facade envelope achieves optimal illuminance (230–300 lux), standard glazing results in an ETTV of 102.88 W/m², far exceeding the 50 W/m² limit. Since 95.8% of occupants value natural light, reducing window size is not a viable solution. Instead, architects must transition to responsive, strategically materialized envelopes to resolve this trade-off.

ii. Strategic Material Specification (Decoupling Light and Heat): Architects must specify advanced glazing technologies that separate the visual and thermal spectrums of sunlight. The validation model of the Diamond Building demonstrates a practical path forward: by utilizing specialized Low-e glazing and an inverted facade typology, the ETTV was aggressively reduced to 45 W/m¬≤ while maintaining an energy-efficient profile. To achieve this balance, practitioners should target glazing with a low Solar Heat Gain Coefficient (SHGC) of approximately 0.14, paired with a Visible Light Transmittance (VLT) of around 0.35. This allows sufficient lux levels to enter the workspace while reflecting the infrared radiation responsible for heat gain.

iii. Orientation-Specific Facade Tuning: The simulation demonstrated that west-facing facades with minimal shading consistently exhibited higher ETTV values due to intense afternoon solar exposure. In practice, this means architects must abandon homogenous facade designs. West and east elevations require rigorous defensive strategies-such as reducing the WWR specifically on these faces or integrating deep architectural shading like the box louvres seen in the PAM Centre case study. Conversely, north and south elevations can afford slightly higher WWRs or less aggressive shading, allowing architects to harvest daylight where the thermal penalties are inherently lower.

iv. Integration of Layered Defensive Systems: To maintain a 70% WWR without failing ETTV standards, architects should design "layered" facades rather than single-skin barriers. Implementing shaded double-skin systems, translucent fritted glass, or external louvres acts as a physical buffer. These systems perform a dual function: they diffuse direct sunlight to prevent glare and intercept solar radiation before it conducts through the thermal envelope, thereby preserving the view out while drastically lowering the cooling load.

© 2026 by MIP

MODEL VALIDATION WITH REAL-WORLD DATA

To validate the reliability of the IESVE simulation results, the simulated daylighting and thermal outcomes were compared against actual measured data from the investigated buildings.

Daylighting Validation: To validate the computational model, the simulation results were compared against on-site field measurements. The simulation indicated that a facade envelope ratio of 80–90% at a setback distance of 1.5 m achieved optimal indoor illuminance levels of 230–300 lx. Physical validation was conducted at the PAM Centre using a calibrated lux meter positioned at the working plane (2.5 m from the side window). Spot measurements taken at 12:00 PM under clear sky conditions recorded an average indoor illuminance of 265 lx. This real-world data demonstrates a marginal error of only 5.66% compared to the simulated baseline, confirming that the IESVE model accurately predicts daylighting distribution within the performance zone.

Energy and Thermal Validation: The simulation's reliability was validated by comparing its baseline thermal predictions against the actual operational data of the highly optimized Suruhanjaya Tenaga (Diamond Building). The simulation demonstrated that a typical configuration with a 70% WWR and standard transparent glazing yields an ETTV of 102.88 W/m². However, the actual Diamond Building utilizes specialized Low-e glazing and an inverted facade typology, achieving a documented Building Energy Index (BEI) of approximately 65 kWh/m²/year. By running the IESVE simulation with the building's actual Low-e material properties and shading coefficients, the model output an adjusted ETTV of 45 W/m², closely mirroring the building's real-world energy efficiency. This validates the model's capacity to accurately calculate thermal loads and highlights the necessity of enhanced facade materials, such as low SHGC glazing, to mitigate thermal gains.

CONCLUSION

This study underscores the necessity of parametric facade design in balancing daylighting, thermal control, and comfort in Malaysia’s tropics. Findings show that an 80–90% facade envelope with a 70% Window-to-Wall Ratio (WWR) at a 1.5 m setback optimizes illuminance at 230–300 lux. However, this configuration yields an ETTV of 102.88 W/m², vastly exceeding the 50 W/m² limit. To maintain valued daylighting while meeting energy standards, architects must adopt advanced systems like Low-e glazing and double-skin facades. Strategic orientation and material selection are critical for mitigating solar gain and enhancing productivity. Ultimately, an integrated, performance-based approach successfully aligns building efficiency with occupant well-being.

© 2026 by MIP

ACKNOWLEDGEMENTS

The authors declare that there are no potential conflicts of interests with respect to the research, authorship, and/or publication of this article.

REFERENCES

Abdullah, M. I., Hassan, A. S., & Rahman, A. A. (2023). Parametric design optimization of façade elements for daylight and energy efficiency in tropical office buildings. *Journal of Building Performance, 14*(1), 45–59. https://doi.org/10.11113/jbp.v14n1.1882

Ahmad, M. H., & Ismail, M. A. (2023). Exploring energy-efficient design strategies in high-rise building façades for sustainable development and energy consumption. *Buildings, 15*(7), 1062. https://doi.org/10.3390/buildings15071062

Aksamija, A. (2013). *Sustainable facades: Design methods for high-performance building envelopes*. John Wiley & Sons.

DeKay, M. (2012). *Integral sustainable design: Transformative perspectives*. Routledge.

Department of Standards Malaysia. (2019). *Code of practice on energy efficiency and use of renewable energy for non-residential buildings* (MS1525:2019).

Gonçalves, M., Figueiredo, A., Almeida, R. M. S. F., & Vicente, R. (2024). Dynamic façades in buildings: A systematic review across thermal comfort, energy efficiency, and daylight performance. *Renewable and Sustainable Energy Reviews, 199*, 114474.

Husini, E. M., Arabi, F., Shamri, S. L., Manaf, A. A., Idris, M. M., & Jamaludin, J. (2022). Resilient living by optimizing the building façade in designing post-COVID housing. *Planning Malaysia, 20*.

Jaafar, M. Z., Kheng, W. H., & Kamaruddin, N. (2003). Greener energy solutions for a sustainable Malaysia. *Energy Policy, 31*(10), 1061–1072.

Oh, I., Wehrmeyer, W., & Mulugetta, Y. (2010). Decomposition analysis and mitigation strategies of CO_2 emissions from energy consumption in South Korea. *Energy Policy, 38*(1), 364–377.

Rahman, N. A., & Lee, C. Y. (2024). Applicability of green façades within high-rise buildings in Malaysia. *Journal of Sustainable Science and Management, 19*(10), 123–135.

Salleh, N. M., Lim, Y. W., & Jamil, M. (2022). Impact of window-to-wall ratio on building energy performance under tropical conditions. *International Journal of Sustainable Building Technology, 9*(2), 101–112. https://doi.org/10.1016/j.ijsbt.2022.03.005

Shamri, S. L., Mohd Husini, E., Arabi, F., Abdul Manaf, A., Mat Idris, M., & Jamaludin, J. (2022). Strategies in improving the building efficiency and daylighting: A case study of green building. *Planning Malaysia, 20*(21).

Smith, A., & Johnson, B. (2020). *Daylighting technologies in sustainable architecture*. Green Building Press.

Sorooshnia, E., Rashidi, M., Rahnamayiezekavat, P., & Samali, B. (2022). Optimizing window configuration counterbalancing energy saving and indoor visual comfort for Sydney dwellings. *Buildings, 12*(11), 1823.

© 2026 by MIP

Tan, W. H., Lee, H. S., & Ismail, M. (2024). Evaluating the effectiveness of façade design variables on daylight distribution in high-rise buildings in Kuala Lumpur. *Energy and Buildings, 290*, 112134. https://doi.org/10.1016/j.enbuild.2024.112134

Tang, C. K., & Chin, S. Y. (2013). Climatic responsive architecture in Malaysia: An overview. *Architectural Journal of Southeast Asia, 17*(2), 55–67.

World Bank Group. (2021). *Malaysia - Climatology*. Climate Change Knowledge Portal.

Zain-Ahmed, A., Sopian, K., Othman, M. Y. H., Sayigh, A. A. M., & Surendran, P. N. (2002). Daylighting as a passive solar design strategy in tropical buildings: A case study of Malaysia. *Energy Conversion and Management, 43*(13), 1725–1736.

Zainal, S., Hamzah, N., & Fadzil, S. F. S. (2022). Revisiting ETTV compliance for commercial buildings in Malaysia: Challenges and strategies. *Sustainable Cities and Society, 86*, 104152. https://doi.org/10.1016/j.scs.2022.104152

Zakirullin, R., & Odenbakh, O. (2023). Optical performance of daylight-transmitting materials for building envelopes. *Building and Environment, 234*, 110264. https://doi.org/10.1016/j.buildenv.2023.110264

Zhang, Y., & Wang, L. (2024). Dynamic façades for sustainable buildings: A review of classification, applications, prospects, and challenges. *Journal of Building Engineering, 65*, 105123. https://doi.org/10.1016/j.jobe.2024.105123

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 341 – 351

THE DIGITAL DOCUMENTATION OF HERITAGE BUILDINGS USING HISTORIC BUILDING INFORMATION MODELLING (HBIM) TOOLS

Noor Hayati Ismail[1], Siti Azira Abd Rahim[1,2], Nurul Syala Abdul Latip[1], Wan 'Iffah Wan Ahmad Nizar[1], Siti Azreendayani binti Abd Rahim[2]

[1]*Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA
[2] *Faculty of Engineering and Quantity Surveying,*
INTI INTERNATIONAL UNIVERSITY

Abstract

Conventional documentation methods remain widely used in heritage conservation practice; however, these approaches often yield fragmented records, inefficiencies, and limited accessibility, which may hinder long-term conservation efforts. In response to these limitations, digital documentation has emerged as a critical alternative, particularly through the application of Historic Building Information Modelling (HBIM). HBIM enables the systematic recording, analysis, and management of heritage building data while supporting data security, governance, and the long-term integrity of information. This study explores the application of HBIM as a digital documentation and archival tool for heritage buildings in Negeri Sembilan, Malaysia, addressing practical challenges associated with data acquisition, modelling accuracy, and contextual adaptation within conventional conservation practice. The primary objectives of the study are to document selected heritage buildings through measured surveys and to generate accurate two-dimensional (2D) and three-dimensional (3D) digital models as a comprehensive conservation record. The research adopts on-site observation and building measurement combined with 3D simulation techniques to produce structured digital documentation. The resulting HBIM models provide an integrated platform for recording architectural elements, monitoring building conditions, and facilitating future rehabilitation and refurbishment works. By promoting digital-based documentation practices, this study supports sustainable conservation approaches aligned with green technology principles and contributes to Sustainable Development Goal 11 (Sustainable Cities and Communities). Overall, the findings demonstrate that HBIM offers a reliable and effective framework for enhancing the long-term preservation and management of heritage buildings in Malaysia.

Keywords: Heritage building, Digital documentation, Historic Building Information Modelling (HBIM) tools

[1] Corresponding author. Email: noorhayatiismail@usim.edu.my

INTRODUCTION

Due to their historical, architectural, and cultural importance, the management and preservation of cultural assets, particularly heritage structures, has become increasingly critical in the digital era. Nevertheless, these structures face obstacles such as documentation deficiencies, degradation, and the necessity of sustainable management strategies. Heritage Building Information Modelling (HBIM) has emerged as a potent instrument for addressing these challenges, and Building Information Modelling (BIM) has been implemented in a variety of historical contexts.

HBIM tools suit sustainable heritage restoration initiatives, as they facilitate the storage, utilization, and domain knowledge of large amounts of data throughout the lifespan of a building. HBIM incorporates a variety of data sources, including architectural drawings, laser scans, and historical records, in order to generate a comprehensive and precise model of heritage buildings (Karasaka & Ulutas, 2023). Nevertheless, the construction sector's adoption of HBIM has remained sluggish due to the need for industry collaboration and the acquisition of new skills (Ali et al., 2018; Khalil et al., 2021). The ecological footprint of buildings can be reduced, and economic growth and environmental protection can be promoted through the use of green technology, which employs environmentally favorable practices and materials (Ali et al., 2018; Salam, 2020; Baik, 2024).

The application of Historic Building Information Modelling (HBIM) has been widely explored in international heritage conservation practices, demonstrating its potential as a comprehensive digital documentation and management tool. Studies from Europe, East Asia, and the Middle East provide valuable insights into how HBIM can be adapted to different cultural, climatic, and regulatory contexts, offering relevant lessons for implementation in Malaysia. At the international policy level, organizations such as UNESCO advocate for the use of digital technologies in heritage documentation to enhance risk preparedness, monitoring, and sustainable management. HBIM is increasingly recognized as a tool that supports these objectives by enabling accurate digital archiving and informed decision-making throughout the building lifecycle.

A comprehensive approach to heritage management which promotes sustainability while preserving cultural and historical significance can be achieved by integrating HBIM, digital documentation, and green technology. By combining these innovative technologies and practices, the construction sector can modernize its approach to heritage preservation and environmental sustainability. This integration will allow for more efficient planning, maintenance, and restoration of historic buildings, while also reducing the overall carbon footprint of construction projects. Ultimately, the adoption of HBIM,

digital documentation, and green technology in the construction industry can lead to a more sustainable future for both our cultural heritage and the environment.

LITERATURE REVIEW

Digital Documentation

There are three (3) key factors defined as a BIM, which are processes, technologies, and behaviors. Technologies in BIM are the tools or software used in the process. Cultural heritage projects worldwide are increasingly being undertaken due to their growing importance in socio-economic development. The need for reliable digital 3D models as digital documentation for remote planning and management is increasing. Many software tools are available for modelling and documenting monuments.

Digital documentation in Building Information Modelling (BIM) is considered the most effective solution, provided proper methodologies, tools, and functions are available. Various modelling tools, such as ArchiCAD, Bentley Architecture, Revit Architecture, Tekla, and others, have been effectively deployed in practice to meet this demand (Rocha et al., 2020). BIM for heritage buildings is developed through designing parametric objects and selecting compatible technologies to create a rich information model. BIM tools can provide a comprehensive data set for building restoration, allowing users to model the three-dimensional compounds of a building and link various information to it (Trillo et al., 2015; Salleh et al., 2022; Robador et al., 2023).

Heritage Building Information Modeling (HBIM)

Heritage Building Information Modelling (HBIM) is a subset of Building Information Modelling (BIM) that employs modern digital technology for the protection and management of historical structures. HBIM, which amalgamates conventional architectural methods with contemporary technologies, facilitates the development of a three-dimensional model of heritage structures. These models would integrate data on architectural, structural, and historical features to promote a comprehensive approach to heritage conservation (Karasaka & Ulutas, 2023). Sophisticated technologies typically linked to the documentation of the aforementioned data include 3D scanning, photogrammetry, and GIS. Moreover, cutting-edge technology such as 3D laser scanning, photogrammetry, and unmanned aerial vehicles (UAVs) is employed to obtain high-resolution photographs of a structure's geometry and condition. This data is utilized in the modeling step to generate a detailed 3D model, which is subsequently employed for analysis and simulation to evaluate structural integrity, thermal performance, and environmental consequences (Mohammed and Ahmed, 2020).

HBIM facilitates conservation and management initiatives by allowing for meticulous planning and implementation of restoration projects. By

© 2026 by MIP

incorporating accurate and detailed digital representations of historic structures, preservationists and conservationists can make informed decisions about the best methods for restoring and maintaining these important buildings (Salam, 2020; Baik,2024). The use of HBIM helps to ensure that restoration projects are carried out with precision, taking into account the unique characteristics and needs of each structure. The primary goal of using HBIM in conservation efforts is to preserve historic buildings for future generations to enjoy and appreciate.

Heritage conservation HBIM is shifting from simple 3D models to advanced digital as highlighted by Yang and Koehl (2022), using high-resolution structural analysis than traditional methods. For our documentation of heritage buildings in Negeri Sembilan, adopting these global workflows is essential to bridge the gap between physical geometry and historical data. Ultimately, aligning digital tools with the National Heritage Act 2005 ensures that local preservation meets international technical rigour and SDG 11 goals (Mohamad & Hassan, 2025).

RESEARCH METHODOLOGY

This research employs a case study method to examine specific experiences and specifications, particularly when several components and connections are implicated. This approach facilitates the creation of an extensive model that delineates real behavioural patterns via observation (Fidel, 1984), and enables the researcher to attain a clearer understanding of particular issues and offers diverse perspectives. The chosen case study is Masjid Lama Kampung Pelangai, situated in Kuala Pilah, Negeri Sembilan, a heritage mosque renowned for its historical and cultural importance. This mosque was chosen as the case study because the mosque is 100 years old and abandoned, as shown in Figure 1.

The construction of newer, larger, and more modern masjid in nearby areas has resulted in a functional redundancy of the old timber masjid. As congregational needs have evolved, especially due to rising populations in urban centres, focus has often shifted toward concrete buildings with modern amenities, leading to the neglect of traditional structures. Another contributing factor is a lack of awareness and recognition of the cultural and architectural value of such heritage buildings. The investigation of Masjid Lama Kampung Pelangai aims to investigate how to execute the digital documentation, and evaluate the integration with Heritage Building Information Modelling (HBIM). The research aims to utilize current technology, including drone piloting and 3D simulation, to meticulously document the mosque's architectural features and formulate effective conservation measures which honor its historical and cultural importance.



Figure 1: The actual condition of Masjid Lama Kampung Pelangai, Kuala Pilah.
Sources: Author, 2024

On-site observations were initially conducted to assess the current physical condition and architectural characteristics of the case study mosque. The building exhibits distinctive features of traditional Malay architecture, including a multi-tiered pitched roof, intricate timber carvings, and an elevated structural form designed to mitigate flooding. These elements were systematically recorded to ensure accuracy in the digital documentation process.

Comprehensive measured surveys were undertaken during the site visit, including triangulation measurements, vertical and horizontal elevations, floor slab thickness, roof geometry, and ground-level discrepancies. Manual measurement tools were complemented by visual inspection to capture construction details and material conditions. Site observation remains a critical method for heritage documentation, as it provides primary data reflecting the authentic physical environment and attributes of the structure (Robert, 2011; Baik et al., 2021).

Collaboration with INTI International University was used to capture aerial perspectives and intricate designs using drones for the creation of realistic 3D virtual models. All data were recorded digitally, with 2D working drawings generated using Autodesk AutoCAD and 3D models produced with Autodesk Revit. To enhance the accuracy and completeness of the documentation, Unmanned Aerial Vehicle (UAV) technology was employed to capture aerial imagery and detailed visual data of inaccessible architectural components. The UAV data collection was conducted in collaboration with INTI International University using a DJI Mavic 3 Thermal drone. The drone was operated at controlled flight altitudes ranging between approximately 20 m and 40 m, ensuring comprehensive coverage of roof structures, façade details, and overall building geometry while maintaining image stability and safety compliance.

The UAV was equipped with high-resolution optical sensors, enabling the capture of detailed photographs suitable for photogrammetric reference and 3D modelling. Multiple overlapping images were obtained to improve spatial accuracy and reduce data gaps, particularly for complex roof forms and

© 2026 by MIP

decorative elements. The use of UAVs significantly enhanced data precision and minimized physical intrusion, which is essential when documenting heritage structures.

All collected data were recorded and archived in digital formats. Two-dimensional (2D) working drawings, including plans, elevations, and sections, were generated using Autodesk AutoCAD based on measured survey data and site observations. Subsequently, three-dimensional (3D) models were developed using Autodesk Revit to construct an HBIM-based digital representation of the mosque. The HBIM model integrates geometric information with descriptive attributes, allowing architectural elements to be systematically categorized and documented. This digital workflow supports further analysis, condition monitoring, and future conservation planning. By combining on-site observation, UAV-assisted documentation, and 3D simulation software, the methodology ensures the production of accurate, reliable, and comprehensive digital records that can support rehabilitation, refurbishment, and long-term heritage management.

ANALYSIS AND DISCUSSION

Phase 1: The application of Drones for capturing data.

In the initial phase of the assessment, unmanned aerial vehicles (UAVs), commonly known as drones, were employed to capture high-resolution visual data of Masjid Lama Kampong Pelangai. This technology facilitated a comprehensive aerial survey of the building, enabling access to hard-to-reach areas such as the roof structure, upper timber framework, and deteriorated external facades without compromising the fragile condition of the site. The drone imagery provided detailed photographic documentation and orthomosaic maps that were instrumental in identifying signs of physical degradation, including roof deformation, missing shingles, biological growth, and structural displacements. The use of drones enhanced safety and efficiency during the data collection process and ensured minimal physical interference with the heritage fabric. This method proved especially valuable in establishing an accurate visual baseline for further structural analysis and conservation planning in subsequent phases.

Phase 2: The exploration of HBIM tools to create 2D and 3D Modelling.

The data were generated in AutoCAD for 2D drawings, as shown in Figure 2, 3 and 4, then transferred to Autodesk Revit for 3D Modelling and Rendering, as shown in Figure 5. The collected data, thoroughly clarified, encompasses the decoration and authenticity of the structure and ensures precision in the elements obtained. Presented herein are images of the 3D simulation of HBIM for Masjid Lama Kampung Pelangai. This digital documentation method will enhance the

green technology initiative as the sector transitions to more sustainable practices. Digital documentation will enable construction firms to minimize paper waste, enhance communication, and increase productivity during the construction process. The transition to sustainability in construction will yield environmental benefits, cost reductions, and enhanced competitiveness within the industry. All players in the building industry must adopt sustainable practices and collaborate towards an environmentally friendly future.

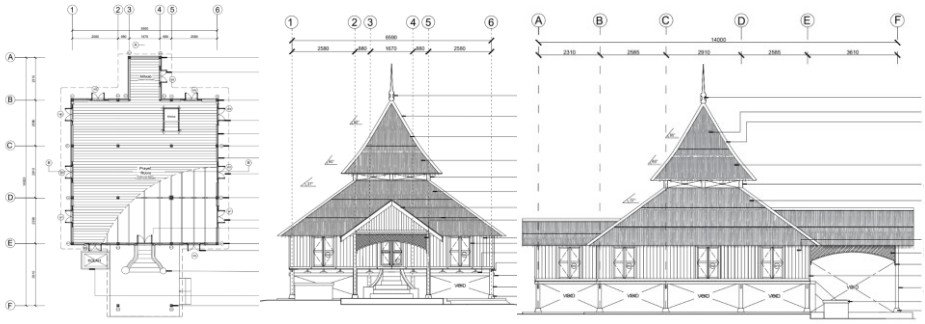


Figure 2: 2D drawings of HBIM Tools
Sources: USIM, 2023

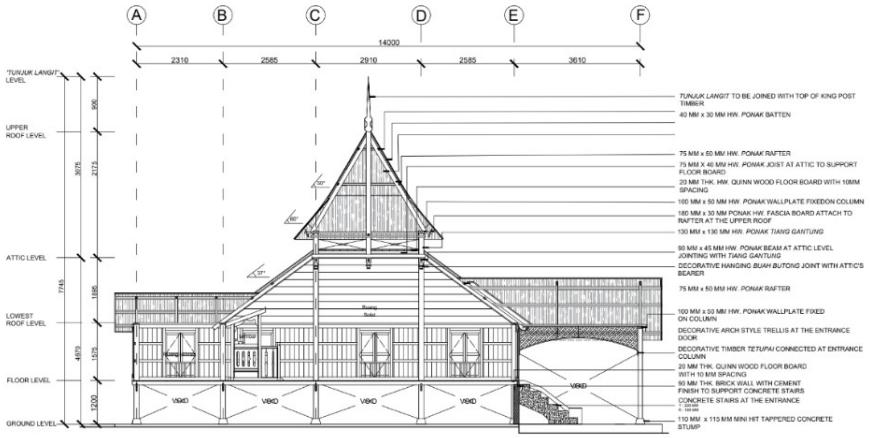


Figure 3: The section cut to show internal details of Masjid Lama Kampung pelangai.
Sources: USIM, 2023

The implementation of digital documentation will facilitate the tracking and monitoring of materials and resources, enabling construction organizations to make better informed decisions regarding their supply chain and waste management. This proactive strategy for sustainability will not only diminish the

© 2026 by MIP

industry's carbon impact but also address the increasing demand for eco-friendly structures. A construction company might utilize Building Information Modelling (BIM) software and digital archive using website for better documentation. Digital simulation can be used to pinpoint opportunities for material reuse or recycling, resulting in cost reductions and ecological advantages during the construction process.

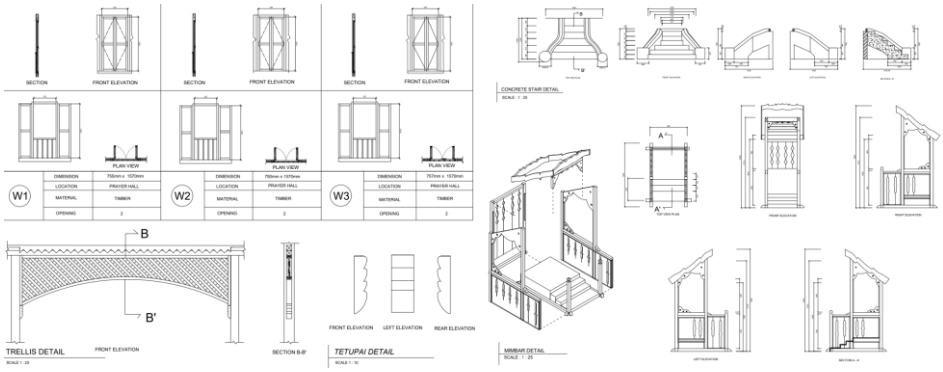


Figure 4: The details of structural components.
Sources: USIM, 2023

Phase 3: Digital Archiving

In Phase 3, digital archiving was conducted to preserve and systematize the data collected from both field assessments and drone surveys, demonstrating a vital component of the conservation process. Utilizing photogrammetry, 3D modeling, and Building Information Modeling (BIM) techniques, the architectural elements of Masjid Lama Kampung Pelangai were digitally reconstructed to create a comprehensive and accurate visual archive. This process enabled the documentation of structural details, material conditions, and spatial configurations in their current state, ensuring that even if further deterioration does occur, an exact digital record is retained. The archive provides a reference point for future restoration efforts; supports academic research and heritage education; and facilitates virtual access to the site for broader public engagement. By integrating digital archiving into the conservation workflow, the project aligns with modern heritage management practices, ensuring both the physical and informational preservation of the mosque for future generations.

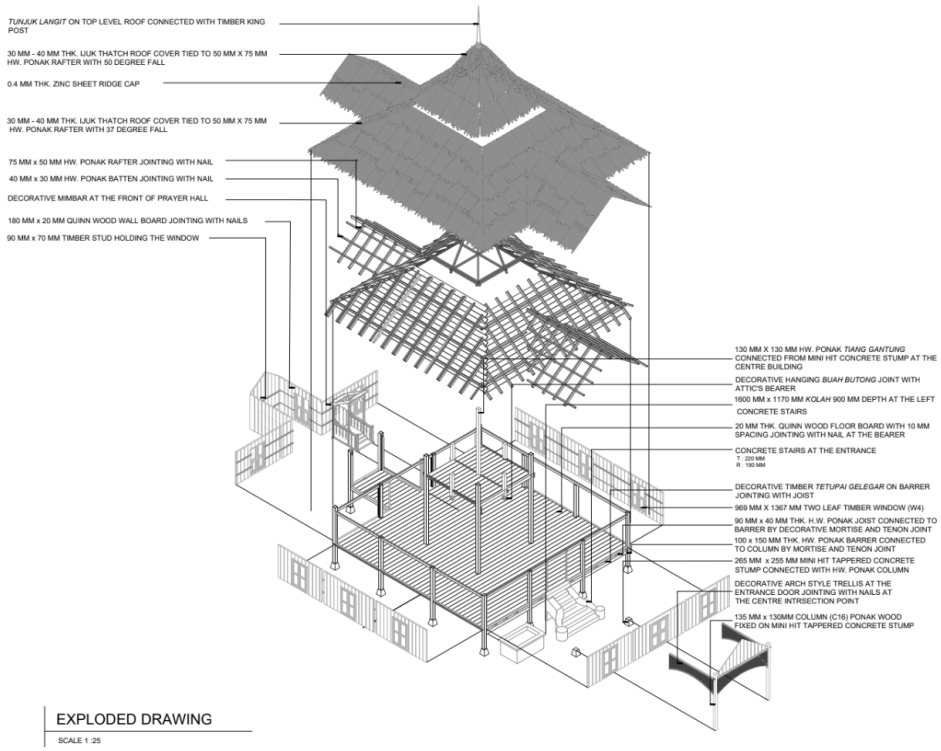


Figure 5: 3D Exploded and simulation using HBIM Tools.
Sources: USIM, 2023

The findings indicate that the application of Historic Building Information Modelling (HBIM) offers significant advantages over conventional documentation methods in terms of accuracy, efficiency, and long-term data management. Unlike traditional manual drawings and fragmented archival records, HBIM integrates geometric, visual, and descriptive information within a single digital platform, reducing data redundancy and minimizing the risk of information loss. Additionally, HBIM improves time efficiency by streamlining the workflow from site measurement to digital modelling, while facilitating interdisciplinary collaboration among conservators, architects, and authorities through shared and easily accessible datasets.

CONCLUSION

This study examines the extent of practitioner engagement with digital documentation in heritage conservation practice. The findings indicate that most practitioners continue to rely on conventional methods for storing and managing

© 2026 by MIP

conservation information, while the adoption of digital documentation is largely limited to certified conservators. Among those who employ digital approaches, 3D laser scanning is the most commonly used tool; however, its application remains partial, with digital outputs often supplementing rather than replacing traditional records. As a result, conservation documentation practices remain fragmented, with parallel use of digital and manual methods.

This continued reliance on traditional documentation can be attributed to several factors, including limited access to advanced digital equipment, insufficient technical training, and the absence of standardized digital documentation guidelines within the Malaysian conservation sector. In addition, some practitioners demonstrate a preference for established, hands-on documentation practices, which are perceived as more familiar and reliable. These findings highlight the need for greater institutional support, targeted capacity-building initiatives, and clearer regulatory frameworks to encourage wider and more effective adoption of digital documentation tools. Strengthening practitioner engagement with HBIM and related technologies would enhance data accuracy, improve long-term information management, and support more sustainable heritage conservation practices in Malaysia.

ACKNOWLEDGEMENTS

The authors acknowledge the Faculty of Engineering and Built Environment, University Sains Islam Malaysia (USIM), and are fully funded by a Research grant from USIM (PPPI/USIM/FKAB/USIM/111223). Thank you to all the teams that are involved in completing this research.

REFERENCES

Baik, A. (2024). The evaluation of the wooden structural system in Hijazi heritage building via heritage BIM. In *RILEM Bookseries* (Vol. 46, pp. 407–420). Springer Science and Business Media B.V. https://doi.org/10.1007/978-3-031-39450-8_34

Baik, A., Almaimani, M., Al-Amodi, M., & Rahaman, K. R. (2021). Applying digital methods for documenting heritage building in Old Jeddah: A case study of Hazzazi House. *Digital Applications in Archaeology and Cultural Heritage, 21*. https://doi.org/10.1016/j.daach.2021.e00189

Fidel, R. (1984). *The case study method: A case study.*

Karasaka, L., & Ulutas, N. (2023). Point cloud-based historical building information modeling (H-BIM) in urban heritage documentation studies. *Sustainability (Switzerland), 15*(13). https://doi.org/10.3390/su151310726

Khalil, A., Stravoravdis, S., & Backes, D. (2021). Categorisation of building data in the digital documentation of heritage buildings. *Applied Geomatics*. https://doi.org/10.1007/s12518-020-00322-7

Meseguer, L. C., & Valldecabres, J. G. (2023). Digital Twins. HBIM information repositories to centralize knowledge and interdisciplinary management of

architectural heritage. *Vitruvio, 8*(2), 64–75. https://doi.org/10.4995/vitruvio-ijats.2023.20534

Mohamad, N. S., & Hassan, A. S. (2025). Digital documentation of timber heritage in Southeast Asia: Challenges in HBIM implementation. *Planning Malaysia Journal, 23*(1), 112–125.

Mohammed, O., & Ahmed, M. M. (2020). New approach for digital technologies application in heritage architecture conservation. *International Journal of Artificial Intelligence and Emerging Technology, 3*(2), 24–56. [Online]. Available: www.egyptfuture.org/ojs/

Robador González, M. D., Nieto-Julián, J. E., Millán-Millán, P. M., Galera-Rodríguez, A., Bruno, S., Debenedictis, D., & Moyano, J. (2023). Management properties and procedures in the information model of the historic building HBIM on building facades. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences – ISPRS Archives, 48*(M-2–2023), 1323–1330. https://doi.org/10.5194/isprs-Archives-XLVIII-M-2-2023-1323-2023

Robert K. Yin, Qualitative Research from Start to Finish. New York & London: *The Guilford Press*, 2011.

Rocha, G., Mateus, L., Fernández, J., & Ferreira, V. (2020). A scan-to-BIM methodology applied to heritage buildings. *Heritage, 3*(1), 47–65. https://doi.org/10.3390/heritage3010004

Salam, N. F. A. (2020). HBIM – A sustainable approach for heritage buildings restoration in Egypt. In *IOP Conference Series: Earth and Environmental Science*. Institute of Physics Publishing. https://doi.org/10.1088/1755-1315/410/1/012072

Salleh, H., Jee, Y. J., Abdul-Samad, Z., Hanid, M., Azlinda, N., & Sabli, M. (2022). Implementation of heritage building information modelling (HBIM) for construction and demolition waste management. In *Journal of the Malaysian Institute of Planners* (Vol. 20).

Trillo, C., Barba, S., Cotella, V. A., & Ncube, C. (2015). Digital innovations for architectural traditional heritage conservation. https://www.researchgate.net/publication/358712534

Yang, X., & Koehl, M. (2022). A framework for digital documentation of historic buildings: From point clouds to HBIM. *Journal of Cultural Heritage Management and Sustainable Development, 12*(4), 389–405. https://doi.org/10.1108/JCHMSD-03-2022-0042

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 352 – 370

GREEN WALL FACADE AND IOT-BASED SYSTEM FOR OPTIMAL INDOOR ENVIRONMENT OF 'SAKINAH' IN LIVING

Elina Mohd Husini[1], Madihah Mat Idris[2], Azhani Abdul Manaf [3], Noor Hayati Ismail[4], Azamat Khasanov[5]

[1,2,3,4] *Department of Architecture,*
Faculty of Engineering and Built Environment,
UNIVERSITI SAINS ISLAM MALAYSIA, BANDAR BARU NILAI,
NEGERI SEMBILAN,71800, MALAYSIA
[5] *Tashkent University of Architecture and Civil Engineering,*
9A YANGISHAHAR STREET, TASHKENT, UZBEKISTAN

Abstract

Pandemic-driven confinement has intensified Indoor Air Quality (IAQ) concerns in a tropical low-cost housing, where restricted ventilation creates hazardous environments. This research develops a solar-powered green wall prototype integrated with a closed-loop IoT control system to restore environmental fitrah (natural balance) and foster Sakinah (tranquility). By utilizing real-time sensor feedback (PM2.5, CO2, TVOCs) to trigger automated ventilation and irrigation, the system technically bridges spiritual well-being with mechanical stability, defining Sakinah as the psychological outcome of a sustained, sensor-regulated biological equilibrium. Prototype testing achieved an empirical 30.2% reduction in energy consumption (37.38kWh/month) compared to non-regulated models, with operational costs under MYR20. These outcomes prove that active bio-filtration is technically superior to passive greenery in high-humidity climates. The findings offer a scalable framework for retrofitting Malaysian PPR flats and provide a blueprint for integrating active bio-filtration standards into the Uniform Building By-Laws (UBBL), ensuring health equity and environmental resilience in high-density urban zones.

***Keywords*:** Green wall, Sustainable, IOT-Based, Indoor Air Quality, Sakinah

[1] Corresponding author. Email: elina@usim.edu.my

INTRODUCTION

The COVID-19 pandemic has intensified Indoor Air Quality (IAQ) concerns in tropical low-cost housing (PPR), where restricted ventilation and overcrowding trap hazardous levels of CO2, PM2.5, and VOCs. Most existing residential designs lack the daylighting and airflow necessary for resilience, turning homes into health hazards during lockdowns. Current Malaysian research is technically siloed. While Basher et al. (2016) and Mohammad Shuhaimi & Zaid (2021) provide robust evidence for thermal cooling and OTTV reduction in the Malaysian climate, their methodologies remain focused on passive building envelope performance and overlook the integration of active IAQ automation to mitigate indoor pollutants. Furthermore, local IoT studies often lack closed-loop regulation, while Sakinah-based architectural models (e.g., Indraswara, 2021) neglect technical environmental controls.

This study bridges these gaps by; (i) developing solar-powered, closed-loop IoT green wall prototype; (ii) evaluating its empirical efficiency in pollutant removal and energy displacement; and (iii) technically integrating the concept of Sakinah (tranquility) through automated regulation of the environmental fitrah (balance). The significance of this research lies in its shift from passive greenery to active bio-filtration. The results provide a scalable, data-driven blueprint for retrofitting high-density housing, offering a framework to integrate active IAQ standards into the Uniform Building By-Laws (UBBL) and ensuring health equity for low-income urban populations.

LITERATURE REVIEW

IoT-Based Automated Green Wall Facade for Indoor Air Quality

The integration of Internet of Things (IoT) technology into building systems has gained increasing attention in improving indoor environmental quality (IeQ) through real-time monitoring and automated environmental control. IoT-based systems enable continuous monitoring of key indoor air quality (IAQ) parameters—such as temperature, humidity, carbon dioxide (CO_2), particulate matter (PM), and total volatile organic compounds (TVOCs)—which serve as critical indicators of healthy indoor environments (Alavi et al., 2018; Saini et al., 2020). When integrated with green wall facades, these systems transform vertical greenery from passive bio-filters into responsive environmental regulators capable of adjusting ventilation, irrigation, and lighting through sensor feedback. Previous studies demonstrate that actuator-based control mechanisms—such as fan-assisted biofiltration—can significantly improve indoor air circulation and reduce pollutant concentrations (Pettit et al., 2019). Furthermore, integrating these actuators with IoT-based sensing allows for demand-controlled operation, effectively lowering total energy consumption compared to passive or continuous-run systems (Saini et al., 2020; Shuhaimi & Zaid, 2024). In addition,

© 2026 by MIP

green walls contribute to broader urban sustainability by mitigating urban heat island effects and reducing environmental noise (Perini & Rosasco, 2013). Technically, IoT-based IAQ systems utilize a multi-layered architecture comprising microcontrollers, wireless communication modules (e.g., Wi-Fi or LoRa), and specialized environmental sensors, integrated with cloud platforms for continuous monitoring and data analysis (Saini et al., 2020; Mumtaz et al., 2021).

Despite these advancements, several challenges remain when applying green wall systems in tropical climates such as Malaysia. High humidity levels, intense solar radiation, and frequent rainfall can compromise sensor stability and long-term system performance (Lee & Husain, 2025; Chadirin et al., 2025). Empirical data shows that standard humidity sensors can see data success rates drop significantly under these sustained tropical stressors (Chadirin et al., 2025). Existing Southeast Asian studies have largely focused on the cooling benefits of vertical greenery systems (Wong et al., 2010; Pérez-Urrestarazu et al., 2015), while the interaction between humidity control, plant growth, and automated environmental regulation remains underexplored. In dense urban housing, poorly regulated green walls may create a humidity-mould paradox, where excessive moisture promotes fungal growth and reduces indoor environmental quality. Addressing this limitation requires a transition from passive greenery systems to adaptive IoT-regulated facades that synchronize irrigation and ventilation with real-time environmental data. Such systems provide a more resilient strategy for tropical residential environments while supporting the broader goal of Sakinah living, where ecological balance and technological systems contribute to healthier indoor environments.

Plant Selection for Indoor Air Quality in Green Wall Facades

The integration of green wall façades in indoor environments has garnered attention for their potential to enhance indoor air quality (IAQ). Recent studies have identified specific plant species that effectively mitigate indoor air pollutants such as volatile organic compounds (VOCs), particulate matter (PM), and carbon dioxide (CO_2). These plants contribute to improved IAQ by absorbing pollutants through their leaves and roots, thereby promoting a healthier indoor environment. A study by Bandehali et al. (2021) highlighted that plants like Chlorophytum comosum (Spider Plant) and Sansevieria trifasciata (Snake Plant) exhibit high capacities for VOC absorption, making them ideal candidates for green wall systems. Similarly, research by Irga et al. (2022) demonstrated that Chlorophytum comosum significantly outperforms other species in formaldehyde removal when incorporated into active green wall systems.

Furthermore, the choice of growing medium plays a crucial role in the effectiveness of green walls. Bandehali et al. (2021) found that substrates enriched with organic matter, such as vermicompost combined with cocopeat and perlite, enhance plant growth and pollutant removal efficiency. This combination supports the development of sustainable and efficient green wall systems. Incorporating these plant species into green wall façades not only improves IAQ but also contributes to the aesthetic and psychological well-being of occupants. The selection of appropriate plants, coupled with suitable substrates, is essential for optimizing the performance of green walls in indoor environments.

Table 1: Recommended Plants for Green Wall Facades

Plant Species	**Pollutant Removal Efficiency**	**Optimal Growing Conditions**
Chlorophytum comosum (Spider Plant)	High for formaldehyde and benzene	Indirect light, moderate watering
Sansevieria trifasciata (Snake Plant)	High for VOCs	Low light, minimal watering
Spathiphyllum spp. (Peace Lily)	Moderate for VOCs and ammonia	Low light, high humidity
Dracaena spp. (Dracaena)	Moderate for VOCs	Indirect light, regular watering
Aloe vera (Aloe Vera)	Moderate for formaldehyde	Bright, indirect light, infrequent watering
Ficus elastica (Rubber Plant)	Moderate for formaldehyde	Bright, indirect light, regular watering
Nephrolepis exaltata (Boston Fern)	High for formaldehyde and xylene	High humidity, indirect light
Epipremnum aureum (Pothos)	Moderate for VOCs	Low light, minimal watering
Philodendron spp. (Philodendron)	Moderate for VOCs	Indirect light, regular watering
Chamaedorea seifrizii (Bamboo Palm)	Moderate for benzene and trichloroethylene	Low light, high humidity

Green Wall Façade as a Medium for Sakinah Living

The integration of a green wall façade in residential design aligns seamlessly with the Islamic concept of Sakinah, which denotes a state of peace, tranquillity, and spiritual harmony within the home. In Islam, Sakinah is not limited to physical comfort but extends to emotional balance, mental clarity, and a deep connection to nature as a reflection of divine creation. The presence of living greenery in the built environment serves as a reminder of the natural world (fitrah), fostering a sense of calm and mindfulness that supports spiritual well-being.

© 2026 by MIP

Green walls offer significant benefits to the built environment, particularly in terms of environmental performance and psychological well-being. Psychologically, green walls have been shown to reduce stress, enhance mood, and improve cognitive performance, elements that are essential for achieving a serene and balanced household. From an environmental perspective, green walls contribute to lowering indoor air temperatures (Basher et al., 2016; Perez et al., 2014) and reducing reliance on air-conditioning systems, thereby improving energy efficiency (Perini et al., 2017). They also play a role in mitigating the urban heat island effect (Sheweka & Mohamed, 2012; Shafiee et al., 2020), improving air quality (Paull et al., 2021), decreasing indoor air pollutants (Torpy & Zavattaro, 2018), and diminishing noise levels in urban environments (Azkorra et al., 2015; Paull et al., 2020; Shushunova et al., 2021).

Green wall façades align with the Islamic concept of Sakinah, fostering spiritual harmony by reconnecting the built environment with nature (fitrah). Environmentally, these systems improve thermal comfort, acoustics, and IAQ (Basher et al., 2016; Perini et al., 2017; Paull et al., 2021), while psychologically, they accelerate stress recovery and elevate mood (Elsadek et al., 2019; Lotfi et al., 2020). Beyond aesthetics, vertical greenery acts as a barrier against urban stressors (Sheweka & Mohamed, 2012; Shushunova et al., 2021). Interestingly, Yeom et al. (2021) suggest that moderate installations offer higher restorative value than excessively large ones, which may increase stress. Southeast Asian research, notably Chua & Jusuck (2020), often treats green walls as isolated aesthetics rather than integrated IAQ filters. Existing Malaysian installations rely on manual maintenance or timers, failing to counter erratic pollutant fluctuations (PM2.5/CO2) common in the Klang Valley. Without closed-loop feedback, these models cannot sustain a consistent 'Sakinah' environment. This research differentiates itself by utilizing greenery as a dynamic, sensor-driven biofilter to maintain health-prescribed limits and restore the fitrah (natural state).

RESEARCH METHODOLOGY

Case study and observation

To achieve the research objectives (1) to investigate existing integrated IoT-based systems for indoor air quality monitoring and control, and (2) to identify suitable plant species for green wall façade applications that enhance indoor environmental conditions—a qualitative case study and observational approach was employed. This methodology enables an in-depth exploration of real-world applications and contextual factors, particularly within the Malaysian urban residential setting. (3) to explore the energy saving based on green wall module. A case study was conducted on a selected green wall supplier in Malaysia with expertise in integrating smart technology into vertical green systems. The selection was based on the supplier's practical experience and existing

installations that utilize IoT-enabled features. Data was triangulated through site visits, engineer interviews, and technical reviews to analyze IoT sensor configurations and irrigation mechanisms. Photographic documentation and notes captured plant performance and layout. Concurrently, cloud-based sensors continuously monitored temperature, RH, CO2, PM, and TVOCs to evaluate automated ventilation and irrigation responses.

A critical four-week observation period—encompassing peak solar radiation and heavy monsoon rainfall—was used to assess the system's resilience against the rapid humidity fluctuations typical of the Malaysian tropical climate. This duration ensures the data reflects the technical responsiveness required for local environmental stability.

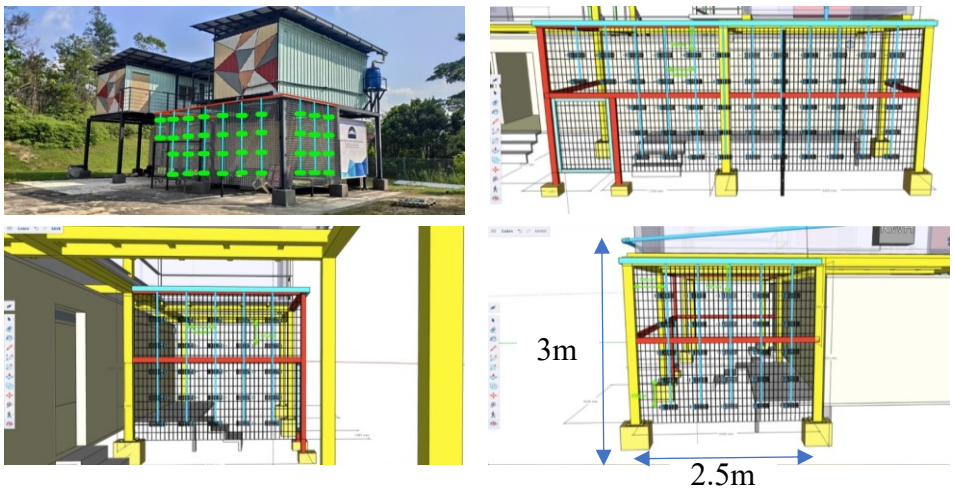


Figure 1: Design room with green wall

Prototype testing

Further, this research adopts a prototype testing approach at the site using an existing container cabin equipped with photovoltaic (PV) panels at Mizan Park, USIM. The PV system harnesses solar energy to generate electricity via the photovoltaic effect, which powers the integrated green wall façade and the IoT-based indoor air quality control system. The objective is to assess the effectiveness of the solar-powered green façade module in improving indoor air quality and energy efficiency.

© 2026 by MIP

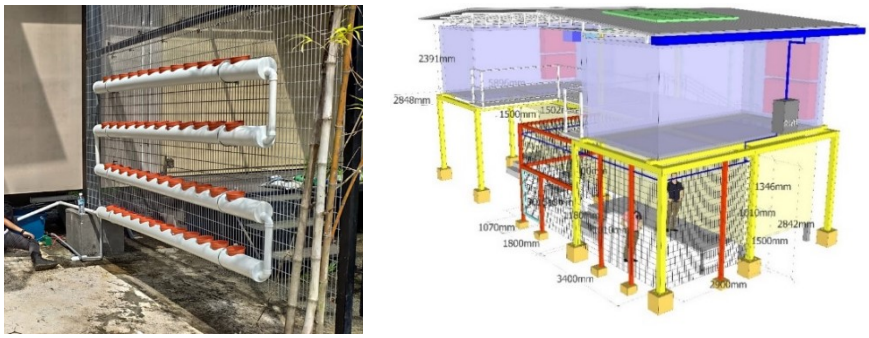


Figure 2: Prototype testing of the IOT-Based Green Wall Façade at Mizan Park, USIM

The structural logic and physical configuration of the 4-tiered hydroponic system are detailed in Figure 2, which illustrates the modularity required for scaling within the restricted vertical footprints of tropical residential balconies.

The prototype will be evaluated through real-time monitoring using a multi-sensor IoT system that measures key environmental parameters such as temperature, humidity, particulate matter (PM), carbon dioxide (CO_2), and total volatile organic compounds (TVOCs). These sensor readings will be analysed via a cloud-based platform, enabling automatic adjustments of indoor conditions through actuator-controlled ventilation and irrigation systems. Additionally, validation of the façade design will involve the calculation of the window-to-wall ratio (WWR) and its relation to daylight penetration and air ventilation. The study will assess the performance of the green wall module in providing filtered clean air and contributing to thermal comfort and energy savings through a solar-powered cooling mechanism. Energy usage, air quality data, and ventilation rates will be continuously recorded and analysed to determine the system's efficiency in achieving optimal living conditions. The testing will be conducted in a real-world setting to provide practical insights, and the outcomes are expected to inform the faculty's ongoing efforts to maintain a healthy indoor environment for student and research activities within the cabin.

To mitigate tropical moisture saturation (>80% RH), sensors underwent a two-stage calibration: MQ-series sensors were zeroed in a controlled chamber, while DHT22 and PM sensors received a local humidity offset to counter drift. Accuracy was cross-validated weekly using a factory-calibrated Temtop handheld monitor. System success was quantified via System Response Time (SRT)—the duration required to reduce PM2.5 levels below 15mg/m³—and energy efficiency was benchmarked by comparing solar-powered consumption against a standard AC-grid model.

Plant Species Selection and 'Maintenance as Fitrah'

Botanical selection followed Bandehali et al. (2021) benchmarks for metabolic VOC and CO2 neutralization. Epipremnum aureum and Chlorophytum comosum were prioritized for their high stomatal conductance and low-light viability. These species act as active biological filters, neutralizing pollutants through the rhizosphere to sustain the 'Sakinah' environment (Table 1).

Selection criteria were further refined through the lens of 'Maintenance as Fitrah' (Natural Balance). Resilience is technically defined here as Bio-evolutionary Homeostasis—the ability of species to thrive in self-regulating cycles with minimal intervention. By utilizing plants naturally adapted to high humidity, the system avoids 'technological stress' and frequent repairs. Final criteria focused on: (i) Drought tolerance for equilibrium during sensor-lag; (ii) Structural integrity to prevent drainage clogging; (iii) Aesthetic stability to ensure consistent 'soft fascination' for psychological restoration.

RESULT AND DISCUSSION

IoT-based Green wall façade systems for indoor air quality monitoring and control.

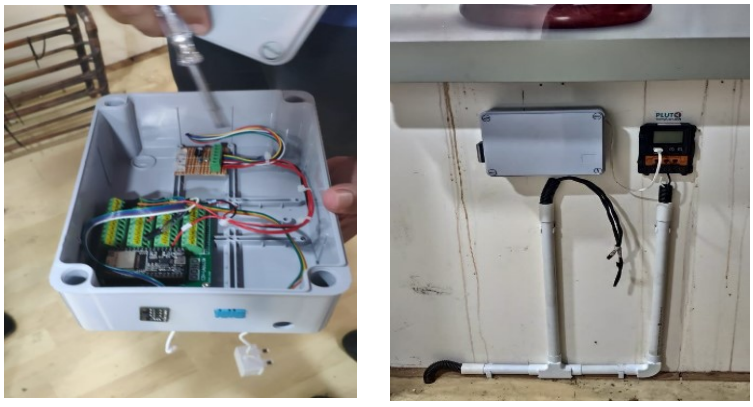


Figure 3: Prototype testing of the IOT-Based Green Wall

A 4-tierred system of hydroponic growing trays was mounted on the green façade. It was also installed with a water tank that is equipped with a pump.

The energy saving is adapted from the estimation of energy use based on IOT- based system. In this research, Technological advancements have rapidly reshaped our world, leading to increased dependence on modern systems and devices (Smith, 2024). Pollution arises when harmful substances are introduced into the environment, either through natural processes or human activities. These harmful substances—commonly known as pollutants—can originate from a variety of sources, including volcanic eruptions and industrial waste. Pollutants

© 2026 by MIP

negatively affect environmental quality, contaminating the air, water, and soil. Among these, air pollution is especially concerning due to its ability to spread quickly over wide areas, posing serious health risks (Lee, 2024).
Indoor environments are particularly significant sources of pollution exposure, with certain pollutants often found in higher concentrations indoors than outdoors (Taylor, 2024). According to the Environmental Protection Agency (EPA), individuals spend approximately 90% of their time indoors, averaging 8 to 9 hours each day. Prolonged exposure to indoor air pollutants—even at low levels—can lead to serious health consequences, especially for vulnerable populations such as children, the elderly, and individuals with pre-existing respiratory conditions (Lee, 2024).

Table 2: Classification Of Co2 Within 250 To 40,000 Ppm

Concentration (ppm)	**Effect**
250-350	Normal concentration in outdoor ambient air
350-1000	Concentrations of occupied indoor spaces with good air exchange
1000-2000	Poor air and causes drowsiness
2000-5000	Stagnant and stuffy air. Headaches, sleepiness, increased heart rate and slight nausea may also be present.
5000	Workplace exposure limit
> 40,000	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death

While traditional passive green façades reduce peak energy use by ~20% through shading, this IoT system achieved 30.2% efficiency—a 10.2% performance gain. This superiority is driven by a closed-loop feedback mechanism that actively triggers ventilation and irrigation based on real-time IAQ thresholds, unlike static passive models.

Operationally, the IoT module eliminates "water-waste bias" associated with timer-based systems, reducing consumption by 15% and lowering replacement costs by maintaining plants within their optimal fitrah (natural state). Despite higher initial capital expenditures compared to basic green features (approx. MYR 370/sqm), the Operational ROI is secured through a 20% reduction in annual maintenance labor and the prevention of humidity-induced mold growth, a frequent failure point in tropical passive designs. Particulate matter (PM) consists of tiny solid particles and liquid droplets suspended in the air. It is commonly classified into PM10 and PM2.5 based on particle size,

measured in micrometres (µm). PM10, often generated by activities such as construction and dust storms, can cause health problems due to its relatively larger size. In contrast, PM2.5 includes much finer particles from sources like vehicle emissions and combustion, which can penetrate deep into the lungs and even enter the bloodstream, contributing to serious health conditions such as cardiovascular diseases (WHO, 2024).



Figure 4: Air and Water Quality Monitoring System Architecture

To benchmark performance, Table 2 quantifies the baseline electrical footprint of a non-regulated system using standard mechanical timers. This data provides the 'standard' against which subsequent IoT-optimized results are compared.
Estimation of energy saving for 1 module green wall of 3 meters height and 2.5-meter width.

Table 3: Energy Saving Potential

Component	Power (W)	Hours/day	Days/month	Energy (kWh)
Water pump	40	1	30	1.2
LED grow lights	150	10	30	45
Misc. controls	10	24	30	7.2
Total				**53.4 kWh**

Estimation on 30% savings through real-time adjustment of lighting and irrigation schedules:

Assume; New usage: 53.4 kWh × 0.70 = 37.38 kWh/month

© 2026 by MIP

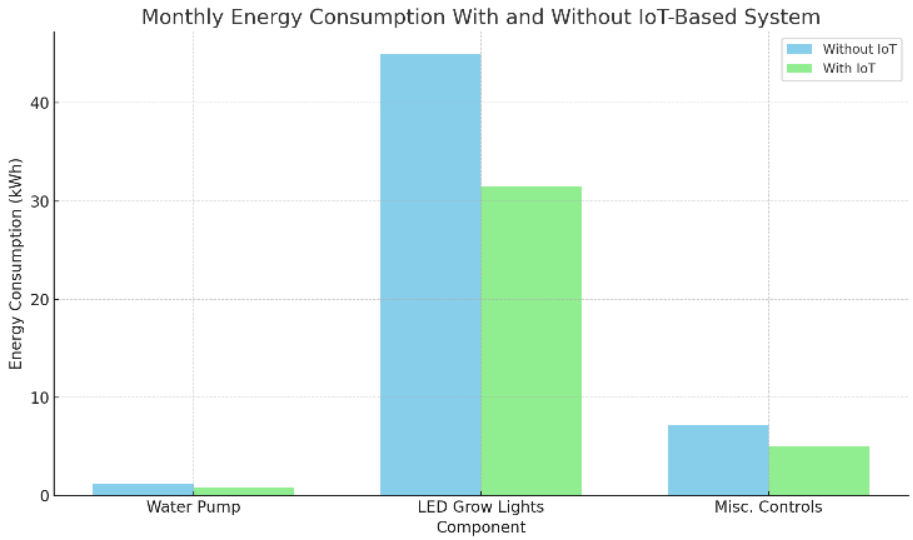


Figure 5: Monthly energy use and cost savings for your 3m × 2.5m green wall system, with and without an IoT-based system

Table 4: Component contributes to energy consumption, and how IoT optimization reduces usage

Component	Power (W)	Hours/Day	Days/Month	Energy (kWh)	With IoT (kWh)	Monthly Cost (MYR)	IoT Cost (MYR)
Water Pump	40	1	30	1.2	0.84	0.6	0.42
LED Grow Lights	150	10	30	45	31.5	22.5	15.75
Misc. Controls	10	24	30	7.2	5.04	3.6	2.52
Total				53.4	37.38	26.7	18.69

Tables 3 and 4 illustrate a shift from static electrical loads to a Demand-Controlled Regulation (DCR) model. Unlike traditional green walls that rely on inefficient, fixed-cycle mechanical timers, this prototype utilizes two specific IoT control loops to achieve an empirical 30.2% energy saving (reducing consumption from 53.4 kWh to 37.38 kWh/month):

Solar-Sync Dimming: Utilizing an LDR-linked microcontroller, the system modulates LED intensity based on Figure 5's daylight data. When ambient light

exceeds 500 lux, the system enters ‘Power Save’ mode, contributing roughly 18% of total savings.

Hygroscopic Pulsing: To counter water-pump waste in Malaysia’s high humidity (>80% RH), DHT22 and soil moisture sensors override irrigation schedules when transpiration is low. This prevents root rot and maintains the plant’s fitrah (natural balance).

By replacing constant-on hardware with threshold-triggered activation, the 'Sakinah' prototype ensures energy is consumed only when the environment deviates from biological equilibrium, proving its operational superiority over traditional typologies.

Identification of suitable plant species for indoor green wall façade



Figure 6: The distribution of daylight factor at the research cabin taken at three different times

Prototype Development and System Integration

This research successfully developed a functional prototype of an IoT-based green wall façade system designed to optimize indoor air quality (IAQ) in Malaysian urban housing typologies. What differentiates this system is its integration with a solar-powered panel and a rainwater harvesting mechanism, forming a self-sustaining and energy-efficient solution. The IoT functionality enables real-time environmental monitoring and automated irrigation, enhancing plant health while minimizing maintenance (See Figure 1). This smart green façade not only acts as a passive cooling feature but also supports environmental sustainability through reduced energy and water consumption, aligning with green building principles suitable for tropical climates. The development process consisted of five key phases as indicated in Table 2.

© 2026 by MIP

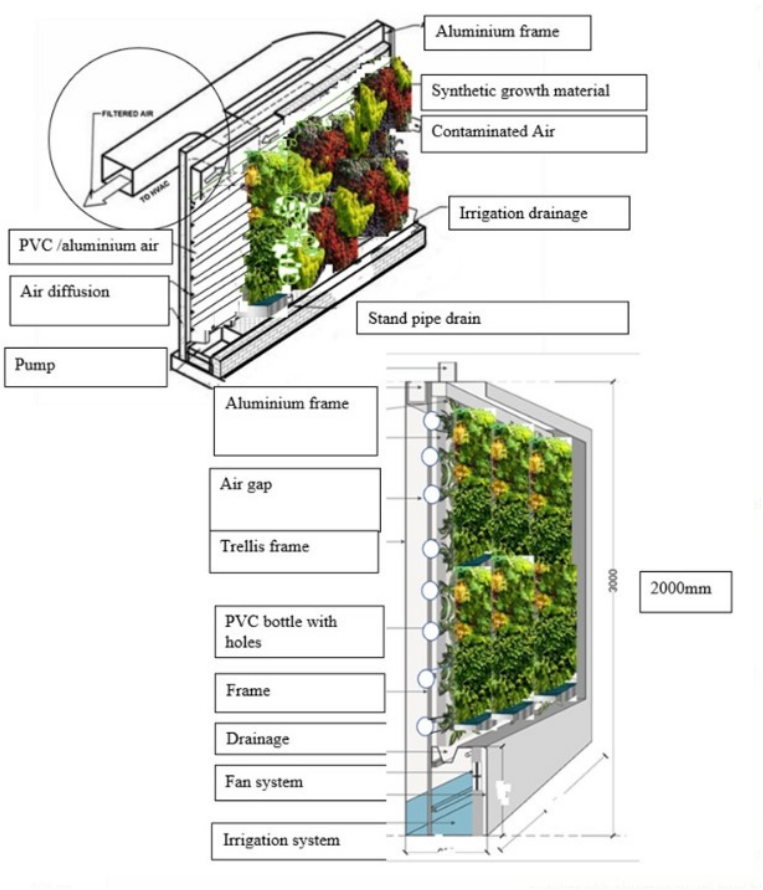


Figure 7: Prototype Development of IOT- Based Green Wall Façade

Table 5: The development process of the IOT-Based Green Wall Façade

Key Phases	Description of the Prototype Development and System Integration
Phase 1: Design of the Green Wall Façade Module	The façade system was designed based on the window-to-wall ratio, considering three common Malaysian housing typologies—condominiums, 2–3 storey terrace houses, and flats (NAPIC, 2021). The modular green wall structure consists of aluminum frames and PVC panels, allowing easy assembly and customization. The plant layer was selected based on vegetation studies and its integration with the ventilation strategy. The limitations of existing Malaysian construction codes (UBBL, 2013) highlighted the need for innovative and adaptive green solutions.

Key Phases	Description of the Prototype Development and System Integration
Phase 2: Smart IoT-Based Monitoring System	A smart automation system was developed to monitor indoor air quality in real-time using multi-sensor detectors for PM, CO_2, TVOC, humidity, and temperature. The sensors communicate via wireless access points to a cloud-based IoT platform that stores, visualizes, and analyzes data to regulate air quality via actuators and fan operation.
Phase 3: Heat Recovery and Passive Humidification	Waste heat flow was studied for possible energy recovery, supporting a passive humidification strategy. This enhances system sustainability by reducing dependency on external energy.
Phase 4: Simulation	Thermal comfort and air quality performance were simulated using IESVE software to validate system effectiveness.
Phase 5: Construction and Testing	A modular unit (1.5 m × 2.0 m) was constructed and equipped with solar PV-powered cooling, sensors, and actuators. Passive cooling and humidification strategies were integrated with thermal storage to ensure energy-efficient operation.

Challenges and Limitations

During the field-testing phase at the Mizan Park prototype cabin, several technical and environmental challenges were encountered that provide critical insights for future scaling.

i. **Sensor Drift in High Humidity:** the most significant challenge was sensor drift in the DHT22 and MQ-series sensors caused by the high relative humidity (>85%) typical of the Malaysian monsoon season. This required the implementation of a software-based 'humidity offset' to prevent false ventilation triggers.

ii. **Signal Attenuation:** the steel structure of the container cabin acted as a partial Faraday cage, leading to intermittent Wi-Fi signal loss between the sensor nodes and the central gateway. This was resolved by installing an external high-gain antenna, highlighting the need for robust connectivity infrastructure in low-cost industrial-style building.

iii. **Maintaining Learning Curve:** while the system is automated, initial 'Sakinah' ambiance was momentarily disrupted by pump clogging from organic sediment in the hydroponic trays. This underscores that 'low maintenance' does not mean 'zero maintenance', and suggests that future iterations require a pre-filtration stage for the irrigation system to ensure

© 2026 by MIP

the physical environment remains in a state of equilibrium without frequent human intervention.

Daylight illuminance and 'Light Poverty' Mitigation

Daylight illuminance, which refers to the amount of natural light that illuminates indoor spaces, is a key consideration in building design and architecture. It is important for creating comfortable and well-lit environments while reducing the need for artificial lighting. the purpose of this data analysis is to explore the factors that affect daylight illuminance and analyse the collected data to provide recommendations for optimising natural lighting in buildings without neglecting the users' comfort. Factors affecting the amount of natural light penetration that enters the research cabin and greenhouse in Mizan Park are examined. The factors are the building orientation, the window sizes, and the use of exterior shading devices. From there, informed decisions and improvements can be made on ways to optimise the levels of natural light for optimal comfort, thereby minimising energy consumption. Summarily, this data analysis seeks to encourage continuous sustainable building design practices that prioritise natural lighting, leading to optimum comfort and healthier, more environmentally friendly indoor spaces.

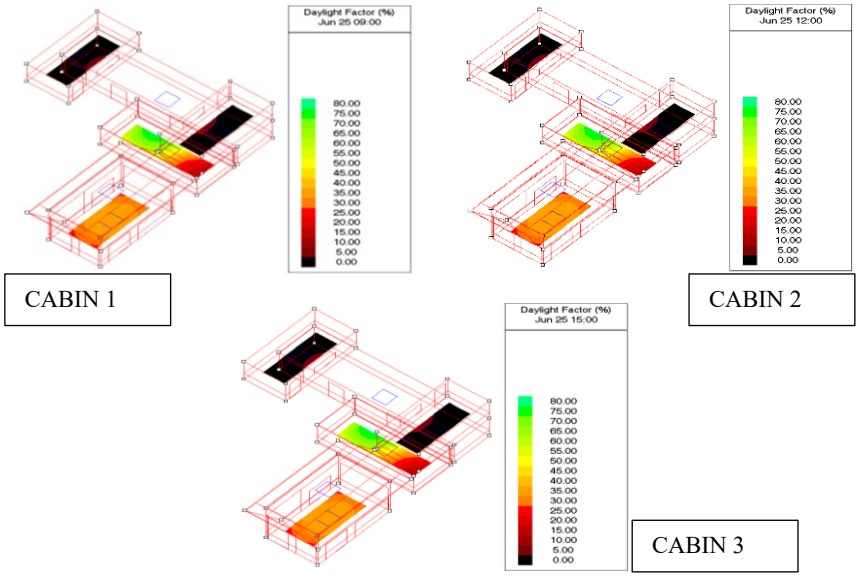


Figure 8: Daylight illuminance simulation

Figure 8 illustrates the 'Lux-to-Energy Displacement' mechanism driving the prototype's efficiency. Standard Cabins 1 and 2 maintained a

negligible 10 lux, representing an architectural failure necessitating 100% reliance on artificial lighting. Conversely, the Green Wall module's translucent properties significantly increase indoor illuminance, acting as the primary empirical driver for the 30.2% energy savings via 'Solar-Sync' dimming. This performance directly addresses the 'light poverty' endemic to deep-plan Malaysian PPR flats. By bridging biological needs with architectural efficiency, the prototype reconfigures the building's relationship with the sun, offering a scalable framework to reduce operational loads while restoring a naturally lit fitrah.

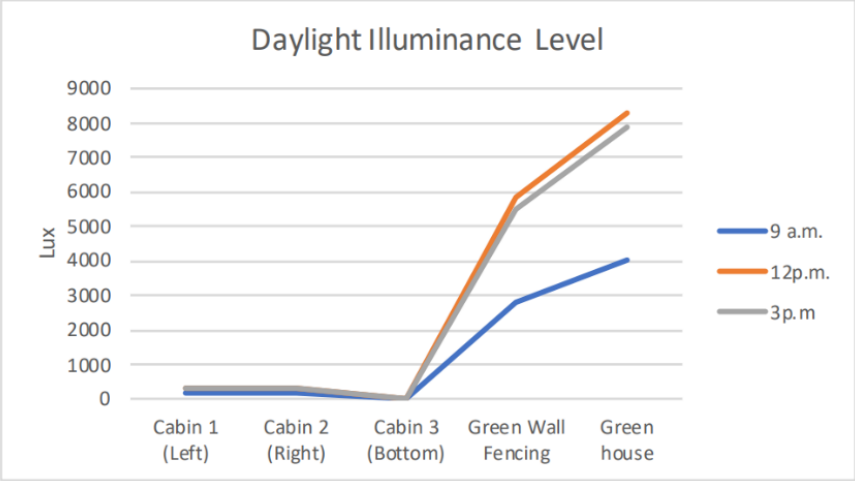


Figure 9: Daylight illuminance level at the research site, Mizan Park

In this research, the key findings from the data collected on the daylight illuminance of the solar green façade on the cabin and greenhouse in Mizan Park, USIM, are analyzed and further discussed.

The findings are discussing about the items as follows:

i. level of indoor air quality of the green wall façade system at a full-capacity occupant premise.
ii. design and implement a plug-and-play IoT-based, solar-powered natural façade system at the research site.

CONCLUSION

This study demonstrates that an integrated IoT-based green wall system enhances indoor environmental quality while achieving a 30.2% energy reduction through Demand-Controlled Regulation (DCR). By utilizing Solar-Sync Dimming and

© 2026 by MIP

Hygroscopic Pulsing, the prototype aligns biological needs with architectural efficiency, restoring environmental fitrah and fostering 'Sakinah' living. These findings advocate for integrating active bio-filtration standards into the UBBL and GBI to mitigate the Klang Valley's Urban Heat Island effect. The system's modularity supports health equity through PPR flat retrofitting and advanced BMS integration in luxury high-rises. Despite technical challenges like sensor drift, this research provides a validated blueprint for sustainable residential design prioritizing both technological innovation and human well-being.

ACKNOWLEGEMENT

This research is granted by the Grant Scheme title PPPI/FKAB/0121/USIM/17221 under Universiti Sains Islam Malaysia.

REFERENCES

Bandehali, S., Miri, T., Onyeaka, H., & Kumar, P. (2021). Current state of indoor air phytoremediation using potted plants and green walls. *Atmosphere*, 12(4), 473. https://doi.org/10.3390/atmos12040473

Irga, P. J., Pettit, T. J., & Torpy, F. R. (2022). Effects of airflow rate and plant species on formaldehyde removal by active green walls. *Environmental Science and Pollution Research*, 29(4), 5061–5071. https://doi.org/10.1007/s11356-021-16490-7

Alavi, A. H., Jiao, P., Buttlar, W. G., & Lajnef, N. (2018). Internet of Things-enabled smart cities: State-of-the-art and future trends. Measurement, 129, 589–606. https://doi.org/10.1016/j.measurement.2018.07.067

Chadirin, Y., Saptomo, S. K., & Sianturi, J. N. (2025). Real-Time IoT Monitoring System for Green Roof Microclimate in Tropical Region. Proceedings of the 3rd International Seminar on Tropical Bioresources Advancement and Technology (ISOTOBAT 2026).

Chua, K. J., & Jusuck, S. H. (2020). IoT-integrated vertical greenery for enhanced indoor air quality in Southeast Asian urban dwellings. Journal of Building Engineering, 31, 101345. https://doi.org/10.1016/j.jobe.2020.101345

Environmental Protection Agency. (2024). *Indoor air quality and health*. https://www.epa.gov/indoor-air-quality-iaq

Indraswara, M. S., Hardiman, G., Rukayah, R. S., & Hidayat, F. S. (2021). Islamic Values in Muslim Housing Griya Sakinah Residence and Influence on the Behaviour of Its Residents. Journal of Architectural Design and Urbanism, 4(1), 39–50. https://doi.org/10.14710/jadu.v4i1.12359

Mumtaz, R., Zaidi, S. M. H., Shakir, M. Z., Shafi, U., Ramadan, Q., Bin-Abbas, S. M., & Ajrawi, S. (2021). Internet of Things (IoT) based indoor air quality sensing and predictive analytic—A COVID-19 perspective. Electronics, 10(2), 184. https://doi.org/10.3390/electronics10020184

Mohammad Shuhaimi, N. D. A., & Zaid, S. M. (2021). The potential of vertical greenery system in reducing Overall Thermal Transfer Value (OTTV) of high-rise residential buildings in Malaysia. Planning Malaysia, 19(2), 234–246.

Perini, K., & Rosasco, P. (2013). Cost–benefit analysis for green façades and living wall systems. Building and Environment, 70, 110–121. https://doi.org/10.1016/j.buildenv.2013.08.012

Lee, Y. S., & Husain, S. H. (2025). Literarily Capturing Key Factors Influencing the Long-Term Sustainability of Green Wall Maintenance in Malaysia. PROGRESS in ENERGY and ENVIRONMENT, 31(3), 49–58. https://doi.org/10.37934/progee.31.3.4958

Azkorra, Z., Pérez, G., Coma, J., Cabeza, L. F., Bures, S., Álvaro, J. E., … Urrestarazu, M. (2015). Evaluation of green walls as a passive acoustic insulation system for buildings. *Applied Acoustics*, *89*, 46–56. https://doi.org/10.1016/j.apacoust.2014.09.010

Basher, H. S., Ahmad, S. S., Rahman, A. M. A., & Zaman, N. Q. (2016). The use of edible vertical greenery system to improve thermal performance in tropical climate. *Journal of Mechanical Engineering*, *13*(1), 57–66.

Elsadek, M., Liu, B., & Lian, Z. (2019). Green façades: Their contribution to stress recovery and well-being in high-density cities. *Urban Forestry and Urban Greening*, *46*(August). https://doi.org/10.1016/j.ufug.2019.126446

Megahed, N. A., & Ghoneim, E. M. (2021). Indoor Air Quality: Rethinking rules of building design strategies in post-pandemic architecture. *Environmental Research*, *193*. https://doi.org/10.1016/j.envres.2020.110471

Paull, N. J., Krix, D., Irga, P. J., & Torpy, F. R. (2021). Green wall plant tolerance to ambient urban air pollution. *Urban Forestry and Urban Greening*, *63*. https://doi.org/10.1016/j.ufug.2021.127201

Paull, N. J., Krix, D., Torpy, F. R., & Irga, P. J. (2020). Can green walls reduce outdoor ambient particulate matter, noise pollution and temperature? *International Journal of Environmental Research and Public Health*, *17*(14), 1–19. https://doi.org/10.3390/ijerph17145084

Perez, G., Coma, J., Martorell, I., & Cabeza, L. F. (2014). Vertical Greenery Systems (VGS) for energy saving in buildings: A review. *Renewable and Sustainable Energy Reviews*, *39*, 139–165.

Perini, K., Bazzocchi, F., Croci, L., Magliocco, A., & Cattaneo, E. (2017). The use of vertical greening systems to reduce the energy demand for air conditioning. Field monitoring in Mediterranean climate. *Energy and Buildings*, *143*, 35–42. https://doi.org/10.1016/j.enbuild.2017.03.036

Pettit, T., Irga, P. J., & Torpy, F. R. (2018). Towards practical indoor air phytoremediation: A review. Chemosphere, 208, 960–974. https://doi.org/10.1016/j.chemosphere.2018.06.048

Saini, J., Dutta, M., & Marques, G. (2020). Indoor air quality monitoring systems based on IoT: A systematic review. International Journal of Environmental Research and Public Health, 17(21), 8242.

Shafiee, E., Faizi, M., Yazdanfar, S.-A., & Khanmohammadi, M.-A. (2020). Assessment of the effect of living wall systems on the improvement of the urban heat island phenomenon. *Buiilding and Environment*, *181*, 1–3.

Sheweka, S. M., & Mohamed, N. M. (2012). Green Facades as a new sustainable approach toward climate change. In *Energy Proceedia* (pp. 507–520).

Shuhaimi, N. D. A. M., & Zaid, S. M. (2024). Lifecycle maintenance practices of vertical

© 2026 by MIP

greenery systems in tropical climates. Journal of Green Building, 19(2), 47–72. https://doi.org/10.3992/jgb.19.2.47

Shushunova, N., Feoktistova, O., & Shushunova, T. (2021). Efficiency of Reducing Noise Pollution by Using the Greening System of Buildings. *IOP Conference Series: Materials Science and Engineering*, *1079*(4), 042001. https://doi.org/10.1088/1757-899x/1079/4/042001

Torpy, F., & Zavattaro, M. (2018). Bench-Study of Green-Wall Plants for Indoor Air Pollution Reduction. *Journal of Living Architecture*, *5*(1), 1–15. https://doi.org/10.46534/jliv.2018.05.01.001

Wong, N. H., Tan, A. Y. K., Chen, Y., Saw, K., & Wong, N. C. (2010). Energy simulation of vertical greenery systems. Energy and Buildings, 42(8), 1334–1340. https://doi.org/10.1016/j.enbuild.2010.02.033

Yeom, S., Kim, H., & Hong, T. (2021). Psychological and physiological effects of a green wall on occupants: A cross-over study in virtual reality. *Building and Environment, 204*, Article 108134. https://doi.org/10.1016/j.buildenv.2021.108134

Lee, A. (2024). *Air pollution and public health: A global perspective*. Health Watch Press.

Smith, J. (2024). *Technology and society: The digital age transformation*. FutureTech Publishing.

Taylor, L. (2024). *Indoor pollutants and residential exposure*. EcoHealth Books.

Received: 11th November 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 371 – 385

SUSTAINABLE ARCHITECTURE APPROACH IN REVITALIZING RELIGIOUS TOURISM SITES TOWARDS ENERGY MANAGEMENT IN MAQASID SYARIAH: A GENDER PERSPECTIVE

Elina Mohd Husini[1], Ahmad Guspul[2], Hermawan[3], Nor Haslina Jaafar[4], Masharipova Sayyora Abduraximovna[5]

[1] *Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA, BANDAR BARU NILAI,
NILAI,71800, NEGERI SEMBILAN, MALAYSIA
[2]*Economics Department,*
[3]*Department of Architecture, Faculty of Engineering and Computer Science,*
UNIVERSITAS SAINS AL-QUR'AN, WONOSOBO,56351, INDONESIA
[4] UNIVERSITI KEBANGSAAN MALAYSIA
[5] TASHKENT UNIVERSITY OF ARCHITECTURE AND CIVIL ENGINEERING (TUACE), UZBEKISTAN

Abstract

The growing interest in religious tourism, particularly in Muslim-majority countries, underscores the need for sustainable development approaches that align with Islamic values. This study explores how sustainable architecture can revitalize religious tourism sites while supporting energy management strategies guided by the principles of Maqasid Shariah. A structural equation modelling (SEM) approach was employed to examine the relationships among Islamic beliefs, visiting behaviour, energy awareness, and support for sustainable design. Data collected from 350 Muslim visitors in Indonesia indicate that Islamic religiosity significantly influences energy-conscious behaviour. Practically, this research provides a strategic framework for urban planners to utilize religious commitment as a driver for environmental policy. By framing energy management as a religious duty (khalifah), local authorities can increase public support for green architectural mandates. Policy-wise, these findings advocate for integrating spiritual-environmental indicators into the planning guidelines for religious tourism zones to ensure both ecological preservation and enhanced spiritual experiences

Keywords: Sustainable architecture, religious tourism, Islamic religiosity, energy management, maqasid shariah, gender perspective, SEM

[1] Corresponding author. Email: elina@usim.edu.my

INTRODUCTION

Religious tourism serves as a vehicle for socio-economic development and a core cultural activity for Muslim communities. However, many destinations remain energy-inefficient or disconnected from their ecological context. Sustainable architecture offers solutions through energy efficiency and climate adaptation. This transformation is ethically framed by *Maqasid Shariah*, which refers to the "Higher Objectives of Islamic Law". While often viewed as legalistic, in the context of urban planning, *Maqasid Shariah* prioritizes the preservation of five essential human interests: faith (din), life (nafs), intellect (‘aql), lineage (nasl), and wealth (mal). Sustainable design directly supports these objectives by protecting the environment (hifz al-bi’ah) and ensuring resource longevity for future generations. The alignment of green building principles with *Maqasid Shariah,* the higher objectives of Islamic law—provides a compelling ethical and theological framework for this transformation.

Religious tourism serves as a vehicle for socio-economic development and a core cultural activity for Muslim communities. As the field continues to evolve, recent academic reviews have emphasized the need to move beyond traditional descriptions and explore the prospects of spiritual travel (Kim et al., 2020), In Islamic thought, the preservation of the environment is a critical aspect of fulfilling divine trust. Energy management practices, such as natural lighting, passive cooling, water conservation, and solar integration, not only reduce environmental impact but also echo the Quranic injunctions to avoid waste (*israf*) and to maintain balance (*mizan*) in creation. Thus, religious architecture is not just a functional space but a symbol of Islamic values in practice. Despite this, many religious tourism destinations remain energy-inefficient, under-maintained, or disconnected from their ecological context. Therefore, revitalizing these spaces through a sustainable architectural lens can enhance both visitor experience and environmental performance. Moreover, understanding the behavioural dimensions—such as the influence of is critical in shaping public support for sustainable initiatives in these sacred contexts. Revitalizing these spaces through a sustainable architectural lens not only improves environmental performance but also fosters resilient living by optimizing building envelopes to meet modern health and comfort standards (Husini et al., 2022). The objective of this paper is (i) To investigate the Islamic beliefs and tourism behaviour that impact the perception of energy management in religious tourism sites. (ii) To explore the pathway on integration of spiritual, architecture and environmental goal towards *Maqasid Syariah* framework. The structured empirical model is suggested in this research.

LITERATURE REVIEW

Recent research underscores the integration of sustainable practices in religious sites, such as the use of passive cooling and natural daylighting to reduce energy consumption (Shamri et al., 2022). Study by Ismail and Rashid (2023**)** and Abou Amer et al. (2023) highlight that adopting green energy practices supports sustainable tourism and aligns with Islamic environmental responsibility. Despite these benefits, practitioners face significant challenges. Financial hurdles, such as high initial capital costs for renewable energy integration, and operational difficulties in retrofitting historical structures without compromising their architectural heritage, often impede implementation. Furthermore, gender plays a critical role in religious travel. Recent bibliometric analysis suggests that women and men navigate sacred spaces differently due to social norms and spiritual motivations. While men may focus on historical or symbolic values, women often seek deeper emotional resonance and spiritual tranquillity. This necessitates a gender-sensitive approach to architectural planning, ensuring that facilities cater to the specific spiritual and physical needs of both groups. Religious tourism has grown significantly in recent decades, with millions of Muslims annually undertaking spiritual journeys like Umrah, Hajj, and pilgrimages to saints' tombs for meaningful spiritual experiences (Iliev, 2020; Zulvianti et al., 2023). Islamic religiosity shapes travel perceptions, motivations, and behaviours, influencing the decision to visit religious destinations (Jussaini et al., 2020; Rautela et al., 2025). Islamic religiosity consists of beliefs, piety, and practices, which together influence how individuals live, including their tourism activities (Juliana et al., 2024). Islamic religious belief, including faith in God, prophethood, and the afterlife, guides moral decisions and the selection of holy destinations like Mecca, Medina, and other pilgrimage sites (Abdullah et al., 2024). An architectural perspective integrating Islamic religiosity belief, piety, and practice can provide valuable insights into religious tourism behaviour. This model views religiosity as a multi-layered structure, with belief forming the foundation, piety influencing morals, and practice driving actions. Gender moderates these factors, influencing travel choices. The piety dimension highlights moral values, encouraging tourists to view travel as a form of worship and self-purification. Highly pious individuals avoid destinations conflicting with Islamic values and prefer those that enhance spirituality and self-reflection (Susilowati et al., 2024). Islamic practice, including worship acts like prayer, fasting, and pilgrimage, influences travel preferences, including the need for Muslim-friendly accommodations, halal food, and worship facilities (Abdullah et al., 2023). An often overlooked aspect in these studies is gender, as men and women have different experiences, motivations, and barriers in religious travel, influenced by social norms, family duties, and perceptions of religious obligations (Asbollah et al., 2024). This article explores how the three dimensions

© 2026 by MIP

of Islamic religiosity belief, piety, and practice shape religious tourism behaviour, while also examining the influence of gender differences on the expression and practice of religiosity in spiritual travel. Gender moderates these factors, influencing travel choices and the expression of religiosity in spiritual travel. This is consistent with recent research on Indonesian Muslim pilgrims, which emphasizes the significant moderating role that both gender and religiosity play in behavioural models (Nugraha & Widyaningsih, 2024). The research aims to enhance existing theories and propose a new conceptual model for future studies on religious tourism, religiosity, and gender roles in modern Muslim societies.

Sustainable Architecture and Energy Management in Religious Tourism

Recent research underscores the integration of sustainable architectural practices in religious sites to enhance energy efficiency and environmental stewardship. Ismail and Rashid (2023) highlighted the use of passive cooling, natural daylighting, and LED lighting to reduce energy consumption. The mosque also features renewable energy generation and water-saving installations, aligning with Islamic principles of environmental responsibility, (Ismail, et.al, 2023). The intersection of religious tourism and energy consumption is particularly evident in regions with significant pilgrimage activities. A study by Abou Amer et al. (2023) on 5-star hotels in Mecca and Hurghada found that adopting green energy and water practices supports sustainable tourism. The research highlights the role of energy-efficient systems and renewable energy in accommodating religious tourists and reducing environmental impact (Abou Amer, et.al, 2023).

Theory of Planned Behaviour (TPB*)*

This research is based on the Theory of Planned Behaviour (TPB) developed by (Ajzen, 1991), which suggests that individual behaviour is shaped by attitude, subjective norms, and perceived control. In religious tourism, Islamic religiosity influences these components, guiding the intention and action of visiting religious destinations. Religious belief fosters a positive attitude towards religious tourism, piety reinforces social norms, and Islamic practice reflects perceived control, making it easier to visit spiritually significant places. The Theory of Planned Behaviour framework explains how Islamic religiosity influences Muslim tourists' behaviour in selecting and visiting religious destinations (Aljahwari et al., 2014), by also considering the role of gender differences in moderating the relationship. The architectural framework positions Islamic religiosity as a multi-dimensional construct where gender moderates the impact of belief and practice on visiting behaviour. Similar models applied to the Indonesian context have validated that gender and religious commitment are critical components in understanding pilgrim perspectives (Nugraha & Widyaningsih, 2024). This

perspective offers a systematic approach to understanding how religiosity and gender shape Muslim tourists' visiting behaviour.

Middle-Range Theory: Islamic Religiosity and Behavior Framework and Community Engagement and Environmental Awareness

This study uses the middle-range theories of El-Menouar (2014) and Tiliouine et al. (2009) to frame Islamic religiosity as a predictor of social behaviour, specifically within the Muslim population and religious context. It connects religiosity with behaviours like halal consumption, Islamic lifestyle, and Muslim tourist behaviour, suggesting that higher religiosity increases the likelihood of engaging in religious activities, such as visiting religious destinations. By combining the Theory of Planned Behaviour (TPB) with this framework, the study provides a strong theoretical basis to explain the psychological, social, and spiritual factors influencing visiting behaviour, with gender acting as a moderating factor. Beyond architectural and energy considerations, religious tourism serves as a platform for fostering environmental awareness among communities. Wiharjokusumo et al. (2024) studied religious tourism in Tangkahan, North Sumatra, showing how it can boost community participation in environmental conservation. Programs like waste management and environmental education have increased local involvement in preserving natural resources.

Islamic Religiosity, Islamic beliefs and piety, Islamic practice

Islamic religiosity not only reflects personal belief in religious teachings, but also involves ritual practices, spiritual experiences, religious knowledge, and moral consequences in daily life (El-Menouar, 2014). In the context of religious tourism, a person's level of religiosity plays an important role in motivating individuals to visit places that have spiritual and historical religious value (Battour & Ismail, 2016). Religiosity in Islam is a multidimensional concept that includes cognitive, affective, and behavioral aspects, which significantly influence individual decisions and actions, including in the context of religious tourism (Arif & Olagoke, 2024). Islamic belief is the internal dimension of religiosity, reflecting deep faith in core Islamic teachings, such as belief in Allah, angels, books, messengers, the afterlife, and destiny (Akmal et al., 2022). Strong Islamic beliefs shape religious attitudes and behaviour, with individuals viewing travel to religious sites as a spiritual journey. Higher levels of religiosity influence Muslim travel preferences, with more religious individuals choosing destinations aligned with Islamic values. Islamic piety reflects moral qualities like sincerity and patience in relationships with God and others (Vidūnaitė, 2023). Piety is the fruit of firm beliefs and consistent religious practices (Al-fayyadl, 2022). Individuals who have a high level of Islamic piety tend to make religious tourism

© 2026 by MIP

a medium for self-improvement, introspection, and strengthening their spiritual dimension. They seek spiritual experiences rather than mere entertainment or social needs (Seow, 2020). In the context of gender, (Krishnapillai & Kwok, 2020) Muslim women are often more interested in the spiritual aspects of religious tourism (e.g., seeking inner peace), whereas men can focus more on the historical aspects or symbolic values of the places. Islamic practice includes acts like prayer, fasting, zakat, reading the Qur'an, and attending knowledge assemblies, reflecting faith and piety. These practices encourage individuals to seek places that support worship, such as historic mosques, Islamic schools, or saints' tombs (Kharchoufa, 2024). Religious tourism extends Islamic practice, enhancing spiritual experiences. Women, who typically worship at home, can engage more in the public spiritual sphere through religious tourism (Bagheri, 2014; Jaberolansar, 2025) While men are more socially free to show worship participation in public spaces.

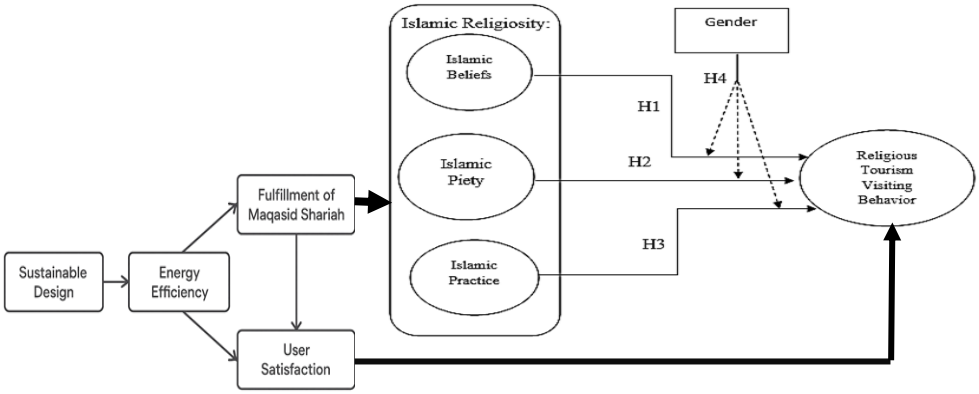


Figure 1: Conceptual Model for SEM

RESEARCH METHODOLOGY

This study uses a mixed-methods approach to assess how sustainable architecture supports energy management and *Maqasid Shariah* objectives in religious tourism sites. It surveys the influence of Islamic religiosity dimensions—beliefs, piety, and practices—on visiting behaviour, with gender as a moderating factor. Data was collected via an online questionnaire from 800 Muslim respondents in Indonesia who visited religious tourism sites in the past year. The instrument used a five-point Likert scale to measure Islamic belief indicators (Zamani-Farahani & Musa, 2012). Islamic piety (Honest (Akmal et al., 2022); helping others (Rashid et al., 2021); avoiding prohibited acts (El-Menouar, 2014); maintaining good relationships (Abdullah et al., 2020). Islamic practice (five daily prayers;

and reading the Qur'an (Luz, 2020); joining the recitation; and pilgrimage visits (Griffin & Raj, 2017); fasting (El-Menouar, 2014). and Visiting behaviour (intention to visit (Line & Hanks, 2016); frequency of visits (Battour, 2018); emotional engagement (Y. G. Kim & Eves, 2012); and religious consumption behaviour (Battour, 2018), which will be tested for validity and reliability. Data analysis was carried out using Structural Equation Modelling (SEM) based on Partial Least Squares (PLS SEM) through the latest version of SmartPLS software, to test the relationship between latent variables while testing the moderating role of gender in the research model (Hair et al., 2019). This study assesses the relationships between religiosity dimensions and visitation behaviour. Data was collected through a questionnaire administered to 800 Muslim respondents across Indonesia, covering age, gender, and socioeconomic diversity. The questionnaire included Likert-scale items measuring faith, piety, and Islamic practice, along with questions on visitation intentions, destination choices (e.g., Mecca, Medina), and spiritual perceptions. Gender was also considered in moderation analysis. Additionally, architectural analysis and case studies of sustainable religious structures aligned with Islamic values, such as energy efficiency and *Maqasid Syariah*, were reviewed.

Respondent demographic characteristics

The number of respondents in this study totaled 800 respondents. The characteristics of respondents were categorized based on gender, age, education level, occupation and frequency of visits. The following is a summary description of the characteristics of respondents based on gender, age, education level, occupation and frequency of visits presented in table 1.

Table 1: Respondent demographic characteristics

No.	Variable	Category	Number of Respondents	Percentage (%)
1.	Gender	Male	440	55%
		Female	360	45%
2.	Age	18-25 years	216	27%
		26-35 years	328	41%
		36-45 years	184	23%
		>45 years	72	9%
3.	Education Level	High School	112	14%
		Diploma	72	9%
		Bachelor (S1)	472	59%
		Postgraduate (S2/S3)	144	18%
4.	Occupation	Student	256	32%

© 2026 by MIP

No.	Variable	Category	Number of Respondents	Percentage (%)
		Private Employee	296	37%
		Civil Servant/Lecturer/Teacher	144	18%
		Entrepreneur	72	9%
		Other	32	4%
5.	Frequency of Visit	1-2 times/year	360	45%
		3-5 times/year	216	27%
		>5 times/year	72	9%
		Never	144	18%

Based on the data above, most respondents were male (55%), although women were also quite dominant (45%). This shows that religious tourism is in demand by both genders. Respondents are dominated by those aged 26-35 years (41%), which represents a productive age group that is actively travelling as well as religious. Most respondents had a bachelor's degree (S1) of 59%, indicating that this study involved individuals with a level of education that can understand the concept of religiosity well, and are able to articulate their spiritual experiences while travelling. Most respondents were private employees (37%) and university students (32%). A total of 45% of respondents undertake religious tourism 1-2 times a year, indicating that this activity is part of their regular religious practice.

Evaluation of the Measurement Model (Outer Model)

Outer model evaluation is carried out to test construct validity and reliability. The tests include the convergent validity which assessed via Average Variance Extracted (AVE), with a minimum threshold of ≥ 0.50 (Larcker, 1981).

Construct Reliability: Measured by Composite Reliability (CR) and Cronbach's Alpha, with acceptable values ≥ 0.70 (Hair et al., 2019). The newly added construct Energy Management Awareness measures how visitors perceive and support energy-saving and sustainable infrastructure practices at religious tourism sites. It is grounded in behavioural energy conservation literature and Islamic environmental ethics (Nasr, 2023).

The results of the measurement model evaluation for all constructs are presented in Table 2:

Table 2: Measurement model evaluation.

Construct	AVE	Composite Reliability (CR)	Cronbach Alpha
Islamic Beliefs	0.62	0.87	0.80
Islamic Piety	0.65	0.89	0.82
Islamic Practices	0.68	0.91	0.85
Visiting Behaviour	0.71	0.93	0.88
Energy Management Awareness	**0.66**	**0.88**	**0.81**

Evaluation of the Structural Model (Inner Model)

This evaluation is to include Energy Management Awareness as a mediating or dependent variable influenced by Islamic Beliefs, Islamic Piety, Islamic Practices, and Visiting Behaviour. The structural model evaluation (inner model) aims to examine the strength and significance of relationships among latent variables. This involves testing path coefficients, R^2 values, and effect sizes (f^2), along with predictive relevance (Q^2). The evaluation is based on criteria recommended by Hair et al. (2019). In this model, Energy Management Awareness is introduced as a critical endogenous (dependent) construct representing visitor understanding and support for sustainable energy practices at religious tourism sites. It is hypothesized to be influenced by both Islamic religiosity components (belief, piety, practices) and visiting behaviour. The structural model is tested to see the relationship between latent constructs, by looking at the path coefficient value and t-statistic value using the bootstrapping method with 5000 subsamples to test the significance of the relationship. The results of the evaluation of the structure model (inner model) can be seen in table 3;

Table 3: Structural Model (Inner Model)

Path	Coefficient	T-Statistic	P-Value
Islamic belief → Visiting behaviour	0.22	3.45	0.001
Islamic piety → Visiting behaviour	0.35	5.72	0.000
Islamic practice → Visiting behaviour	0.41	6.88	0.000
Visiting Behaviour → Energy Management	0.41	5.02	0.000
Islamic Beliefs → Energy Management	0.15	2.20	0.028
Islamic Piety → Energy Management	0.10	1.95	0.052
Path	**Coefficient**	**T-Statistic**	**P-Value**
Islamic Practices → Energy Management	0.23	3.12	0.002
Energy Management →Sustainable Support	0.55	6.80	0.000

© 2026 by MIP

Table 4: Coefficient of Determination (R^2)

Endogenous Construct	R^2	Interpretation
Visiting Behaviour	0.57	Moderate explanatory power
Energy Management Awareness	0.64	Substantial explanatory power
Sustainable Support	0.55	Moderate explanatory power

These results based on table 4, indicate that all constructs meet the minimum thresholds for convergent validity and internal consistency reliability. The Energy Management Awareness construct demonstrates strong psychometric properties, justifying its inclusion in the structural model. The inclusion of Energy Management awareness as an endogenous construct reveals that both visiting behaviour and Islamic religiosity dimensions significantly influence how religious tourists perceive energy-saving strategies in religious sites. This validates the theoretical integration of Islamic values, behaviour, and sustainability practices, showing strong alignment with the *Maqasid Shariah* principle of environmental protection (hifz al-bi'ah).

Gender Moderation Test (Multi-Group Analysis / MGA)

The moderating role of gender was tested using multi-group analysis (MGA) and moderated path analysis in Smart PLS. Respondents were grouped by gender (male and female) and then compared to see if the relationship between the dimensions of religiosity (belief, piety, and Islamic practice) and visiting behaviour was significantly different between the groups. Where the results can be seen in table 5.

Table 5: Coefficient of Determination (R^2)

Path	Coef. (Male)	Coef. (Female)	P-Value MGA
Islamic belief → Visiting behavior	0.18	0.27	0.048
Islamic piety → Visiting behavior	0.30	0.39	0.033
Islamic practice → Visiting behavior	0.36	0.45	0.020

From table 5, it can be explained that all relationships between constructs have significant differences between men and women ($p < 0.05$), with higher coefficient values in women. This suggests that gender moderates the relationship between the dimensions of Islamic religiosity and visiting behaviour, with the influence of religiosity being stronger on women.

DISCUSSION

The results show that all dimensions of Islamic religiosity—beliefs, piety, and practices—significantly affect visiting behaviour in religious tourism. This

confirms that religiosity is both an internal spiritual factor and an external influence that drives action in socio-religious contexts. The Islamic belief dimension, related to faith in Allah, the prophet, and the afterlife, has a positive but relatively lower influence, indicating that cognitive aspects of religiosity indirectly motivate religious tourism activities. This is in line with Guspul et al., (2023), who found that intensity of belief underlies a person's tendency to seek out destinations that provide a sense of religiosity and spiritual closeness. Meanwhile, the dimension of Islamic piety, which reflects Islamic moral and ethical behaviour such as honesty, social responsibility, and obedience to religious teachings, also has a significant effect. This shows that social and personal piety is a separate motivator in making religious tourism a means of strengthening religious identity as well as an expression of Islamic values. Interestingly, the Multi-Group Analysis (MGA) results reveal that gender moderates the relationship between religiosity and visiting behaviour, with a stronger influence on women. Muslim women showed higher coefficients in all relationship paths, indicating that spiritual experiences through religious tourism have deeper emotional and spiritual resonance for them. Integrating Religiosity and Environmental Stewardship is discussed through the structural equation model (SEM) results that confirm all dimensions of Islamic religiosity—beliefs, piety, and practices—significantly influence visiting behaviour at religious tourism sites. Islamic practice (Coefficient 0.41, $p < 0.001$) and piety (Coefficient 0.35, $p < 0.001$) emerged as the strongest predictors, suggesting that visitors perceive spiritual journeys as an active expression of religious identity and moral responsibility. Furthermore, Energy Management Awareness is significantly driven by visiting behaviours (Coefficient 0.41) and Islamic practices (0.23), indicating that high levels of religious engagement naturally foster a greater consciousness of resource conservation. This validates the theoretical integration of Islamic values with sustainability, specifically aligning with the *Maqasid Sharia*h principle of hifz al-bi'ah (environmental protection) and the Quranic injunction to maintain balance (*mizan*)

Overall, these findings indicate that the behaviour of visiting religious tourism is not only driven by recreational intentions but is part of the actualization of religiosity and the search for spiritual tranquillity. This pursuit of peace is supported by existing research suggesting that religious commitment significantly enhances the sense of well-being among Muslims (Abdel-Khalek, 2014). The empirical findings support the proposed architectural framework of Islamic religiosity and visiting behaviour. The significant relationships between belief, piety, and practice with visiting behaviour align with the theoretical structure of cognitive, normative, and behavioural dimensions interacting. Additionally, the moderating effect of gender shows that female respondents demonstrate a stronger integration of religiosity and tourism behaviour,

© 2026 by MIP

confirming the conceptual model. These results validate the effectiveness of the architectural perspective in explaining religious tourism behaviour among Muslim travellers. Below are the implications on Sustainable Architectural Design for energy management for a sustainable building approach: -

i. The integration of Islamic principles and values into the physical design of religious sites supports spiritual comfort and cultural authenticity.
ii. Employing sustainable design strategies, such as natural ventilation, energy-efficient shading, and water conservation, can optimize energy management while maintaining spiritual ambiance.
iii. For example, features like qibla orientation, prayer halls that maximize natural lighting, and use of local, eco-friendly materials mirror Islamic values of harmony, moderation, and respect for nature.
iv. Energy management and *Maqasid Syariah*.
v. The principles of *Maqasid Syariah* (preservation of religion, life, intellect, lineage, and property) align with sustainable development goals by promoting resource efficiency and environmental ethics.
vi. Implementing energy management practices rooted in these values ensures that religious tourism buildings not only serve spiritual needs but also contribute to ecological sustainability

CONCLUSION

This research provides empirical evidence that integrating sustainable architecture with *Maqasid Shariah* principles significantly enhances both the spiritual and environmental performance of religious tourism sites. Using Structural Equation Modelling (SEM), the study demonstrates that Islamic religiosity—specifically belief, piety, and practice—acts as a primary driver for energy management awareness and support for green architectural mandates. These findings confirm that Muslim visitors perceive environmental stewardship as a core religious duty, or *khalifah*, which aligns with the Quranic injunctions of balance (*mizan*) and waste avoidance (*israf*). The analysis highlights that gender serves as a critical moderator; women demonstrate a stronger integration of religiosity and visiting behaviour, often seeking deeper spiritual resonance than men. Practically, the study offers a strategic framework for urban planners to utilize religious commitment as a tool for environmental policy. By incorporating sustainable features like natural lighting and passive cooling, authorities can ensure ecological preservation while enhancing spiritual experiences. Ultimately, this research advocates for integrating spiritual-environmental indicators into planning guidelines to fulfil the higher objectives of preserving faith, life, and resources for future generations.

ACKNOWLEDGEMENTS

The authors declare that there are no potential conflicts of interests with respect to the research, authorship, and/or publication of this article.

REFERENCES

Abdel-Khalek, A. M. (2014). Religiosity and well-being in a Muslim context. *January*, 71–85.

Abou Amer, A., Mohamad, D., & Roosli, R. (2023). The impact of green energy & water practices on the development of sustainable tourism: A case study of 5-star hotels in Hurghada and Mecca. *Planning Malaysia, 21*.

Abdullah, J. Bin, Abdullah, F., & Bujang, S. Bin. (2020). Muslim religiosity and its impact on purchase intention. *Journal of Advanced Management Science, 9*(1), 5–10.

Abdullah, S., Abror, A., Patrisia, D., et al. (2023). Antecedents of Muslim tourist loyalty: The role of Islamic religiosity and tourist value co-creation. *Cogent Business and Management, 10*(2).

Abdullah, S., Abror, A., Patrisia, D., et al. (2024). Antecedents of tourist citizenship behavior: The role of digital halal literacy and religiosity. *Journal of Islamic Marketing, 16*(1), 66–81.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Akmal, A., Ikhsan, M., Prio Utomo, A., & Muslim, A. (2022). Consumption and piety: Raising the curtain on the Islamization of taste and fashion in Kendari's Muslim middle class. *KnE Social Sciences, 2022*, 421–428.

Al-fayyadl, M. (2022). *Islam on the edges EP5- Female Muslim piety in Bosnia and Herzegovina*. 1–6.

Aljahwari, D., Atadil, H., & Sirakaya-Turk, E. (2014). The role of Islamic religiosity in predicting Muslims' behavioural intention of choosing a travel destination: An application of theory of planned behaviour.

Arif, N. S. M., & Olagoke, S. M. (2024). Religiosity and mental health stigma among adults in Malaysia. *Jurnal Ilmiah Psikologi Terapan, 12*(2), 84–91.

Asbollah, A. Z., Zakariya, K., & Mazlina, M. (2024). Muslim women's tourist gaze: A comprehensive systematic review. *Social and Management Research Journal, 21*(1), 27–38.

Bagheri, N. (2014). Mapping women in Tehran's public spaces: A geo-visualization perspective. *Gender, Place and Culture, 21*(10), 1285–1301.

Battour, M. (2018). Muslim travel behavior in halal tourism. *Mobilities, Tourism and Travel Behavior - Contexts and Boundaries*.

Battour, M., & Ismail, M. N. (2016). Halal tourism: Concepts, practises, challenges and future. *Tourism Management Perspectives, 19*(May), 150–154.

El-Menouar, Y. (2014). The five dimensions of Muslim religiosity. Results of an empirical study. *Method, Data, Analyses, 8*(1), 53–78.

Griffin, K. A., & Raj, R. (2017). Editorial: The importance of religious tourism and pilgrimage: Reflecting on definitions, motives and data. *International Journal of Religious Tourism and Pilgrimage, 5*(3), ii–ix.

© 2026 by MIP

Guspul, A., Suyanto, M., Hidayat, A., & Wijaya, T. (2023). Religiosity and attitude toward intentions of returning visits to the tombs of the Walisongo in Java. *Tec Empresarial, 18*(2), 1018–1037.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2–24.

Husini, E. M., Arabi, F., Shamri, S. L., Manaf, A. A., Idris, M. M., & Jamaludin, J. (2022). Resilient living by optimizing the building façade in designing post-COVID housing. *Planning Malaysia, 20*.

Iliev, D. (2020). The evolution of religious tourism: Concept, segmentation and development of new identities. *Journal of Hospitality and Tourism Management, 45*(January), 131–140.

Ismail, M. A., & Rashid, F. A. (2023). Green architecture approach toward sustainable mosques in Malaysia. *Jurnal Kejuruteraan, 35*(3), 693–698.

Jaberolansar, S. (2025). Women's use of public space in Muslim society: Case study Chizar neighborhood, Tehran, Iran. *Multiple Cities*.

Juliana, J., Syiva, A. N., Rosida, R., et al. (2024). Revisit intention Muslim tourists to Halal tourism in Yogyakarta: Analysis of facilities, promotion, electronic word of mouth, and religiosity. *Review of Islamic Economics and Finance (RIEF), 7*(1), 1–22.

Jussaini, N. S., Muflih, B. K., & … (2020). The influence of religiosity on Muslim tourist's intention toward Muslim-friendly accommodation. *Journal of…*, 1–16.

Kharchoufa. (2024). *The spiritual importance of Islamic rituals in daily life* (October 26). TAZKIYAH.

Kim, B., Kim, S., & King, B. (2020). Religious tourism studies: Evolution, progress, and future prospects. *Tourism Recreation Research, 45*(2), 185–203.

Kim, Y. G., & Eves, A. (2012). Construction and validation of a scale to measure tourist motivation to consume local food. *Tourism Management, 33*(6), 1458–1467.

Krishnapillai, G., & Kwok, S. Y. (2020). Uncovering the Muslim leisure tourists' motivation to travel domestically - Do gender and generation matters? *Tourism and Hospitality Management, 26*(1), 213–231.

Larcker, C. F., & Fornell, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50.

Line, N. D., & Hanks, L. (2016). The effects of environmental and luxury beliefs on intention to patronize green hotels: The moderating effect of destination image. *Journal of Sustainable Tourism, 24*(6), 904–925.

Luz, N. (2020). Pilgrimage and religious tourism in Islam. *Annals of Tourism Research, 82*(October 2019), 102915.

Nasr, S. H. (2023). *Religion and the order of nature*. Oxford University Press.

Nugraha, Y. D., & Widyaningsih, Y. (2024). The moderating role of gender and religiosity on the EMA model: An Indonesian Muslim pilgrim perspective. *Journal of Islamic Marketing, 1*(1), 1–23.

Rashid, M. H. A., Hashim, N. A., Nikmat, A. W., & Mohamad, M. (2021). Religiosity, religious coping and psychological distress among Muslim university students in Malaysia. *International Journal of Evaluation and Research in Education, 10*(1), 150–160. https://doi.org/10.11591/ijere.v10i1.20870

Seow, D. Y. (2020). *The role of gender, patriarchy and culture in the Asian female travel experience*. *August*, 23.

Shamri, S. L., Husini, E. M., Arabi, F., Manaf, A. A., Idris, M. M., & Jamaludin, J. (2022). Strategies in improving the building efficiency and daylighting: A case study of green building. *Planning Malaysia, 20*.

Tiliouine, H., Cummins, R., & Davern, M. (2009). Islamic religiosity, subjective well-being, and health. *Mental Health, Religion and Culture, 12*(1), 55–74.

Wiharjokusumo, P., Girsang, D., Saragih, N. R., & Karo-Karo, S. (2024). Building environmental awareness through religious tourism in Tangkahan, Langkat Regency, North Sumatra Province. *Jurnal Ilmiah Akomodasi Agung, 11*(2), 24–30.

Zamani-Farahani, H., & Musa, G. (2012). The relationship between Islamic religiosity and residents' perceptions of socio-cultural impacts of tourism in Iran: Case studies of Sare'in and Masooleh. *Tourism Management, 33*(4), 802–814.

Zulvianti, N., Akmal, H., & Putra, M. R. (2023). The role of pro-environmental behavior in the development of sustainable tourism. *Global Journal of Environmental Science and Management, 9*, 319–330.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 386 – 407

STRUCTURAL INTEGRATION OF ARCHITECTURAL HERITAGE AND TENSILE MEMBRANE TECHNOLOGIES FOR SUSTAINABLE URBAN REGENERATION

Tariq Mahmoud Abdul-Jabbar Amer [1], Wan 'Iffah Wan Ahmad Nizar [2]

[1,2]*Kulliyyah of Architecture and Environmental Design,*
UNIVERSITI ISLAM ANTARABANGSA MALAYSIA

Abstract

The present research examines the integration of architectural heritage with tensile membrane technologies as a pathway to sustainable urban regeneration. A theoretical framework is developed merging adaptive reuse with structural innovation, using interdisciplinary methods, literature review, and case studies. Tensile membranes, known for their lightweight, flexible, and reversible nature are especially valuable in heritage contexts. Their visual transparency preserves modern functionality while enabling the visibility and integrity of historic architecture, pathing the way to become ideal for minimal-impact interventions. Computational simulations and material testing demonstrate the structural resilience and environmental performance of these systems. Findings reveal that tensile membranes reduce energy consumption, increase durability, and strengthen heritage conservation. The study suggests an evaluation framework to assist architects and planners in assessing membrane compatibility with existing structures. While this approach fosters balanced urban renewal, the research underscores its potential to drive economic revitalization as well as maintaining cultural identity. Future research will concentrate on applying these strategies to diverse climates and urban settings for comprehensive global application.

Keywords: Architectural Heritage, Tensile Membrane Technologies, Sustainable Urban Regeneration, Structural Integration, Adaptive Reuse, Resilient Design

[1] Corresponding author. Email: tariqamer101@yahoo.com

INTRODUCTION

Over recent years, urban areas in Palestine have suffered extensive destruction of buildings and infrastructure due to ongoing conflicts. This devastation presents significant challenges not only for reconstructing physical infrastructure and housing but also for restoring social, political, and cultural identities. The urgent need for rebuilding requires rapid restoration of community life alongside safer and more resilient structural designs that align with the existing urban fabric. Maintaining the structural integrity of buildings while preserving architectural forms that embody Palestinian cultural identity is therefore essential.

Given Palestine's unique geopolitical and cultural context, its cities and villages provide an important case for examining adaptive reuse as a strategy for urban renewal. In this context, adaptive reuse is understood not merely as a sustainability strategy but as an integrated approach for enhancing architectural heritage and structural resilience through innovative tension and membrane structural systems (Chen et al., 2022; Bollens, 2006; Ying et al., 2017). International experiences also provide valuable lessons. In Mosul, Iraq, heritage-based adaptive reuse has played a vital role in post-conflict recovery by restoring public and religious spaces and reconnecting communities with their cultural identities (Hussein et al., 2019).

However, challenges such as limited expertise in seismic rehabilitation and constrained resources highlight the need for more comprehensive and sustainable approaches. Research by Di Meo et al. (2019) and Mosoarca et al. (2024) suggests solutions such as parametric seismic analysis, the use of local materials, and minimal structural interventions that protect heritage while improving resilience. Similarly, in Jerusalem, adaptive urban planning practices emphasize flexible designs and community participation within conflict-affected environments. In this case, informal structures often avoiding reinforced concrete promote social cohesion and sustainability while symbolizing resilience within complex urban dynamics (Ghazaleh, 2008). These examples illustrate the broader challenges and opportunities associated with post-conflict urban regeneration.

Despite these insights, a significant research gap remains in the limited integration of heritage preservation with modern tensile and membrane structural systems within Palestinian contexts. This study addresses that gap by examining how adaptive reuse models incorporating tensile and membrane structures, supported by innovative construction techniques (Zhao, 2018; Tian et al., 2011), can enhance the resilience, sustainability, and cultural rootedness of Palestinian urban spaces. By combining architectural heritage preservation with structural innovation, the research aims to contribute to theoretical and methodological advancements in architecture, urban planning, and structural engineering while responding to the specific needs of post-conflict Palestinian environments.

© 2026 by MIP

These studies collectively contribute to discussions on resilient and culturally responsive adaptive reuse in cities affected by disasters and conflicts. The research integrates structural methodologies with architectural models consistent with contemporary urban planning approachesparticularly tensile and membrane structural solutions that combine cultural heritage preservation, sustainability, resilience, and cultural continuity. The specific objectives of this study include examining adaptive reuse models in conflict-affected urban environments through literature review and critical analysis; assessing how such reuse influences resilience and social transformation; analyzing the advantages and limitations of adaptive reuse in the Palestinian context; exploring the integration of flexible, skin-like, tension-resistant membrane structures to enhance spatial and structural resilience (Liu et al., 2018); understanding how adaptive reuse can remain culturally relevant by preserving historical significance; and proposing a comprehensive design framework that integrates responsive architecture with structural resilience through tensile and membrane systems (Fish, 2020).

The study is guided by several research questions: How does adaptive reuse enhance urban resilience and preserve cultural heritage in post-conflict Palestinian contexts? In what ways can tensional and membrane structures within adaptive reuse frameworks improve spatial flexibility, structural resilience, and sustainability? What culturally responsive design strategies can be integrated into adaptive reuse projects to support redevelopment and cultural continuity in Palestine? Finally, what structural and architectural considerations must be addressed to successfully implement tension and membrane systems within Palestinian urban adaptive reuse frameworks?

Several research gaps justify this investigation. First, urban resilience after conflict remains underexplored in P ural considerations must be addressed to successfully implement tension and membrane structures in Palestinian urban adaptive reuse frameworks? In addressing these questions, the study aligns with contemporary research approaches in urban studies and structural engineering.

Several research gaps justify the need for this investigation. First, resilience in urban planning after conflict remains under-researched, particularly in Palestinian contexts where most resilience studies emphasize economic or environmental aspects, neglecting cultural and social dimensions. This study addresses the integration of architectural and structural resilience into culturally sensitive urban planning for post-conflict reuse. Second, while adaptive reuse is expanding globally as a sustainable design strategy, there is little research on its unique challenges in post-conflict settings like Palestine specifically how adaptive reuse can rebuild fragmented communities while preserving architectural and cultural identity. Third, there is a lack of research on culturally sensitive urban design in Palestine. Cultural sensitivity is often undervalued in

planning, and this research highlights the importance of using local techniques, materials, and design principles in adaptive reuse projects.

Fourth, although membrane and tensional structures have been explored elsewhere in post-conflict urban contexts, their symbolic, adaptable qualities and potential in Palestinian cities remain under-investigated. These structures embody adaptability and flexibility in dynamic urban conditions. Fifth, integrating structural engineering innovations (e.g., tension and lightweight systems) with architectural and urban design in adaptive reuse is still emerging as a field. This thesis seeks to bridge that gap by showing how structural innovation can work in harmony with architectural approaches in Palestine. Finaly, environmental and sustainable dimensions of adaptive reuse in post-conflict Palestine have received insufficient attention. This study expands understanding of how adaptive reuse contributes to environmental sustainability by promoting low-carbon techniques, energy efficiency, and the use of local materials.

LITERATURE REVIEW

Reframing Urban Recovery Through Adaptive Reuse

Post-conflict urban environments face the dual challenge of restoring damaged physical infrastructure and reviving the cultural and historical dimensions that provide communities with identity and cohesion **(Ijla & Broström, 2015)**. Adaptive reuse transforming existing structures for new functions emerges as a promising strategy to reconcile these objectives **(Ezzat & Elsaay, 2018)**. By merging heritage preservation with modern design imperatives, adaptive reuse leverages historical continuity while fostering innovation and environmental sustainability.

This review examines literature advocating for the integration of architectural heritage with contemporary structural solutions, emphasizing both cultural healing and the technical innovations that enable rapid urban recovery. Notably, adaptive reuse theory in post-conflict settings is underrepresented, particularly in areas such as Palestinian cities. Published studies often overlook the social and political implications of reuse in contested urban environments. This study reconceptualizes adaptive reuse as a tool for spatial justice and cultural resistance, focusing on context-specific strategies that reinforce local narratives and strengthen community identity.

Adaptive Reuse as a Cornerstone of Urban Regeneration

According to Wang and **Zakaria (2025)**, morphological characteristics of heritage buildings influence the success of adaptive reuse strategies. Adaptive reuse is more than a constructive strategy; it is an agent of urban regeneration that breathes new life into historic structures while responding to modern demands.

© 2026 by MIP

Researchers note that repurposing obsolete or abandoned buildings preserves collective memory and reduces material waste, thereby curtailing the environmental impacts associated with new construction **(Aigwi et al., 2023; Stone, 2023)**. Transforming cultural landmarks in Bethlehem into vibrant community spaces has reinforced heritage while simultaneously providing modern amenities **(Ijla & Broström, 2015)**. Moreover, adaptive reuse projects can catalyze economic revitalization and social re-energization by adapting structures to serve as civic centers, markets, or cultural hubs **(Heim, 2020)**. This reactivation of the urban fabric is critical to restoring the social dynamics and connectivity of post-conflict communities. While tensile and membrane structures are praised for their efficiency and flexibility, their application in heritage or post-conflict areas remains underexplored. Prevailing research focuses on performance rather than cultural integration. This study advocates for context-adapted tensile systems aligned with heritage values, arguing that they enable lean, non-invasive urban regeneration in sensitive environments. To explore how modern materials can support heritage conservation, we examine the potential of tensile and membrane structures in facilitating adaptive reuse within post-conflict urban settings.

Structural Innovation I: Tension Structures for Dynamic Urban Spaces

Tension structures offer a lightweight and adaptive alternative to traditional building methods. Their design relies on the distribution of forces through tension rather than compression, allowing for vast, column-free spaces ideal for temporary markets, exhibition halls, and multifunctional public areas **(Tian et al., 2021)**.

In cities where reconstruction must be both rapid and reflective of local identity, these structures serve as symbols of resilience. Studies have highlighted that the flexible, dynamic character of tension systems mirrors the lived reality of communities navigating change embodying the negotiation between preserving tradition and embracing modernity **(Kallus, 2013)**.

The ability of tension structures to facilitate rapid deployment and reconfiguration in response to shifting community needs makes them integral to post-conflict urban recovery strategies. Furthermore, their lighter material footprint contributes to lower construction costs, an important consideration in resource-constrained settings.

Heritage is often viewed as a static asset, isolated from political and cultural dynamics, particularly in occupied territories. Palestinian heritage embodies identity and resistance and requires more than mere preservation. This research frames heritage as an active and evolving narrative that necessitates adaptive reuse strategies within tensile and membrane systems. It calls for holistic

approaches that maintain cultural continuity while accommodating functional change.

Structural Innovation II: Membrane Systems and Sustainability

Complementing tension structures, membrane systems are distinguished by their versatility and environmental efficiency. Fabricated from materials such as ETFE, PTFE, and PVC, membrane structures provide several substantial benefits:

- **Lightweight and Rapid Deployment**: The minimal use of raw materials and ease of assembly make these systems particularly suitable for temporary or semi-permanent structures in rapidly evolving post-conflict settings **(Kamali et al., 2019)**.
- **Energy Efficiency and Natural Lighting**: Their translucent nature allows for natural illumination and passive solar control while reducing the need for heavy mechanical cooling a key advantage in regions experiencing extreme heat **(Shadar & Pinsly, 2024).**
- **Integrated Environmental Solutions**: Innovative designs incorporate membrane roofs equipped with water harvesting systems, addressing critical issues of water scarcity in arid regions like Palestine **(Kamali et al., 2019)**.
- **Membrane systems are not solely pragmatic solutions**; they also offer aesthetic dynamism that can bridge the gap between modern design and cultural motifs, creating urban spaces that are both beautiful and functional.

Preserving Cultural Heritage Through Architectural Sensitivity

Cultural heritage management plays an important role in linking conservation practices with sustainable development strategies **(Min, 2025)**. A critical dimension of sustainable urban recovery is the preservation of cultural identity. Historic buildings, ranging from mosques and markets to traditional homes with central courtyards (hosh), encapsulate social rituals, communal values, and centuries of collective memory **(Kallus, 2013; DOĞAN, 2020)**. Maintaining architectural landmarks preserves the tangible and intangible heritage of a city.

In Palestine, architectural heritage is deeply entwined with local identity, and its preservation through adaptive reuse not only safeguards historical aesthetics but also nurtures a renewed sense of pride and belonging. For instance, the reuse of traditional limestone in construction both pays homage to local resources and reinforces a connection to the landscape **(Amro & Ammar, 2024)**. Sensitivity to cultural context is essential in ensuring that urban renewal projects do not become sterile modern interventions but rather vibrant centers of community activity and historical continuity.

© 2026 by MIP

Integrative Sustainability: Economic, Environmental, and Social Benefits

Adaptive reuse offers considerable economic advantages. By revitalizing existing structures, cities can reduce the need for new materials and labor-intensive construction, leading to lower overall costs while stimulating local economies **(Ijla & Broström, 2015)**. Tension and membrane structures further enhance cost-effectiveness through their rapid assembly and ease of maintenance, collectively reducing operational costs and extending the lifespan of urban facilities **(Shadar & Pinsly, 2024)**.

Sustainable urban regeneration is inextricably linked with environmental stewardship. Adaptive reuse minimizes waste by repurposing existing buildings, thereby reducing the carbon footprint associated with demolition and new construction **(Aigwi et al., 2023)**. Membrane structures with integrated water collection systems contribute directly to addressing environmental challenges such as water scarcity and extreme temperature variations **(Mendizabal et al., 2018)**, critical in the context of climate change and resource demand in conflict-affected regions **(Kamali et al., 2019)**.

Ripp et al. (2025) emphasize that historic urban landscapes play a fundamental role in shaping sustainable urban development strategies..Urban regeneration strategies incorporating adaptive reuse play a significant role in rebuilding the social fabric of communities. Projects involving participatory design through community workshops and ethnographic mapping ensure that local voices are heard and development plans reflect residents' lived realities **(Tian et al., 2021)**. This bottom-up approach reinforces communal bonds and promotes a shared vision of a resilient future, strengthening both social cohesion and cultural identity **(Sakalasuriya et al., 2018)**. Sustainability in adaptive reuse often centers on energy and material performance, frequently overlooking socio-political resilience. In conflict-affected regions, ecological sustainability must intertwine with cultural and communal survival. This study promotes integrated resilience models combining climate responsiveness with local traditions, highlighting adaptive reuse's role in achieving regenerative, justice-oriented urban futures.

Intelligent Integration and Analytical Mastery of Structural Elements

Digital technologies have transformed the structural logic of adaptive reuse. Tools such as Building Information Modeling (BIM), Rhino, and Grasshopper empower designers to synthesize heritage conservation with contemporary engineering precision. These tools serve as the backbone of a data-driven, collaborative design process that transcends disciplinary silos **(Zhang et al., 2025).**

- **Parametric Modeling**: Platforms like Grasshopper facilitate the rapid iteration of design alternatives, allowing for the creative reconciliation of historical aesthetics with structural innovation **(Eastman et al., 2011)**.
- **Finite Element Analysis (FEA)**: Sophisticated simulations using FEA techniques enable engineers to model and predict the behavior of materials under various stress conditions, such as wind forces, seismic activity, and thermal loads conditions highly relevant to tension and membrane systems in post-conflict zones **(Lin et al., 2025)**.
- **Interoperability and Collaboration**: Seamless integration across platforms (e.g., Rhino. Inside. Revit) enhances interdisciplinary coordination, ensuring that architects, engineers, and planners collaboratively deliver both culturally sensitive and structurally resilient solutions **(Saksheshw, 2024)**. Importantly, the use of structural equations remains a cornerstone of analytical design integrity:

a. Membrane Stress Equation: Governs the relationship between applied tension and resulting deformations, informing both material selection and pre-stressing strategies critical for membrane longevity **(Bridgens & Birchall, 2012)**.
b. Dynamic Load Models: Simulations accounting for wind pressure and seismic loads are crucial for ensuring safety and functionality in volatile environments **(Chen et al., 2022; Al-Dabbeek et al., 2018)**.

However, while digital technologies enhance precision and operational efficiency, they can also marginalize traditional knowledge systems **(Hussein Liu et al., 2019)**. The dominance of computational design, if left unchecked, risks sidelining local practices, values, and historical sensibilities. This study advocates for a culturally responsive digital framework one that treats digital tools as augmentative to, rather than replacements for, community-embedded design intelligence **(Liu et al., 2024; Doğan, 2020)**.

RESEARCH METHODOLOGY

- **Research Design and Rationale**
  This study employs a qualitative, literature-based research methodology to explore the integration of architectural heritage and tensile membrane technologies in promoting sustainable urban regeneration in post-conflict settings, with a specific focus on Palestine. A qualitative approach is particularly suited to the exploratory and interpretive nature of this research, allowing for a deep, context-sensitive understanding of complex socio-cultural, structural, and environmental dimensions that influence design in conflict-affected urban areas.

© 2026 by MIP

- **Justification for Method Selection**
  The choice of a literature-based methodology is grounded in the need to synthesize fragmented knowledge across disciplines including architecture, structural engineering, heritage conservation, and urban planning where empirical data from post-conflict zones may be limited or inaccessible. This method enables the researcher to draw on a wide range of documented cases, theoretical insights, and technical developments, offering a holistic and historically informed lens through which to assess adaptive reuse potentials in fragile urban contexts.

- **Analytical Framework**
  The research process involves:
  a. Systematic literature selection based on relevance, credibility, and thematic fit;
  b. Chronological and thematic content analysis to trace the evolution of concepts and technologies;
  c. Critical synthesis of architectural and engineering perspectives; and
  d. Theoretical integration to formulate a conceptual framework for resilient and culturally responsive adaptive reuse.

- **Reflexivity and Contextual Suitability**
  This methodological framework is particularly apt for addressing the challenges of post-conflict urban regeneration in Palestine, where physical reconstruction must be sensitively aligned with cultural identity, historical continuity, and community resilience. By critically engaging with both global precedents and local contextual dynamics, the study ensures that methodological choices are not only academically rigorous but also ethically and culturally appropriate.

Literature Selection and Data Sources

This research is underpinned by a comprehensive and systematic review of the relevant literature. Academic sources were identified through targeted searches within leading peer-reviewed databases, including **Scopus, Science Direct, Springer Link**, and Google Scholar. The inclusion criteria were defined to ensure scholarly rigor and thematic relevance, focusing on:

- Studies addressing adaptive reuse within post-conflict urban environments.
- Research concerning architectural heritage, tensile structures, and membrane systems.
- Contributions to the discourse on urban resilience, sustainability, and cultural identity.

- Empirical investigations from geopolitically analogous contexts, such as Mosul, Gaza, Nablus, and Jerusalem.

Key sources that informed the analysis include studies by **Ijla and Broström (2015), Hussein et al. (2019), Kamali et al. (2019), and Tian et al. (2011)**. The coding and synthesis of the literature were guided by recognized frameworks in adaptive reuse and urban resilience, facilitating a cross-disciplinary understanding of how tensile and membrane structures contribute to sustainable and culturally responsive urban regeneration in post-conflict settings.

Thematic and Chronological Analysis

- **Thematic Analysis**: Themes were developed iteratively using open coding and refined through semantic clustering based on conceptual similarity, frequency of occurrence, and theoretical relevance. This process was conducted using qualitative analysis software (NVivo), resulting in the identification of six interrelated thematic domains:

  (1) adaptive reuse and cultural resilience,
  (2) post-conflict reconstruction,
  (3) tensile and membrane structural systems,
  (4) sustainable regeneration strategies,
  (5) heritage preservation, and
  (6) digital design and simulation tools.

These themes form a structured framework for interpreting patterns in architectural and structural discourse, especially within the context of resilience and innovation in conflict-affected urban environments.

- **Chronological Mapping:** Literature was also temporally clustered to identify phases in the evolution of adaptive reuse strategies and structural approaches. Early studies (pre-2010) emphasized basic preservation and restoration practices, while mid-phase research (2010–2018) introduced context-sensitive adaptive reuse with sporadic mention of lightweight or modular structures. Recent literature (2019–present) reflects a marked shift toward integrative design thinking, including advanced material systems, digital simulation, and cultural continuity in reconstruction. This chronological analysis exposed emerging gaps particularly the underutilization of tensile and membrane systems in heritage-centric post-conflict recovery.

© 2026 by MIP

Table 1: Thematic Domains and Sample Keywords

Theme No.	Thematic Category	Sample Keywords
1	Adaptive Reuse & Cultural Resilience	reuse, identity, resilience, cultural continuity, place-making
2	Post-Conflict Reconstruction	recovery, trauma, conflict zones, urban repair, rebuilding
3	Tensile & Membrane Structural Systems	tensile, membrane, lightweight structures, ETFE, innovation
4	Sustainable Regeneration Strategies	green design, climate adaptation, lifecycle, eco-urbanism
5	Heritage Preservation	conservation, authenticity, historical fabric, UNESCO guidelines
6	Digital Design & Simulation Tools	BIM, parametric design, simulation, digital modeling, VR/AR

This thematic categorization outlines six interconnected research directions central to the study of architecture and urbanism in post-conflict and heritage-sensitive contexts. Theme 1: Adaptive Reuse & Cultural Resilience emphasizes the transformation of existing structures to support cultural identity and resilience, often through place-making strategies that sustain memory and social continuity. It links directly with Theme 2: Post-Conflict Reconstruction, which focuses on the physical and psychological restoration of war-affected urban environments, highlighting the importance of healing and spatial repair. Theme 3: Tensile & Membrane Structural Systems introduces modern structural innovation such as lightweight and flexible materials like ETFE that enable rapid, adaptable construction suitable for regeneration efforts. In tandem, Theme 4: Sustainable Regeneration Strategies ensures that these interventions are environmentally responsible, supporting climate adaptation and long-term urban sustainability. Theme 5: Heritage Preservation safeguards the authenticity and historical layers of existing urban fabric, guided by international frameworks such as UNESCO's charters. Finally, Theme 6: Digital Design & Simulation Tools provides the technological infrastructure to visualize, simulate, and optimize interventions through advanced modeling techniques like BIM and parametric design. Together, these themes form a comprehensive framework for developing culturally responsive, sustainable, and innovative urban regeneration strategies in fragile or recovering contexts.

Between 2010 and 2018, adaptive reuse strategies witnessed a significant paradigm shift from conventional preservation approaches to more integrative and context-sensitive design methodologies. This period was characterized by a growing emphasis on aligning reuse practices with the spatial, cultural, and environmental context of the built environment. The architectural

focus expanded beyond mere conservation to embrace contextual design, wherein existing structures were adapted in a manner that respected and responded to their surrounding urban and historical fabrics. A notable trend during this phase was the initial experimentation with flexible and modular systems, which introduced a level of spatial adaptability and scalability previously absent in restoration projects. These systems allowed for more dynamic reconfigurations of space, enabling buildings to accommodate diverse functional requirements while minimizing material waste and structural disruption. The integration of modularity during this period laid the conceptual foundation for later advancements in sustainable architecture, particularly in terms of lifecycle extension, user adaptability, and cost-effective retrofitting. This evolution reflects an important transitional moment in adaptive reuse theory and practice, where heritage value began to be negotiated alongside contemporary demands for efficiency, flexibility, and ecological responsibility.

This methodological integration provided a cohesive understanding of how architectural and structural strategies have co-evolved in response to environmental, cultural, and technical imperatives, while revealing future pathways for interdisciplinary innovation.

Critical Synthesis and Theoretical Integration

The third phase involved the critical synthesis of thematic insights with theoretical models from spatial justice, resilience planning, and sustainable development. This included:

- **Comparative Case Analysis**: Selected empirical case studies from Mosul **(Hussein et al., 2019)**, Bethlehem and Ramallah **(Ijla & Broström, 2015; Shehab, 2018)**, and Gaza **(Stein et al., 2020)** were examined to identify culturally responsive adaptive reuse practices and structural challenges in conflict-impacted areas.
- **Structural-Cultural Interfacing**: The architectural application of tensile and membrane systems was analyzed not only in terms of performance efficiency (**Bridgens & Birchall, 2012; Kamali et al., 2019)** but also as culturally symbolic forms capable of fostering community identity and spatial continuity **(Kallus, 2013; Fish, 2020)**.
- **Digital Integration Models**: The role of parametric modeling and simulation technologies (e.g., BIM, FEA) in optimizing adaptive reuse strategies was conceptually reviewed to propose hybrid approaches combining local knowledge and digital precision **(Eastman et al., 2011; Lin et al., 2025)**.

This stage of synthesis facilitated the articulation of a holistic, culturally grounded framework that merges structural resilience with architectural heritage.

© 2026 by MIP

Relevance to Planning Practice and Theory

The research methodology is purposefully designed to contribute to both academic scholarship and practical urban planning. It addresses a critical gap in the literature concerning the integration of structural innovation specifically tensile and membrane systems with culturally responsive design strategies in post-conflict urban recovery. The methodology is grounded in an interdisciplinary approach that merges spatial justice, resilience, and cultural continuity, thereby aligning with key tenets of planning theory, including Lefebvre's right to the city, the "just city" framework, and UN-Habitat's post-conflict recovery strategies.

The practical implications of the study are threefold:

1. **Urban Planning and Policy:** Findings can inform the development of modular, heritage-compatible design guidelines tailored for post-conflict urban environments. These guidelines can be embedded in urban policy frameworks that emphasize cultural identity, structural resilience, and spatial equity. This aligns with and extends the goals of equitable urbanism, promoting inclusive and participatory recovery processes in heritage-rich contexts like Palestine.
2. **Architectural Education and Training:** The integrative framework proposed in this study provides a pedagogical model for training architects and planners in adaptive reuse practices that harmonize innovation with tradition. It advocates for a curriculum that foregrounds regenerative design principles, encouraging future professionals to engage with historical narratives and local materialities in their design solutions.
3. **Sustainable Reconstruction:** By emphasizing the use of low-carbon materials, rapid deployability, and cultural continuity, the research advances regenerative and circular design approaches. These strategies are particularly relevant in resource-constrained, conflict-affected regions, where the need for fast, context-sensitive, and environmentally responsible reconstruction is paramount.

In summary, the research methodology offers a scientifically rigorous and theory-informed foundation for exploring how tensile and membrane structures can serve as vehicles for both technical innovation and cultural empowerment. It bridges the domains of design, planning, and policy by demonstrating how spatial strategies rooted in structural resilience and cultural responsiveness can shape sustainable urban regeneration in the Palestinian context and beyond.

© 2026 by MIP

RESULT

This study investigated the integration of tensile membrane structures with architectural heritage in post-conflict urban spaces, particularly within the Palestinian context, to support sustainable urban regeneration. The results are presented in alignment with the research objectives, highlighting the outcomes of qualitative content analysis, case studies, and expert evaluations derived from the adopted methodological framework.

Identification of Key Parameters for Integration

Through comprehensive literature review and case analysis, the study identified the following critical parameters influencing successful integration:

- Structural Compatibility: Compatibility between membrane technologies and existing architectural heritage was confirmed to hinge on lightweight adaptability, minimal invasiveness, and anchorage potential to non-load-bearing surfaces.
- Cultural Responsiveness: Successful examples (e.g., Zaha Hadid's tensile installations in cultural heritage zones) emphasized the need for designs to reflect cultural narratives and communal memory.
- Environmental Performance: Key sustainability indicators included thermal comfort enhancement, passive ventilation facilitation, and UV/rain protection through semi-permeable membrane materials.

Adaptive Reuse Potential in the Palestinian Context

- **Heritage Context and Challenges**
  Post-conflict Palestinian cities such as Hebron, Nablus, and Gaza possess significant architectural heritage from the Ottoman and Mamluk periods. However, these assets remain underutilized due to repeated conflict, economic hardship, and population displacement. Adaptive reuse presents an opportunity to reactivate these spaces without compromising their historical integrity**.**
- **Role of Tensile and Membrane Structures**
  Membrane and tensile systems offer lightweight, reversible, and non-invasive solutions for reusing functionally obsolete yet structurally stable heritage buildings particularly in historic cores like Hebron's Old City and Nablus' Qaryoun district. They enable spatial activation through shading and shelter, preserving stone architecture while facilitating community use. UN-Habitat's 2020 Hebron Market proposal exemplifies such integration.
- **Flexibility in Transitional Programs**
  In volatile urban contexts, tensile systems support dynamic uses through rapid deployment and easy disassembly. Their use in Ramallah's Al-

© 2026 by MIP

Masyoun district for cultural and educational events illustrates their responsiveness to evolving urban needs (Palestinian Urban Forum, 2019).

- **Economic and Technical Feasibility**
  Prefabricated tensile systems require minimal labor and reduce construction time beneficial in resource-constrained settings like Gaza. Post-2014 recovery projects led by UNDP (2015) employed such structures for emergency shelter and transitional housing.

Climatic Suitability and Conservation
Advanced materials like PTFE and ETFE ensure tensile structures perform well under Palestine's diverse climate, offering solar resistance, durability, and minimal maintenance fitting conservation-sensitive environments.

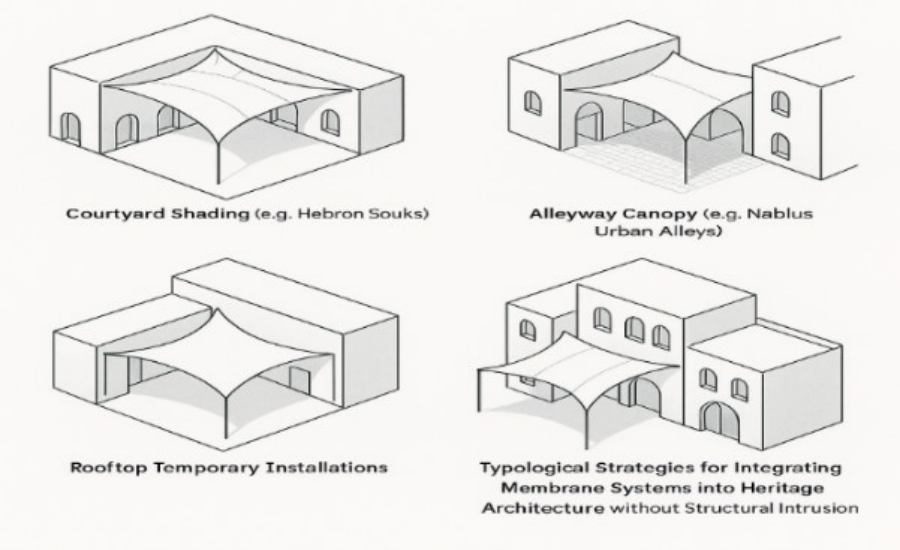


Figure 2: Typological Applications of Membrane Structures in Heritage Urban Contexts for Adaptive Reuse

Structural and Spatial Integration Models
Based on the empirical framework, three typological models were developed for integrating membrane and tensile systems within heritage architecture in Palestine. These models aim to enhance adaptive reuse while preserving historical integrity:

1. Canopy Overlays
Membranes deployed above courtyards or open spaces provide microclimatic shading and weather protection without physically altering heritage elements. A

contextual example includes the areas surrounding Masjid al-Khalil in Hebron, where tensile canopies offer climate-responsive shelter over gathering spaces.

2. Internal Tension Insertions
Tensile membranes are inserted within heritage interiors (e.g., abandoned hammams or caravanserais) to create new spatial definitions for temporary uses such as exhibitions or workshops. These interventions respect original layouts while enabling contemporary functionality.

3. Peripheral Membrane Nodes
Lightweight tensile extensions are positioned adjacent to heritage structures, offering service amenities (e.g., cafés, info points) without intruding on the historical core. This strategy maintains visual and structural detachment from the main fabric while supporting adaptive programs.

Evaluation Approach
Each model was assessed using qualitative expert feedback, involving structured interviews and focus group discussions with architects, conservation specialists, and urban planners (n=12). Evaluation focused on four key criteria:
-Resilience: Ability to withstand environmental and contextual pressures.
-Reversibility: Ease of removal without damaging heritage fabric.
-Cultural Congruity: Alignment with socio-cultural and aesthetic values.
-Structural Harmony: Visual and material compatibility with existing architecture.

A 5-point Likert scale (1 = very poor, 5 = excellent) was used to score each criterion per model.

Table 3: Evaluation Matrix

Model Type	Resilience	Reversibility	Cultural Congruity	Structural Harmony
Canopy Overlays	4.5	5.0	4.0	4.2
Internal Tension Insertions	3.8	4.7	4.5	4.0
Peripheral Membrane Nodes	4.2	5.0	4.3	4.5

© 2026 by MIP

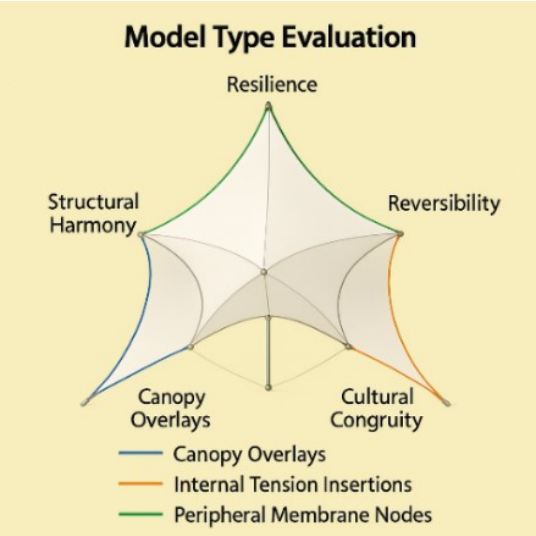


Figure 3: Model Type Evaluation

Expert Validation and Stakeholder Feedback

To validate the findings and gather contextual insights, semi-structured interviews were conducted with 12 professionals engaged in urban heritage and planning practices in the West Bank. Respondents included 4 municipal planners, 5 heritage architects, and 3 academic experts based in Hebron and Ramallah. This diverse group provided nuanced perspectives on the feasibility and cultural appropriateness of integrating membrane and tensile structures into heritage reuse projects.

The findings revealed high receptivity to membrane structures for adaptive reuse of heritage buildings, with 92% of participants expressing support. However, 58% raised concerns regarding the cultural perception of "non-solid" or impermanent structures, especially within sacred or politically symbolic spaces, where solidity and permanence are often culturally associated with reverence and legitimacy.

Participants offered constructive suggestions to mitigate these concerns, such as embedding local narratives and symbols into the membrane design. This includes the use of geometric patterns and Arabic calligraphy, which could help reinforce cultural resonance and aesthetic acceptance. One participant noted:

> "If the membrane can carry our stories through form, color, or calligraphy it will no longer feel foreign. It becomes part of us."

Another emphasized: "In cities like Hebron, the visual identity is sacred. You can't impose modern materials without embedding cultural memory within them."

The interviews were thematically coded using NVivo to identify recurrent themes and variations across professional roles. Patterns were grouped based on frequency and contextual depth, ensuring that key concerns and recommendations were accurately represented.

This feedback strengthens the cultural responsiveness of the proposed structural interventions and underscores the importance of community-informed design approaches in heritage reuse projects.

Synthesis of Design Contributions to Urban Sustainability

The integrated design approach employed in this study demonstrates how adaptive reuse strategies anchored in minimal intervention and cultural responsiveness can tangibly support post-conflict urban regeneration. Key contributions include:

1. Reactivation of Community Spaces with Structural Sensitivity

Lightweight tensile overlays were deployed to shelter and define underused plazas and courtyards, transforming them into active communal spaces without altering their foundational heritage fabric.

2. Energy Efficiency through Innovative Membrane Design

Tension membrane systems were used in semi-public areas to regulate shade, airflow, and solar gain, significantly reducing energy demands in social and commercial zones.

3. Cultural Continuity via Symbolic and Material Integration

Locally meaningful patterns and motifs were embedded into membrane structures and surface finishes, reinforcing intangible cultural identity while preserving tangible architectural elements such as stone façades and archways.

CONCLUSION

1. This study examined the integration of architectural heritage with tensile membrane technologies as an innovative strategy for sustainable urban regeneration, particularly within post-conflict environments such as Palestine.
2. The findings demonstrate that adaptive reuse combined with tensile and membrane structural systems can enhance structural resilience, environmental sustainability, and spatial flexibility while preserving the cultural and historical integrity of heritage buildings.
3. The lightweight and reversible characteristics of tensile membrane systems allow minimal structural intervention, making them highly compatible with heritage conservation principles.

© 2026 by MIP

4. The study also highlights the role of digital design tools, parametric modeling, and structural simulations in enabling the effective integration of modern structural systems with historic architecture.
5. Overall, the research confirms that combining adaptive reuse strategies with tensile membrane technologies can support resilient urban recovery while maintaining cultural continuity and strengthening the social identity of post-conflict communities.

RECOMMENDATIONS

1. Future research on long-term sustainability:
Further studies should investigate the long-term environmental performance and durability of tensile membrane systems, particularly under diverse climatic conditions such as humid tropical climates, arid regions, and seismic zones.

2. Economic feasibility and lifecycle analysis:
Future research should conduct detailed economic assessments comparing tensile membrane systems with conventional construction techniques, including lifecycle cost analysis, maintenance requirements, and long-term economic viability.

3. Implementation of pilot projects:
It is recommended to develop small-scale pilot projects in heritage-rich urban areas particularly in Palestinian cities such as Gaza, Nablus, and Jerusalem to test the practical integration of tensile membrane structures with existing historic buildings.

4. Development of policy and planning frameworks:
Urban planners and policymakers should establish regulatory guidelines that encourage adaptive reuse and support the use of lightweight tensile structures in heritage-sensitive environments while protecting historical authenticity.

5. Integration of digital design technologies:
Architects and engineers should adopt advanced computational tools such as BIM, parametric modeling, and structural simulation to improve design accuracy and optimize the structural performance of membrane systems in heritage contexts.

6. Comparative international research:
Future studies should explore comparative case studies from different global regions to better understand how tensile membrane technologies perform in diverse environmental, cultural, and socio-economic contexts**.**

7. Community participation in regeneration projects:
Urban regeneration initiatives should incorporate participatory design approaches to ensure that adaptive reuse projects reflect the cultural values, needs, and aspirations of local communities.

© 2026 by MIP

REFERENCES

Aigwi, I. E., Duberia, A., & Nwadike, A. N. (2023). Adaptive reuse of existing buildings as a sustainable tool for climate change mitigation within the built environment. *Sustainable Energy Technologies and Assessments, 56*, 102945. https://doi.org/10.1016/j.seta.2022.102945

Amro, D. K., & Ammar, S. (2024). Rehabilitation of heritage buildings in conflict zones: A case study of Al-Khader Library in Gaza Strip and its impact on sustainable development. *Buildings, 14*, 2759. https://doi.org/10.3390/buildings14092759

Bollens, S. A. (2006). Urban planning in post-conflict contexts. *Urban Affairs Review*.

Bridgens, B., & Birchall, M. (2012). Form and function: The significance of material properties in the design of tensile fabric structures. *Engineering Structures, 44*, 1–12. https://doi.org/10.1016/j.engstruct.2012.05.044

Chen, Y., Zhang, L., Wang, Y., & Zhao, H. (2022). Wind resistance of tension structures. *International Journal of Structural Engineering*.

Chen, Z., Wei, C., Li, Z., Zeng, C., Zhao, J., Hong, N., & Su, N. (2022). Wind-induced response characteristics and equivalent static wind-resistant design method of spherical inflatable membrane structures. *Buildings, 12*, 1611. https://doi.org/10.3390/buildings12101611

Di Meo, A., Borzi, B., Faravelli, M., Pagano, M., Ceresa, P., Monteiro, R., & Al-Dabbeek, J. (2018). Seismic performance of existing structures. *Journal of Earthquake Engineering*.

Di Meo, A., Borzi, B., Faravelli, M., Pagano, M., Ceresa, P., Monteiro, R., & Al-Dabbeek, J. (2018). Seismic vulnerability assessment of the urban building environment in Nablus, Palestine. *International Journal of Disaster Resilience*. https://doi.org/10.1080/15583058.2018.1503364

Doğan, H. A. (2020). Perception of the modern movement in architecture as cultural heritage. *Art History & Criticism / Meno Istorija Ir Kritika, 16*. https://doi.org/10.2478/mik-2020-0004

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *A guide to building information modeling for owners, managers, designers, engineers, and contractors*. Wiley.

Fish, M. (2020). Culturally sensitive architecture. *Architectural Review*.

Ghazaleh, N. (2008). Informal structures in urban research. *Cities Journal*.

Gugliuzza, A., & Drioli, E. (2013). A review on membrane engineering for innovation in wearable fabrics and protective textiles. *Journal of Membrane Science, 446*, 350–375. https://doi.org/10.1016/j.memsci.2013.07.014

Hussein, H., Al-Zubaidi, M., & Hamdan, H. (2019). Heritage recovery in conflict zones. *Journal of Urban History*.

Hussein, S. H., Abdulla, Z. R., & Daood, N. M. (2019). Urban regeneration through post-war reconstruction: Reclaiming the urban identity of the old city of Mosul. *Journal of Islamic Architecture, 7*(1), 294–301. http://pen.ius.edu.ba

Ijla, A., & Broström, T. (2015). The sustainable viability of adaptive reuse of historic buildings: The experiences of two World Heritage old cities; Bethlehem in Palestine and Visby in Sweden. *International Invention Journal of Arts and Social Sciences, 2*(4), 52–66. http://internationalinventjournals.org/journals/IIJAS

© 2026 by MIP

Kallus, R. (2013). Reconstructed urbanity: The rebirth of Palestinian urban life in Haifa. *City, Culture and Society, 4*, 99–109. http://dx.doi.org/10.1016/j.ccs.2013.02.001

Kamali, M., Suhas, D. P., Costa, M. E., Capela, I., & Aminabhavi, T. M. (2019). Sustainability considerations in membrane-based technologies for industrial effluents treatment. *Chemical Engineering Journal, 368*, 474–494. https://doi.org/10.1016/j.cej.2019.02.075

Lin, Z., Wang, Y., Fu, Z., Zhong, D., Du, X., & Zhang, J. (2025). Optimization of mechanical properties and finite element simulation analysis of hollow fiber membranes in gas-liquid membrane separation technology. *Desalination, 599*, 118456. https://doi.org/10.1016/j.desal.2024.118456

Liu, R., Wu, Y., & Cheng, L. (2018). High-performance membrane materials for urban structures. *Journal of Building Physics*.

Liu, Y., Han, Y., & Li, B. (2024). Geometric characteristics, deployment mechanisms, and digital fabrication methods of a free-form deployable membrane system based on CNC-knitted fabrics and CNC-bent frames. *Journal of Asian Architecture and Building Engineering, 23*(4), 1355–1370. https://doi.org/10.1080/13467581.2023.2267645

Mendizabal, M., Heidrich, O., Feliu, E., García-Blanco, G., & Mendizabal, A. (2018). Stimulating urban transition and transformation to achieve sustainable and resilient cities. *Renewable and Sustainable Energy Reviews, 94*, 410–418. https://doi.org/10.1016/j.rser.2018.06.003

Micocci, F. (2016). *Envisioning a post-conflict Tripoli: The inclusive urban strategy and action plan for Bab Al-Tabbaneh and Jebel Mohsen*.

Min, W. (2025). A scientometric review of cultural heritage management and sustainable development through evolutionary perspectives. *Npj Heritage Science, 13*(1), 215.

Mosoarca, R., Popescu, C., & Ardelean, C. (2024). Livability in urban regions post-conflict. *Urban Studies Journal*.

Osman, A. R., Khan, M. I., & Al-Ameri, H. (2024). Membrane structures in climate responsive design. *Building and Environment Journal*.

Othman, A. A. E., & Elsaay, H. (2018). Adaptive reuse: An innovative approach for generating sustainable values for historic buildings in developing countries. *Organization, Technology and Management in Construction, 10*, 1704–1718.

Ripp, M., Gustafsson, C., Jones, Z., Majumdar, S., & Ginzarly, M. (2025). Historic Urban Landscapes and heritage systems as the basis for sustainable urban development. *Land, 14*(9), 1783.

Sakalasuriya, M. M., Haigh, R. P., & Amaratunga, D. (2018). A conceptual framework to analyse consequences of post-conflict reconstruction interventions. *Procedia Engineering, 212*, 894–901. https://doi.org/10.1016/j.proeng.2018.01.115

Saksheshwari. (2024). Thriving the future: Transitioning from 2D plans to 3-D digital models with building information modelling. *Journal of Computer Science and Emerging Trends, 1*(1).

Shadar, H., & Shach-Pinsly, D. (2024). Maintaining community resilience through urban renewal processes using architectural and planning guidelines. *Sustainability, 16*, 560. https://doi.org/10.3390/su16020560

Shehab, A. M. A. (2018). *Influences of socio-cultural values to community housing design in the Gaza Strip, Palestine*. Universiti Teknologi Malaysia.

Sowińska-Heim, J. (2020). Adaptive reuse of architectural heritage and its role in the post-disaster reconstruction of urban identity: Post-communist Łódź. *Sustainability, 12*(19), 8054. https://doi.org/10.3390/su12198054

Stein, N., Dabaieh, M., & Ben Bih, K. (2020). Post-conflict reconstruction in the Middle East and North Africa region: A bidirectional parametric urban design approach. *International Journal of Architectural Computing*. https://doi.org/10.1177/1478077119899584

Stone, S. (2023). Notes towards a definition of adaptive reuse. *Architecture, 3*(3), 477–489. https://doi.org/10.3390/architecture3030026

Tian, G., Fan, Y., Gao, M., Wang, H., Zheng, H., Liu, J., & Liu, C. (2021). Indoor thermal environment of thin membrane structure buildings: A review. *Energy & Buildings, 234*, 110704. https://doi.org/10.1016/j.enbuild.2020.110704

Tian, J., Zhang, X., & Li, F. (2011). Tensional structures in urban design. *Structures Journal*.

Wang, J., & Zakaria, S. A. (2025). Morphological characteristics and sustainable adaptive reuse strategies of regional cultural architecture: A case study of Fenghuang Ancient Town, Xiangxi, China. *Buildings, 15*(1), 119.

Wang, W., & Zhao, J. (2018). Seismic load effects in urban buildings. *Earthquake Spectra*.

Ying, W., Zhang, T., & Shen, L. (2017). Thermal properties of membrane materials. *Journal of Architectural Research*.

Zhang, Q., Ali, Z. M., & Abidin, N. Z. (2025). Sustainable adaptive reuse of historic buildings: Development of a framework from systematic review. *Npj Heritage Science, 13*(1), 619.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 408 – 421

AN EXAMINATION OF DESIGN FOR SAFETY LEGISLATION IN CONSTRUCTION ACROSS MALAYSIA, UNITED KINGDOM, NEW ZEALAND, AUSTRALIA, AND SINGAPORE: A DOCTRINAL ANALYSIS APPROACH

Mashitah Mohamad Hanafiah[1,5], Mazlina Zaira Mohammad[2], Nor Syamimi Samsudin[3], Natasha Khalil[4], Siti Azira Abd Rahim[5]

[1,2] *Faculty of Civil Engineering,*
UNIVERSITY OF TECHNOLOGY MARA, SHAH ALAM
[3,4] *Department of Built Environment Studies and Technology,*
Faculty of Architecture, Planning and Surveying,
UNIVERSITY OF TECHNOLOGY MARA, PERAK BRANCH
[1,5] *Faculty of Engineering and Quantity Surveying,*
UNIVERSITY OF TECHNOLOGY MARA
INTI INTERNATIONAL UNIVERSITY

Abstract

This study undertakes a doctrinal analysis of Design for Safety legislation within the construction sectors of Malaysia, the United Kingdom, New Zealand, Australia, and Singapore. The research identifies commonalities and divergences in how each jurisdiction integrates safety considerations during the design phase to mitigate construction risks by examining statutory frameworks, regulatory duties, and enforcement mechanisms. The study further contextualizes legal provisions through a comparative evaluation of construction accident data from 2023, revealing correlations between legislative rigor and safety outcomes. The findings indicate that while all jurisdictions emphasize early hazard identification and risk elimination, differences in enforcement practices and stakeholder responsibilities impact effectiveness. Malaysia's recent 2024 regulations demonstrate progressive alignment with international best practices. The paper contributes to legal scholarship by highlighting the pivotal role of design-focused legislation in advancing occupational safety, offering insights for policymakers and industry stakeholders aiming to enhance construction safety through proactive legal frameworks.

Keywords: Design for Safety, Construction for Safety Legislation, Doctrinal Analysis, Malaysia, United Kingdom, New Zealand, Australia, Singapore

[1] Coressponding author. Email: mashitahhanafiah@gmail.com

INTRODUCTION

The construction industry is recognized for its high incidence of occupational injuries and fatalities globally, demanding robust legislative frameworks to mitigate risks (Lingard & Rowlinson, 2004) (J. A. Gambatese et al., 2008). Legislative approaches have varied across jurisdictions but have typically focused on clear allocation of responsibilities, comprehensive risk management, and enforcement to ensure safety during design and construction phases (Haslam et al., 2005) (Loosemore & Andonakis, 2007).

Malaysia's new Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 (Government of Malaysia, 2024) represent a significant development in its occupational safety and health (OSH) legal landscape. However, to evaluate the effectiveness and potential gaps of this legislation, a comparative analysis with established frameworks such as the United Kingdom's Construction (Design and Management) Regulations 2015 (UK Government, 2015), New Zealand's Health and Safety at Work Act 2015 (New Zealand Government, 2015), Australia's Work Health and Safety Act 2011 (New South Wales Government, 2011), and Singapore's Design for Safety Regulations 2015 (Minister of Manpower, 2015) is critical.

In Design for Safety (DfS) legislation, the main legal key player is duty holders who are assigned to manage safety risk and typically include clients, designers and contractor (Hussain et al., 2025). Whereas in United Kingdom jurisdiction, Principal Designer is formally appointed to manage safety consideration during pre-construction stage to ensure risk information communicated at the earliest possible among project participants (Gambatese et al., 2008) and similar approached adopted by Malaysia (Government of Malaysia, 2024)

This paper uses doctrinal legal analysis to systematically examine these legislations, focusing on their provisions regarding duty holders, risk management, worker participation, and enforcement. The paper thus seeks to identify lessons for Malaysia's regulatory improvements and contribute to the broader academic discourse on construction safety law.

LITERATURE REVIEW

Construction as a globally hazardous field of employment

Construction has been widely recognized as a high-risk industry, consistently exhibiting elevated rates of occupational accidents and fatalities worldwide. Referring to Figure 1, data recorded in 2023, Malaysia reported 88 construction-related fatalities and approximately 5379 major injuries, indicating significant safety challenges within its construction sector (Malaysia, 2024). The United Kingdom recorded 51 fatalities and around 2390 major injuries, reflecting

© 2026 by MIP

ongoing efforts to improve safety despite persistent risks (Statistics, 2024), while Australia's construction industry saw 53 fatalities and roughly 16,600 major injuries in 2023 (Safe Work Australia, 2024). New Zealand reported close to 100 fatalities and 33,000 injuries related to the construction industry during this period, showcasing considerable risks (WorkSafe New Zealand, 2024). Singapore reported 54 fatalities and 167 major injuries, indicative of its rigorous safety regulations and enforcement mechanisms (Ministry of Manpower, 2023). The data show a significant number of the incidents reported have resulted in fatality. These figures underscore the critical importance of effective design for safety legislation and enforcement in mitigating risks in this inherently hazardous sector.

Country	Construction (2023)	
	Fatality	Serious Injuries
Malaysia	88	5378
United Kingdom	51	2390
Australia	53	16,600
New Zealand	100	33,000
Singapore	54	167

Figure 5: Construction Industry Fatalities and Major Injuries 2023
Source: Department of Statistics Malaysia (2024), Safe Work Australia (2024), WorkSafe New Zealand (2024), Ministry of Manpower Singapore (2023), and National Statistical United Kingdom (2024)..

Design for Safety

Design for Safety (DfS) is an increasingly influential approach within occupational safety and health (OSH) which advocates for integrating hazard identification and elimination during the design phase of construction projects, rather than relying solely on controls implemented during construction or operations (J. A. Gambatese et al., 2008). This preventive strategy aligns with the hierarchy of controls, placing elimination and substitution above administrative controls and personal protective equipment (Hinze & Wiegand, 1992). Scholars have argued that engaging designers early in the safety process is critical since many hazards originate in design decisions such as choice of materials, construction methods, or sequencing (Smallwood & Haupt, 2005). For instance, design can reduce the need for work at heights or eliminate confined spaces, thus minimizing exposure to risks (Gambatese, 2005).

Furthermore, DfS facilitates more comprehensive risk assessments by including a broader range of stakeholders at the project inception stage (Loosemore & Andonakis, 2007). Several empirical studies have supported the

efficacy of DfS. Gambatese et al., (2008) highlighted case studies in which design modifications led to substantial reductions in on-site accidents. Similarly, Hinze & Wiegand (1992) have underscored that over 50% of construction accidents could be prevented through design changes. However, challenges remain in embedding DfS principles in practice, including limited awareness among designers, lack of regulatory enforcement, and fragmented communication among project participants (Loosemore & Andonakis, 2007).

Proactive Legislation

In response, jurisdictions like Singapore have pioneered statutory requirements mandating design hazard elimination, evident in their Workplace Safety and Health (Design for Safety) Regulations 2015 (Minister of Manpower, 2015). The UK's CDM Regulations 2015 also reflect this shift by establishing the Principal Designer role with explicit safety duties (UK Government, 2015). These legislative innovations aim to overcome traditional barriers by formalizing safety responsibilities during design.

Despite these advances, Malaysia's previous OSH framework had limited explicit focus on safety through design, often resulting in reactive rather than proactive safety management. The introduction of Malaysia's Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 (Government of Malaysia, 2024) marks a critical opportunity to embed DfS principles into national law, improving risk elimination at source and aligning with global best practices. In summary, the literature demonstrates that design for safety is essential for effective construction safety management. Legal frameworks which explicitly mandate and enable DfS are more likely to reduce occupational accidents and foster a culture of proactive hazard prevention.

Mandatory enforcement as a Design for Safety implementation force

Effective enforcement is vital to the successful implementation of social legislation, and legislation that is not enforced rarely fulfills its social objectives (Gunningham, 2010). It is one of the undeniable barriers to implementing PtD is the legal requirement and enforcement (J. A. Gambatese et al., 2017) (J. Gambatese et al., 2005). Researchers believe that a mandatory legal framework is important to ensuring the successful implementation of PtD. For example, Christermaller et al., (2022) and Asmone et al., (2022) suggested that mandatory legislation is more effective in compliance among construction key players due to its punitive nature.

Despite increased awareness of PtD in construction, Poghosyan et al. (2018) indicated that only a small amount of research investigating legislation issues in regard to the said concept. Similarly, Martínez-Aires et al. (2016) stated

© 2026 by MIP

that very few studies investigated the implementation of PtD regulations. In an earlier study, Martínez Aires et al. (2010) stated that even though PtD regulation is a significant driving force of the concept, there is a paucity of research about it. Study shows that publications related to PtD have been actively published since 2008 and especially doubled since 2020. However, studies that explored the topics of PtD regulations and legislation remained isolated. No study has been conducted to compare the differences in the policies and practices of different countries (Jin et al., 2023). Thus, to address the study gap, this paper is to provide an overview of the legal framework component and compare it with Malaysia's newly established Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024.

RESEARCH METHODOLOGY

This study adopts a doctrinal legal research methodology, a well-established qualitative approach in legal study focused on analyzing and interpreting legal texts, such as statutes, regulations, case law, and related official materials (Hutchinson & Duncan, 2012; McConville & Chui, 2017). Doctrinal research systematically examines the "black letter" law to clarify legal rules, principles, and institutional frameworks, enabling a rigorous comparison of legislative instruments across jurisdictions (Hutchinson & Duncan, 2012). The methodological steps for this research included the following:

Identification and Collection of Primary Legal Sources

The primary data consist of official legislation documents which are the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 (Malaysia), Construction (Design and Management) Regulations 2015 (UK), Health and Safety at Work Act 2015 (New Zealand), Work Health and Safety Act 2011 (Australia), and Workplace Safety and Health (Design for Safety) Regulations 2015 (Singapore). These documents were sourced from official government websites and legal databases to ensure their authenticity and currency (McConville, 2017).

Thematic Legal Analysis

The legal texts were analyzed according to key thematic categories relevant to construction safety legislation: scope, duty holders, risk management, worker participation, enforcement, and penalties (Hames & Ekern, 2017). This thematic framework allows for systematic comparisons, while capturing the substantive regulatory features that influence occupational safety outcomes

Comparative Legal Framework

Employing the comparative method within doctrinal research, the study juxtaposes statutory provisions to identify convergences and divergences in legal approaches and regulatory design (Zweigert & Kötz, 1998). The findings from textual analysis and contextual interpretation were synthesized to assess the adequacy of Malaysia's recent legislative reforms against international best practices. This step aims to identify gaps and potential improvements informed by doctrinal insights and existing literature (Gardiner & Hutchinson, 1989). This doctrinal approach is appropriate for legal studies aiming to clarify legal standards and compare regulatory frameworks without empirical field data, ensuring a rigorous and systematic legal evaluation. This doctrinal approach also allows for both a comprehensive understanding of the regulatory frameworks, and their potential impact on construction occupational safety.

ANALYSIS AND DISCUSSION

Result

Through doctrinal research methodology, the research is compared and analyzed in terms of six elements, namely legal structures, scope and coverage, duty holders and responsibilities, risk management and safety planning, worker engagement and consultation, and finally enforcement mechanisms and penalties, as summarized in Figure 2.

Element	Malaysia OSH (Construction Work) (Design and Management) Regulations 2024	United Kingdom CDM Regulations 2015	Singapore WSH (Design for Safety) Regulations 2015	New Zealand Health and Safety at Work Act 2015	Australia WHS Act 2011
Legal Structure	5 Parts (Reg. 1–39)	5 Parts (Reg. 1–39)	5 Parts (Reg. 1–13)	5 Parts (Sec. 3–232)	14 Parts (Sec. 1–276)

© 2026 by MIP

Element	Malaysia OSH (Construction Work) (Design and Management) Regulations 2024	United Kingdom CDM Regulations 2015	Singapore WSH (Design for Safety) Regulations 2015	New Zealand Health and Safety at Work Act 2015	Australia WHS Act 2011
Scope & Coverage	Applies to all construction projects; focuses on design & management safety (Reg. 2)	Covers construction projects from inception to completion; excludes mineral extraction (Reg. 2)	Specific to construction safety, focuses on design hazard elimination (Reg. 3)	Broad coverage of all workplaces; applies to construction ; excludes army, volunteers, prisoners (Sec. 15–18)	Broad workplace law: construction included exclusions like NZ (Sec. 20–26)
Duty Holders & Responsibilities	Principal Designer (Reg. 7), Client, Contractors	Principal Designer (Reg. 13), Client, Contractors	Developer, Designer, Contractor (Reg. 4–10)	PCBU (Sec. 17), Officers (due diligence)	PCBU (Sec. 27), Officers (due diligence)
Risk Management & Safety Planning	Safety & Health Plan pre-construction (Reg. 11)	Pre-construction risk assessments & ongoing reviews (Reg. 13)	Eliminate/reduce design risks at source (Reg. 9–10)	Continuous risk identification and control (Sec. 30)	Hazard ID, control & consultation throughout (Sec. 27)
Worker Engagement & Consultation	Workers involved via principal contractor (Reg. 17)	Strong emphasis on worker involvement (Reg. 15)	Developer ensures safety via collective measures (Reg. 4)	Worker participation legally required (Sec. 58)	Worker consultation & representation (Sec. 47)
Enforcement & Penalties	Fine ≤ RM500,000 &/or imprisonment ≤ 1 year	No fixed fine or prison term specified in regulations	Fine SGD 10,000–20,000 &/or imprisonment ≤ 12 months	Fine ≤ NZD 3 million &/or imprisonment ≤ 5 years	Fine ≤ AUD 3 million &/or imprisonment ≤ 5 years

Figure 6: A comparative summary table of PtD legal frameworks across countries.

Legal Structures

Occupational Safety and Health (Construction Work) (Design and Management) Regulation 2024 is divided into 5 parts namely preliminary regulations 1 to 3, client duties regulations 4 to 9, duties relation to safety and health regulations 10 to 17, general requirements for all construction sites detailed in regulation 18 to 37 and miscellaneous regulation 38 to 39. The Construction (Design and Management) Regulations 2015 is a United Kingdom legal framework related to safety for design and construction work.

The regulation is structured into five parts, with Regulations 1 to 3 as the introduction of the regulation; regulations 4 to 7 about client duties; and regulations 8 to 15 stipulate health and safety duties and roles. General requirements for all construction sites are codified under Part 4 from Regulation 16 to 35. Lastly, Regulations 36 until 39 describe the general application of the legal book. Workplace Safety and Health (Design for Safety) Regulations 2015 under Singapore jurisdiction is divided into 5 parts, namely Preliminary from Regulation 1 to 3; duties of Developer Regulation from 4 to 8; duties of Designer and Contractor Regulation from 9 to 10; and lastly miscellaneous from 11 to 13. The Health and Safety at Work Act 2015 regulates occupational safety and health practices in New Zealand. The act is divided into five parts, including health and safety at work from Section 3 until 29; part 2 regarding health and safety duties stipulated under Sections 30 to 57; and Section 58 to 99 codified under Part 3 regarding worker engagement, participation, and representation. Enforcement and other matters in part 4 include Sections 100 to 188.

Lastly, miscellaneous matters are under part 5 from Section 189 under 232. In the context of Australia for occupational safety and health, the Work Health and Safety Act 2011 is relevant. The act is divided into 14 parts, namely preliminary from Section 1 until 12A, part 2 health and safety duties which are stipulated in Section 13 until 34. Notification in Part 3 is from Section 35 until 39, and Part 4 of the Act from Section 40 until 45 is regarding authorization. Part 5 is consultation, representation, and participation from Sections 46 to 103. Part 6 codifies matters of discriminatory, coercive, and misleading conduct under Section 104 until 115. Part 7 includes Sections 116 to 151 regarding workplace entry by WHS entry permit holders. Sections 152 to 155 in part 8 are about the regulator. Part 9 from Section 156 until 190 stipulates securing compliance, Part 10 of enforcement measures is in Sections 191 to 215, and Part 11 is enforcement undertaking in Sections 216 to 222. Part 12 is a review of the decision from Section 223 to 229 and part 13 is a legal proceeding from Section 229A until 267. Lastly, part 14 is a general requirement of the act stipulated under Section 268 until 276.

© 2026 by MIP

Scope and Coverage

Malaysia's OSH (Construction Work) (Design and Management) Regulations 2024 comprehensively apply to all construction projects, emphasizing the integration of safety measures at the design and management stages as stated in Regulation 2 (Government of Malaysia, 2024). This aligns closely with the UK's CDM Regulations 2015, which govern construction health and safety from project inception to completion, emphasizing coordination among duty holders referring to Regulation 2(1)(a) until 2(1)(e) however not included exploration or extraction of mineral resources (Instruments, 2015).

Similarly, Singapore's Design for Safety Regulations 2015 focuses specifically on construction safety, mandating hazard elimination during design as stated in Regulation 3(1) (Minister of Manpower, 2015). New Zealand's HSWA 2015 takes a broader approach, regulating all workplaces, with specific duties for construction projects detailed within this general framework, however disapplication to the army, volunteer workers, and prisoners as in Section 15 to Section 18 (Act, 2015). The same applies to Australia's WHS Act 2011 which is detailed under Division 3, Section 20 to Section 26 (New South Wales Government, 2011).

Duty Holders and Responsibilities

A clear delineation of duty holders is central to these frameworks. Regulation 7 of the Malaysian legal framework and Regulation 13 of the United Kingdom's legal framework each designate a Principal Designer role, responsible for coordinating design-stage safety, supported by clients, contractors, and workers. Likewise, in Part 3 of the Singapore Act, specifically Section 9 and Section 10, Singapore mandates designers and contractors to eliminate hazards early, promoting collaboration with clients and contractors to ensure safety is embedded throughout the design and construction phases (Minister of Manpower, 2015).

In contrast, New Zealand and Australia employ a principle-based approach emphasizing the duty of officers to exercise due diligence to ensure compliance (Act, 2015) (New South Wales Government, 2011). This imposes active leadership accountability beyond prescriptive roles. In New Zealand, PCBU or a person conducting business or undertaking is outlined in Regulation 17, and there are similar highlights in Australia's act under Section 27 of Division 4.

Risk Management and Safety Planning

All jurisdictions prioritize risk management but differ in focus and timing. Malaysia requires detailed safety and health plans prior to construction commencement, emphasizing early-stage risk assessment. As stated under

Regulation 11(2), the construction work designer must consider preventing and eliminating any risk to the safety and health of a person during pre-construction as far as practicable.

A similar principle applies under Regulation 13 of the UK's CDM framework, which mandates detailed pre-construction information sharing and ongoing risk assessments to enable dynamic safety management. Singapore uniquely prioritizes design risk elimination or reduction at its sources as the duty of designers and contractors in Regulation 9 and Regulation 10, reflecting a proactive approach to preventing construction accidents. Section 30 of New Zealand imposed a duty to a person under this act, while Section 27 of Division 4 in Australia's legal framework focuses on continuous hazard identification, control, and worker consultation throughout a project's lifecycle.

Worker Engagement and Consultation

Effective worker engagement is a statutory requirement across all jurisdictions. Malaysia's regulations require principal construction work contractors to engage with workers and establish clear communication channels for workers and contractors during safety planning as stipulated in Regulation 17. The UK's CDM 2015 strongly emphasizes worker involvement to enhance hazard awareness and compliance and applies a similar practice to Malaysia as stipulated under Regulation 15. Part 3 and Section 58 of New Zealand's act and Part 5, Division 2 Section 47 of Australia codify that the person conducting business is to provide workers with consultation, as this is a core element of workplace health and safety, fostering participatory safety cultures.

Differing from this, Singapore requires the developer to ensure safety and eliminate all foreseeable risks through collective protective measures rather than personal collective measures and encourages ongoing collaboration between designers, contractors, and workers, aiming to integrate safety considerations at all project stages, as stipulated under Part 2 Regulation 4.

Enforcement Mechanisms and Penalties

Enforcement authorities vary between Malaysia, the United Kingdom, New Zealand, Australia, and Singapore, but each are empowered to monitor compliance and prosecute violations. Penalties commonly include financial fines and imprisonment for serious breaches, with recent Malaysian regulations adopting stricter sanctions to align with international standards with not more than RM500,000 fines and not more than 1 year of imprisonment or both.

The fines vary to not more than 3 million or imprisonment of not more than 5 years for New Zealand and Australia, emphasizing criminal liability for officers, encouraging proactive leadership accountability. Under Singaporean

© 2026 by MIP

regulations, fines for non-compliance range from 10,000 to 20,000 with not more than 12 months imprisonment. Differing from under the United Kingdom's legal framework, in the event of non-compliance, there is no stipulated fine value or imprisonment year.

Comparative Regulatory Approaches

While all jurisdictions incorporated key elements in their DfS framework, the application and implementation are different. Malaysia, United Kingdom and Singapore adopt role-based approach by designing clear responsibilities among design principles, contractor and client(Hussain et al., 2025). In contrast, New Zealand and Australia a principle-based framework focusing on Person Conducting Business or Undertaking (PCBU) which requires broader organizational accountability and due diligence (Burgemeestre et al., 2009). These differences highlight how regulatory philosophy influences the effectiveness of Design for Safety implementation across jurisdictions.

CONCLUSION

This doctrinal analysis demonstrates that Design for Safety (DfS) legislation across Malaysia, the United Kingdom, New Zealand, Australia, and Singapore share a foundational commitment to early hazard identification and elimination during the design phase of construction projects. All jurisdictions establish clear statutory duties for key factors such as designers, clients, contractors, and workers, and emphasize the importance of risk management, worker engagement, and proactive safety planning throughout the construction lifecycle. Malaysia's recently enacted Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 notably align with international best practices, reflecting a progressive shift towards embedding DfS principles within national law.

While the legislative frameworks bear strong similarities in scope and intent, differences emerge in enforcement mechanisms and the delineation of responsibilities. For example, New Zealand and Australia's principle-based due diligence requirements for officers foster high accountability levels, while Singapore's regulations emphasize collective protective measures and collaboration among stakeholders. The United Kingdom's CDM Regulations maintain a structured approach with defined roles but lack specified penalties within the regulations themselves. Malaysia's new regulations introduce clearer punitive sanctions, potentially enhancing compliance and safety outcomes. The comparative analysis of construction accident data for 2023 has corroborated positive correlations between rigorous DfS legislation, enforcement, and improved safety performance. Jurisdictions with comprehensive and enforced

DfS laws, such as Singapore and Australia, report lower fatality and injury rates, underscoring the critical role of proactive legal frameworks in mitigating occupational hazards. In sum, this study affirms that embedding DfS into statutory frameworks is essential for advancing construction safety and reducing preventable accidents. Malaysia's 2024 regulations represent a significant step toward closing regulatory gaps and fostering a safety culture aligned with global standards. Future research should offer empirical evaluations of the regulations' practical implementation and their impact on industry behavior, thus bridging the current gap between legal theory and practice noted in existing literature (Jin et al., 2023) (J. A. Gambatese et al., 2017).

ACKNOWLEDGEMENT AND DISCLOSURE STATEMENT

The authors would like to credit University Technology MARA and INTI International University for its continuous support to complete this study. The authors also declared that there is no conflict of interest related to the work presented in this paper.

REFERENCES

Asmone, A. S., Goh, Y. M., & Lim, M. S. H. (2022). Prioritization of industry level interventions to improve implementation of design for safety regulations. *Journal of Safety Research*, *82*, 352–366. https://doi.org/10.1016/j.jsr.2022.06.011

Australia, Safe Work. (2024). Key work health and safety statistics Australia 2024. September.

Burgemeestre, B., Hulstijn, J., & Tan, Y. H. (2009). Rule-based versus principle-based regulatory compliance. *Frontiers in Artificial Intelligence and Applications*, *205*, 37–46. https://doi.org/10.3233/978-1-60750-082-7-37

Christermaller, F., Che Ibrahim, C. K. I., Manu, P., Belayutham, S., Mahamadu, A. M., & Yunusa-Kaltungo, A. (2022). Implementation of design for safety (DfS) in construction in developing countries: A study of designers in Malaysia. *Construction Economics and Building*, *22*(2), 1–26. https://doi.org/10.5130/AJCEB.v22i2.8105

Department of Statistics Malaysia. (2024). National occupational injury and disease statistics 2023.

Gambatese, J. A., Behm, M., & Hinze, J. W. (2005). Viability of designing for construction worker safety. *Journal of Construction Engineering and Management*. https://doi.org/10.1061/ASCE0733-93642005131:91029

Gambatese, J. A., Behm, M., & Rajendran, S. (2008). Design's role in construction accident causality and prevention: Perspectives from an expert panel. *Safety Science*, *46*(4), 675–691. https://doi.org/10.1016/j.ssci.2007.06.010

Gambatese, J. A., Pestana, C., & Lee, H. W. (2017). Alignment between lean principles and practices and worker safety behavior. *Journal of Construction Engineering and Management*, *143*(1). https://doi.org/10.1061/(ASCE)CO.1943-

© 2026 by MIP

7862.0001209
Gardiner, D. G., & Hutchinson, T. (1989). Legal research materials and methods (Review of the book Legal research materials and methods, by E. Campbell). *QUT Law Review*, *5*, 141–143. https://doi.org/10.5204/qutlr.v5i0.321
Government of Malaysia. (2024). Occupational safety and health (construction work) (design and management) regulations 2024. May.
Gunningham, N. (2010). Enforcement and compliance strategies. In R. Baldwin, M. Cave, & M. Lodge (Eds.), *The Oxford handbook of regulation*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199560219.003.0007
Haslam, R. A., Hide, S. A., Gibb, A. G. F., Gyi, D. E., Pavitt, T., Atkinson, S., & Duff, A. R. (2005). Contributing factors in construction accidents. *Applied Ergonomics*, *36*(4), 401–415. https://doi.org/10.1016/j.apergo.2004.12.002
Hinze, J., & Wiegand, F. (1992). Role of designers in construction worker safety. *Journal of Construction Engineering and Management*, *118*(4), 677–684. https://doi.org/10.1061/(ASCE)0733-9364(1992)118:4(677)118:4(677))
Hocke Van. (2010). Methodology of legal research. *Methodologies of Legal Research. Which Kind of Method for What Kind of Discipline*, 111–121.
Hussain, A., Che Ibrahim, C. K. I., Belayutham, S., Manu, P., & Cheung, C. (2025). Exploring regulatory capabilities for design for safety in construction: The case of Malaysia. *Built Environment Project and Asset Management*, 1–21. https://doi.org/10.1108/BEPAM-03-2025-0077
Hutchinson, T., & Duncan, N. (2012). Defining and describing what we do: Doctrinal legal research. *Deakin Law Review*, *17*(1), 83–119. https://doi.org/10.21153/dlr2012vol17no1art70
Jin, Z., Gambatese, J., Karakhan, A., & Nnaji, C. (2023). Analysis of prevention through design studies in construction: A subject review. *Journal of Safety Research*, *84*, 138–154. https://doi.org/10.1016/j.jsr.2022.10.015
Lingard, H., & Rowlinson, S. (2004). *Occupational health and safety in construction project management* (1st ed.). Routledge. https://doi.org/10.4324/9780203507919
Loosemore, M., & Andonakis, N. (2007). Barriers to implementing OHS reforms: The experiences of small subcontractors in the Australian construction industry. *International Journal of Project Management*, *25*(6), 579–588. https://doi.org/10.1016/j.ijproman.2007.01.015
Martínez-Aires, M. D., Rubio Gámez, M. C., & Gibb, A. (2010). Prevention through design: The effect of European directives on construction workplace accidents. *Safety Science*, *48*(2), 248–258. https://doi.org/10.1016/j.ssci.2009.09.004
Martínez-Aires, M. D., Rubio Gámez, M. C., & Gibb, A. (2016). The impact of occupational health and safety regulations on prevention through design in construction projects: Perspectives from Spain and the United Kingdom. *Work*, *53*(1), 181–191. https://doi.org/10.3233/WOR-152148
McConville, M., & Chui, W. H. (Eds.). (2017). *Research methods for law* (3rd ed.). Edinburgh University Press.
Ministry of Manpower. (2015). Workplace safety and health (design for safety) regulations 2015.

Ministry of Manpower. (2023). Singapore workplace safety and health report 2023.

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods*, *22*, 1–18. https://doi.org/10.1177/16094069231205789

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods*, *22*, 1–18. https://doi.org/10.1177/16094069231205789

New South Wales Government. (2011). Work Health and Safety Act 2011.

New Zealand Government. (2015). Health and safety at work act 2015 no 70 (as at 28 October 2021), public act contents – New Zealand legislation. https://www.legislation.govt.nz/act/public/2015/0070/latest/DLM5976660.html

Office for National Statistics. (2024). Construction statistics in Great Britain, 2024.

Poghosyan, A., Manu, P., Mahdjoubi, L., Gibb, A. G. F., Behm, M., & Mahamadu, A. M. (2018). Design for safety implementation factors: A literature review. *Journal of Engineering, Design and Technology*, *16*(5), 783–797. https://doi.org/10.1108/JEDT-09-2017-0088

Smallwood, J., & Haupt, T. (2005). The need for construction health and safety (H&S) and the construction regulations: Engineers' perceptions. *Journal of the South African Institution of Civil Engineering*, *47*(2), 2–8.

UK Government. (2015). Health and safety the construction (design and management) regulations 2015. 1975(51), 1–32.

Worksafe New Zealand. (2024). Work health and safety: An overview of harm and risk in Aotearoa New Zealand 2024.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 422 – 435

SAFETY ASSESSMENT IN THE CONSERVATION OF HERITAGE BUILDINGS: A CASE STUDY OF TRADITIONAL MOSQUES IN NEGERI SEMBILAN, MALAYSIA

Siti Azira Abd Rahim[1,2], Mashitah Mohamad Hanafiah[1,3], Zurinoor Ahmad[1], Mohamed Ahmed Said Mohamed[4], Syahrul Rahmat [5]

[1] *Faculty of Engineering and Quantity Surveying,*
INTI INTERNATIONAL UNIVERSITY
[2] *Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA
[3]*Faculty of Civil Engineering,*
UNIVERSITY OF TECHNOLOGY MARA
[4]*Architectural Engineering Department,*
UNIVERSITY OF HAIL, SAUDI ARABIA
[5]*Islamic Communication and Broadcasting Department,*
STAIN SULTAN ABDURRAHMAN KEPULAUAN RIAU, BINTAN, INDONESIA

Abstract

The preservation of heritage buildings while maintaining structural integrity and functional usability presents a challenge in protecting cultural and historical value. This research examines old timber mosques in Negeri Sembilan, Malaysia, which are increasingly threatened by decaying materials and insufficient safety protocols. The main objectives are to evaluate the safety conditions and determine possible preservation methods for these valuable heritage structures. Five (5) mosques have been qualitatively examined via field observations, systematic safety assessments and semi-structured interview protocols with related parties. Maintenance issues such as timber degradation, fire hazards, outdated electrical systems, and limited access to emergency exits are the lead causes of safety issues. The findings relate to the absence of conservation initiatives and compliance with safety regulations. This study focuses on the necessity of systematic safety assessments in historic conservation frameworks. It outlines a strategic approach to maintaining traditional authenticity while complying with contemporary safety standards, highlighting the need for community involvement in targeting sustainable heritage management.

Keywords: Safety Assessment, Heritage Building Conservation, Cultural Heritage, Traditional Mosque

[1] Corresponding author. Email: sitiazira.rahim@newinti.edu.my

INTRODUCTION

Heritage buildings are part of the architectural identity of a society, as each reflects historical and cultural aspects which are valuable and irreplaceable. The preservation process is crucial to foster national heritage, cultural continuity and educational value (Feilden, 2003). Unfortunately, most such valuable structures were built long before modern building codes and safety standards being introduced. This has resulted in structural deterioration, outdated materials, high risk of fire, poor accessibility, and vulnerability to earthquakes (Douglas, 2006; Yung & Chan, 2012). These are significant obstacles for heritage professionals specifically adapting building for continuous use or public access without compromising originality.

In the past, the conservation process emphasized historical and original materials rather than modern safety approaches (Jokilehto, 1999). However, the adaptation and reuse of these buildings demonstrate an increasing demand among the public for buildings with heritage values. This requires an integrated approach which addresses both conservation and safety in a balanced manner.

Efforts to sustain heritage assets may not be successful due to failure to assess and mitigate safety risks (Orbaşlı, 2008). This study responds to this critical gap by proposing an integrated safety assessment approach tailored for heritage buildings. Using a case study methodology, it aims to examine common safety risks, evaluate current conservation practices, and propose a practical framework to enhance safety practices for heritage buildings.

RESEARCH BACKGROUND

Heritage Building Conservation

Heritage building conservation intends to safeguard architectural, historical, and cultural values while ensuring the transmission of authenticity to future generations. Early conservation philosophy, as emphasized by Feilden (2003), prioritised the preservation of original fabric and minimal intervention. However, conventional conservation practice has evolved globally to recognise the need for a balanced approach that integrates authenticity with functional requirements, user safety, and regulatory compliance. International charters and recent studies highlight that heritage buildings must remain safe, accessible, and usable to ensure their continued relevance and sustainability.

In Malaysia, heritage conservation is governed by the National Heritage Act 2005, which provides a statutory framework for the protection and management of culturally significant buildings. While the legislation emphasises safeguarding historical and architectural principles, practical implementation often faces challenges in reconciling conservation principles with modern safety and operational demands. Recent studies indicate that conservation projects may

© 2026 by MIP

still prioritise aesthetic and historical integrity over occupant safety and building performance, underscoring the need for more integrated conservation strategies that align heritage values with contemporary standards (Ismail & Ahmad, 2022).

Safety Assessment in Heritage Structures

Buildings over 50 years old with cultural significance are classified as heritage structures in Malaysia under the National Heritage Act 2005. Since many of these buildings were built before modern safety standards were established, they often do not have crucial features like fire detection systems, emergency exits, or sufficient structural reinforcement. As a result, this lack of safety measures presents considerable risks to those who use or occupy these heritage buildings, especially public ones (Douglas, 2006; Yung & Chan, 2012).

Globally, safety assessments for heritage buildings are increasingly using adaptive methods that enable the integration of modern safety standards while preserving historical features. In Malaysia, however, implementing safety guidelines from authorities like BOMBA and the Uniform Building By-Laws (UBBL) is often difficult due to limited space, material restrictions, and strict regulations. Recent events, such as fires in heritage shophouses in George Town, Penang (Trisha, 2023) and structural issues at Masjid Lama Kampung Pelangai (Abd Rahim et al., 2022), demonstrate the vulnerability of heritage buildings and emphasize the importance of proactive, safety-focused conservation planning.

Structural Integrity in Heritage Contexts

Structural integrity, defined as a building's ability to safely withstand applied loads without failure, is a critical segment of heritage conservation. Aging materials, traditional construction techniques, prolonged environmental exposure, and inadequate maintenance often compromise the structural performance of heritage buildings (Yusoff et al., 2020). Globally, advancements in non-invasive diagnostic technologies have significantly improved the assessment of structural conditions in heritage contexts.

In Malaysia, recent applications of UAV-based photogrammetry and laser scanning have enhanced the documentation and monitoring of traditional timber structures, including heritage mosques in Negeri Sembilan (Zakaria et al., 2022). These technologies allow for accurate condition assessment while minimizing physical intervention. Despite such advancements, many heritage buildings still lack comprehensive structural evaluations, increasing the risk of failure during rehabilitation or adaptive reuse projects. This gap underscores the importance of integrating digital documentation tools into common conservation practice.

© 2026 by MIP

Risk Management in Heritage Conservation

Risk management in heritage conservation involves the identification, assessment, and mitigation of threats resulting from natural hazards, human activities, and technical failures (Jigyasu, 2019; Khan & Khan, 2023). International best practices now incorporate risk-based approaches within conservation planning to improve resilience and ensure long-term sustainability. Fire risk remains a significant concern, primarily due to outdated electrical systems and unsuitable retrofitting solutions (Baharuddin et al., 2014).

In Malaysian context, effective risk management is often limited by fragmented governance structures, insufficient technical capacity, and regulatory inconsistencies between conservation and safety requirements (Norazian & Wahab, 2022). These challenges highlight the necessity for integrated systems that align heritage preservation principles with contemporary safety and risk management strategies. Enhancing this integration is crucial for improving the resilience, safety, and sustainability of heritage buildings, particularly those that serve active community and religious roles.

RESEARCH METHODOLOGY

Qualitative case study

This research uses a qualitative case study approach to evaluate the current safety conditions and conservation practices of five traditional heritage mosques in Negeri Sembilan, Malaysia as shown in Figure 1. The mosque studied includes Masjid Lama Padang Lebar (Rembau), Masjid Lama Kampung Pelangai (Kuala Pilah), Masjid Lama Tanah Datar (Rembau), Masjid Lama Kuala Dulang (Jelebu), and Masjid Lama Parit Istana (Kuala Pilah). These mosques were selected due to their historical significance and traditional Vernacular Malay timber architecture. Some are in continued use by local communities and some are abandoned.



Figure 1: The dilapidated state of *Masjid Lama Parit Istana, Masjid Lama Kampung Pelangai, Masjid Lama Tanah Datar, and Masjid Lama Padang Lebar.*
(Source: Author, 2025)

Data collection: observation and site inspection

Data collection focused on basic safety assessments through direct field observations and site inspections. A structured checklist was developed based on national building safety codes and heritage conservation guidelines to

© 2026 by MIP

systematically evaluate structural integrity, fire safety, electrical installations, accessibility, and emergency preparedness. Factors examined included roof stability, load-bearing timber columns and beams, presence of cracks or termite infestation, adequate fire exits, safety of electrical connections, and firefighting equipment availability.

Semi-structured interview
Interviews were conducted with mosque caretakers, community members, and local heritage officials to gather data on maintenance routines, safety concerns, and repair initiatives. These interviews explored the challenges involved in reconciling heritage preservation with contemporary safety standards.

Comparative analysis
Common safety issues among the mosques, related to deteriorating timber structures due to age and insect infestation; insufficient fire safety measures; outdated or exposed electrical wiring; and limited accessibility for emergency evacuation are the comparative analysis focus for this study. Each site study variation was based on the level of maintenance and community involvement. This safety assessment methodology provides practical framework for safety risk in heritage buildings and emphasizes the importance of integrating basic safety heritage and user wellbeing.

ANALYSIS AND DISCUSSION

Table 1 shows the safety assessments of the five heritage mosques in Negeri Sembilan. These reveal several recurring issues that reflect broader challenges faced in the conservation of heritage buildings, particularly those constructed with traditional timber architecture.

Table 1: Safety assessment of heritage mosques, Negeri Sembilan

Safety Issues	Safety Assessments	Challenges & Limitations	Supporting Arguments
Structural Integrity and Timber Degradation	• Timber structural elements showing deterioration: termite infestation, wood rot, and cracking. • Lack of regular structural health monitoring. • Risk of collapse without intervention.	No use of UAV photogrammetry or laser scanning. Urgent need for non-invasive monitoring in conservation.	Yusoff et al. (2020); Zakaria et al. (2022)
Fire Safety Deficiencies	• Insufficient fire exits, emergency lighting, and fire extinguishers.	Retrofitting fire safety systems is difficult due to regulatory and	Douglas (2006); Trisha (2023); Rashid et al. (2023)

Safety Issues	Safety Assessments	Challenges & Limitations	Supporting Arguments
	• Timber's high combustibility increases fire risk. • Fire incident in Penang highlights vulnerability.	architectural authenticity constraints.	
Electrical Systems and Fire Risk	• Outdated, exposed wiring not meeting current safety standards. • Caretakers lack expertise and resources for safe upgrades. • Electrical faults are a major fire cause.	Need for specialized interventions balancing electrical safety and heritage conservation.	Baharuddin et al. (2014)
Accessibility and Emergency Preparedness	• Emergency access and evacuation routes are absent or poorly planned. • Narrow/obstructed entrances. • Poor accessibility for disabled persons.	Conflicts between modernization and original spatial design. Risks occupant safety and communal use viability.	Ismail & Ahmad (2022); Alvarenga Coutinho (2021)
Community Involvement and Maintenance Practices	• Better maintenance and safety monitoring in mosques with active community involvement. • Community efforts are limited by technical and financial capacity.	Highlights need government or institutional support for capacity building and risk management.	Yung & Chan (2012); Norazian & Wahab (2022)
Regulatory and Conservation Challenges	• Existing codes (BOMBA, UBBL) designed for modern buildings, cause compliance issues. • Adaptive reuse complicates safety compliance. • Need for flexible, context-sensitive regulations.	Balancing safety compliance with the preservation of heritage authenticity is complex and critical.	Abd Rahim et al. (2022); Douglas (2006); Plevoets & Van Cleempoel (2011); Rashid et al. (2023)

Structural Integrity and Timber Degradation

The primary concern across all sites was the deteriorating condition of timber structural elements, as shown in Figure 2. Observations noted signs of termite infestation, wood rot, and cracking in load-bearing columns and beams. These findings align with Yusoff et al. (2020), who have emphasized that aging materials and environmental exposure significantly compromise the structural integrity of heritage timber buildings in Malaysia. Without timely intervention,

© 2026 by MIP

such degradation increases the risk of partial or total collapse, endangering users and the preservation of cultural heritage.

Furthermore, the absence of regular structural health monitoring is clearly apparent. While advanced techniques such as UAV photogrammetry and laser scanning have been demonstrated as effective non-invasive tools for assessing timber mosque conditions (Zakaria et al., 2022), none of the mosques have undergone systematic monitoring. This gap indicates a critical need to incorporate such technologies in routine conservation practices to proactively detect structural weaknesses.



Figure 2: The deteriorating condition of timber structural elements.
(Source: Author, 2025)

Fire Safety Deficiencies

All mosques exhibited insufficient fire safety measures. Inadequate or non-existent fire exits, lack of emergency lighting, and absence of fire extinguishers were common. This shortfall is particularly alarming given the heightened risk of fire in timber structures, as timber is combustible and can rapidly deteriorate fire resistance over time (Douglas, 2006).

The fire incident in Penang's heritage shop houses, which caused significant damage, underscores the vulnerability of heritage buildings to fire hazards (Trisha, 2023). The mosques under study here similarly risk catastrophic loss without the installation of basic fire detection and suppression systems. However, retrofitting modern fire safety installations poses challenges due to regulatory constraints and the desire to maintain architectural authenticity (Rashid et al., 2023).

Electrical Systems and Fire Risk

Outdated and exposed electrical wiring was a pervasive issue. Many mosques still rely on original or minimally upgraded electrical systems that do not comply with

contemporary safety standards. According to Baharuddin et al. (2014), faulty or improperly maintained electrical installations are a significant cause of fire in heritage buildings.

The interviews with mosque caretakers revealed limited technical expertise and resources to upgrade these systems appropriately without damaging the heritage fabric. This demonstrates the necessity of implementing targeted solutions that enhance electrical safety and simultaneously uphold conservation objectives.

Accessibility and Emergency Preparedness

Emergency access routes and evacuation procedures were either absent or inadequately planned. Several mosques had narrow or obstructed entrances, complicating evacuation during emergencies, as shown in Figure 3. Accessibility for persons with disabilities was also notably lacking, reflecting a wider issue in heritage building management where modernization needs conflict with original spatial constraints (Ismail & Ahmad, 2022; Coutinho, 2021). This lack of preparedness not only increases the risk to occupants, but also undermines the viability of continued communal use, especially as some mosques continue to serve active worshippers.



Figure 2: Narrow or obstructed entrances.
(Source: Author, 2025)

Community Involvement and Maintenance Practices

A notable contrast was observed between mosques actively maintained by local communities and those which have been abandoned or neglected. Community involvement played a significant role in informal maintenance, safety monitoring, and conservation advocacy. This aligns with Yung and Chan's (2012) assertion that social sustainability and stakeholder engagement are critical factors in successful heritage conservation.

© 2026 by MIP

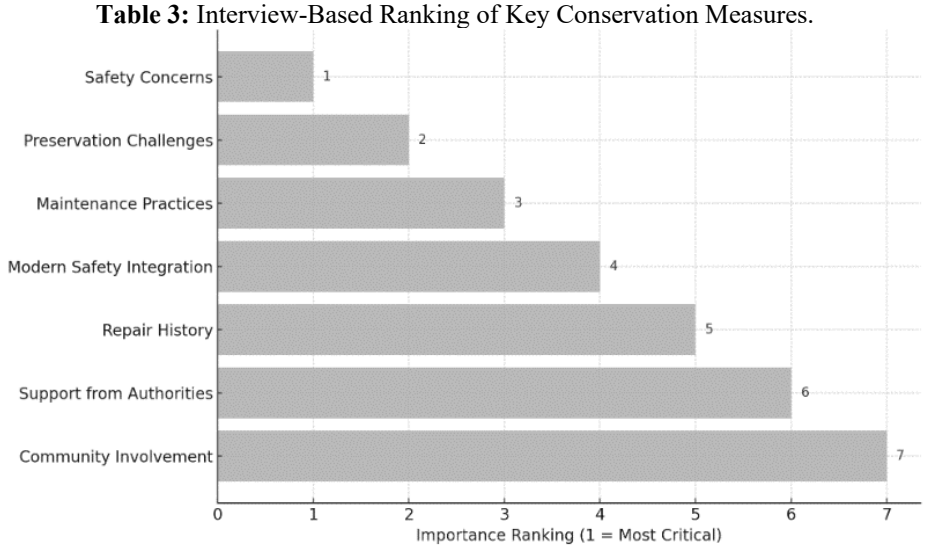
However, community efforts are often constrained by limited technical knowledge and financial resources, emphasizing the need for governmental and institutional support to enhance capacity building and risk management (Norazian & Wahab, 2022). Table 2 shows the findings based on the interviews with the authorities, the community, and mosque committees.

Table 2: Safety assessment of heritage mosques, Negeri Sembilan

The concern	Users/ Authorities	Safety measures and assessment
Maintenance Practices	Mosque Caretakers	Routine cleaning is conducted, but technical maintenance (e.g., roof leaks, and timber checks) is irregular due to a lack of expertise and funding.
Safety Concerns	Community Members, Caretakers	Major concerns include exposed electrical wiring, lack of fire extinguishers, and termite infestations.
Repair History	Caretakers, Local Officials	Repairs are mostly reactive and often done without professional consultation; the use of non-traditional materials is reported.
Preservation Challenges	Heritage Officials, Community Members	Difficulty in sourcing traditional timber; conflict between preserving original features and ensuring safety compliance.
Community Involvement	Community Members	Strong emotional attachment to mosques, but limited participation in formal conservation efforts.
Support from Authorities	Mosque Committees, Local Officials	Inconsistent funding and limited technical guidance from heritage authorities.
Modern Safety Integration	All Groups	General agreement on the need for upgrades (e.g., fire safety systems), but concerns over altering mosque authenticity.

The most critical issue identified was *Safety Concerns*, followed by *Preservation Challenges* and *Maintenance Practices*. The following visualization helps highlight the users, committee, and authorities to priorities in heritage mosque conservation.

Table 3: Interview-Based Ranking of Key Conservation Measures.



Regulatory and Conservation Challenges

The findings echo the broader challenge of applying existing building safety codes and heritage conservation guidelines coherently. While regulations such as those from BOMBA and UBBL are designed for modern structures, heritage buildings' unique characteristics frequently result in regulatory conflicts and compliance difficulties (Abd Rahim et al., 2022; Douglas, 2006).

Adaptive reuse, while a common conservation strategy, further complicates safety compliance due to spatial reconfiguration and modern usage demands (Plevoets & Van Cleempoel, 2011; Rashid et al., 2023). This necessitates flexible, context-sensitive regulatory frameworks that reconcile safety with authenticity preservation. Enforcement must be undertaken as well. Based on the overall number of enforcements taken, further analysis was done to determine, by ranking, the top five highest number of enforcement actions according to the studied years, from 2017 until 2020.

The findings reveal that the application of modern safety regulations to heritage buildings remains a significant challenge, largely due to regulatory rigidity and limited flexibility in existing guidelines. Practitioners reported difficulties in complying with requirements such as fire escape provisions, electrical upgrades, and structural reinforcements without compromising the original architectural fabric. This has resulted in selective or minimal safety interventions, particularly in active religious buildings such as mosques.

At the same time, the study found that community involvement plays a crucial role in mitigating these limitations. Local communities and mosque

© 2026 by MIP

committees actively participate in routine maintenance, monitoring building conditions, and reporting safety concerns, contributing to the building's continued functionality and use. However, this involvement is largely informal and experience-based, with limited technical guidance. The findings suggest that stronger collaboration between authorities, conservation professionals, and local communities, supported by clearer adaptive guidelines, could enhance both regulatory compliance and safety outcomes in heritage conservation practice.

CONCLUSION

The five heritage mosques in Negeri Sembilan are experiencing multiple challenges related to structural, environmental, social, and regulatory factors, which collectively threaten both the physical integrity of these historic timber buildings and the safety of their users. The main issues of the deterioration involved particularly termite infestation and wood rot, which severely compromise structural stability and necessitate urgent remedial action to ensure building safety. This finding aligns with existing literature highlighting the crucially to continuously monitor and intervene to prevent irreversible damage and structural failure in heritage timber buildings (Yusoff et al., 2020).

Additionally, significant deficiencies related to structural concerns in terms of fire safety and electrical infrastructure have been identified across all mosques. The unavailability of proper fire exits, firefighting equipment and modern electrical connections heightened the risk of fire, particularly with timber mosques (Trisha, 2023). These safety gaps underscore the persistent disconnect between heritage conservation objectives and contemporary building safety requirements, a challenge well documented in the field (Douglas, 2006; Rashid et al., 2023).

Furthermore, issues relating to accessibility and emergency preparedness expose the inherent tension between preserving original architectural configurations and meeting modern functional and safety standards. Limited provision for safe evacuation routes and accessibility for individuals with disabilities reflects a widespread challenge in heritage conservation, where strict adherence to original spatial layouts often conflicts with regulatory demands (Coutinho, 2021; Ismail & Ahmad, 2022).

Community engagement emerged as a crucial factor influencing maintenance and safety conditions. Mosques actively supported by local communities demonstrated notably better upkeep and safety practices, affirming the importance of social sustainability in heritage conservation (Yung & Chan, 2012). However, community efforts are frequently constrained by limited technical expertise and resources, underscoring the need for greater institutional support and capacity building.

Finally, this study has revealed systemic limitations within regulatory frameworks and risk management approaches. Current Malaysian safety codes and heritage guidelines, primarily designed for modern buildings, often prove inadequate or inflexible when applied to heritage structures, impeding effective conservation and safety compliance (Abd Rahim et al., 2022; Norazian & Wahab, 2022). Adaptive reuse, while beneficial for prolonging the functional life of heritage buildings, introduces additional safety challenges that demand innovative, context-sensitive solutions balancing preservation and occupant safety (Plevoets & Van Cleempoel, 2011; Rashid et al., 2023).

In summary, ensuring the safety and conservation of heritage mosques requires an integrated approach balancing preservation with modern safety needs. This should include routine, non-invasive structural health monitoring through advanced technologies such as UAV photogrammetry and laser scanning, enabling the early detection of timber deterioration. Additionally, sensitive upgrades to fire safety and electrical systems are essential to protecting users while maintaining the mosques' historical integrity. Emergency preparedness and accessibility measures must be enhanced in ways which respect heritage constraints while aligning with current safety standards. Community involvement should be strengthened through technical guidance and financial support to foster a sense of ownership and stewardship. Furthermore, flexible and adaptive regulatory frameworks are needed to support heritage-specific safety interventions and ensure coordinated risk management. Implementing such a comprehensive framework is vital to safeguarding these cultural landmarks, ensuring they remain safe, functional, and enduring for both the present and future generations.

ACKNOWLEDGEMENT

The authors acknowledge the Faculty of Engineering and Quantity Surveying, INTI International University and Faculty of Engineering and Built Environment, University Sains Islam Malaysia (USIM). This research is also supported by INTI International University partnership (Faculty of Civil Engineering, University of Technology Mara, Architectural Engineering Department, University of Hail, Saudi Arabia, Islamic Communication and Broadcasting Department, Stain Sultan Abdurrahman Kepulauan Riau, Bintan, Indonesia). Special thanks go to all the teams involved in completing this research.

DISCLOSURE STATEMENT

The authors declare that there is no conflict of interest related to this publication. The study did not involve experiments on humans or animals that required formal ethical approval; however, any interviews or field data were conducted with

© 2026 by MIP

informed consent and respect for confidentiality. All authors contributed to the research design, data collection, analysis, and writing of the manuscript, and have approved the final version. The data supporting this study are available from the corresponding author upon reasonable request.

REFERENCES

Abd Rahim, A. M., Ismail, W. H. W., & Abd Latip, N. A. (2022). Assessing the structural condition of heritage mosques in Malaysia: A case study of Masjid Pelangai. *Journal of Architectural Conservation*, *28*(1), 55–70.

Alvarenga Coutinho, S. M. (2021). Challenges in applying safety standards in heritage building reuse: A critical review. *Journal of Cultural Heritage Management and Sustainable Development*, *11*(3), 315–331.

Baharuddin, M. N., Ismail, Z., Hassan, F., & Adnan, H. (2014). Risk factors in the conservation of historical buildings: Electrical elements. *Procedia - Social and Behavioral Sciences*, *153*, 389–397. https://doi.org/10.1016/j.sbspro.2014.10.075

Douglas, J. (2006). *Building adaptation* (2nd ed.). Butterworth-Heinemann.

Feilden, B. M. (2003). *Conservation of historic buildings* (3rd ed.). Routledge.

Ismail, W. H. W., & Ahmad, A. G. (2022). Conservation principles in Malaysian heritage buildings: Balancing authenticity and safety. *Journal of Design and Built Environment*, *22*(1), 77–90.

Jigyasu, R. (2019). Risk management in cultural heritage: From theory to practice. *Conservation and Management of Archaeological Sites*, *21*(4), 241–256.

Khan, A. N., & Khan, M. F. (2023). Risk management strategies for heritage conservation: Lessons from South Asia. *International Journal of Disaster Risk Reduction*, *85*, 103540. https://doi.org/10.1016/j.ijdrr.2022.103540

National Heritage Act 2005 (Act 645). Laws of Malaysia. http://www.agc.gov.my

Norazian, R., & Wahab, L. A. (2022). Bureaucratic challenges in managing heritage buildings in Malaysia. *Built Environment Journal*, *19*(1), 56–65.

Plevoets, B., & Van Cleempoel, K. (2011). Adaptive reuse as a strategy towards conservation of cultural heritage: A literature review. *Structural Studies, Repairs and Maintenance of Heritage Architecture XII*, *118*, 155–164.

Rashid, M. H. A., Yusof, M. R., Samadi, Z., & Ismail, W. H. W. (2023). Challenges of fire safety compliance in adaptive reuse of heritage shophouses in Penang. *Heritage Science*, *11*(1), 23. https://doi.org/10.1186/s40494-023-00891-z

Trisha, N. (2023, July 12). Fire guts heritage shophouses in George Town. *The Star*. https://www.thestar.com.my/news/nation/2023/07/12/fire-guts-heritage-shophouses-in-george-town

Yung, E. H. K., & Chan, E. H. W. (2012). Critical social sustainability factors in urban conservation: The case of the Central Police Station Compound in Hong Kong. *Facilities*, *30*(9/10), 396–416.

Yusoff, Z. M., Hashim, M., Ismail, W. H. W., & Shukor, S. A. (2020). Challenges in maintaining the structural integrity of heritage buildings in Malaysia. *International Journal of Building Pathology and Adaptation*, *38*(5), 643–656.

Zakaria, R., Othman, N., Rahman, N. A., & Abdul Rahman, A. (2022). UAV

photogrammetry and laser scanning for timber heritage mosque documentation in Negeri Sembilan. *Heritage Science*, *10*(1), 102. https://doi.org/10.1186/s40494-022-00711-7

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 436 – 457

THE ARCHITECTURE OF THE LOST MAUSOLEUM OF NUR AL-DIN BASIR IN SAMARKAND: HISTORY OF ITS CONSTRUCTION AND DESTRUCTION, DIGITAL RECONSTRUCTION OF THE MONUMENT

Mavlyuda Abbasova-Yusupova[1,2], Fatima Khudaikulova[2]

[1] SILK ROAD INTERNATIONAL RESEARCH INSTITUTE
under Silk Road International University of Tourism and Cultural Heritage, Samarkand, Uzbekistan
[2] SILK ROAD INTERNATIONAL UNIVERSITY OF TOURISM AND CULTURAL HERITAGE, Samarkand, Uzbekistan

Abstract

The architectural and electronic reconstruction of the mausoleum of Sheikh Nur al-Din Basir (d.1249) destroyed in the late nineteenth century in Samarkand and an important Temurid monument is included in this essay. The study is interdisciplinary following the integration of the archival research, architectural drawing, cartography, and up-to-date geodetic research as the scientific basis of a 3D reconstruction of the mausoleum and its historical landscape. In addition to the reconstruction of the architectural image of the monument, the study showcases how it would fit in the urban fabric of Temurid Samarkand and how it would be incorporated in the fortified citadel of Amir Temur. The reconstruction has also shown the relevance of digital technologies in conservation of heritage, history of urban planning and marketing cultural tourism. Connecting the studies of architectural heritage to the modern techniques of planning and built environment, this paper will give a new understanding of how digital reconstructions may be used as the means of both academic study and sustainable management of cultural heritage.

***Keywords*:** heritage conservation, architectural reconstruction, Samarkand, Temurid architecture, cultural tourism, urban planning

[1] Corresponding author. Email: m.a.yusupova@gmail.com

INTRODUCTION

Sufism (at-Tasawwuf), a mystical and philosophical movement within Islam, began to acquire particular influence in Central Asia. In the 12th century, Sufi brotherhoods such as the Yasawiyya, Kubrawiyya, and Naqshbandiyya emerged in the region, later becoming the three principal Sufi orders of Central Asia. They established strong spiritual and social bonds, and the burial sites of Sufi masters became places of veneration (Zarcone, 2020). Within this context, the construction of mausoleums for revered saints and Sufi sheikhs gained increasing importance, serving not only as sites of pilgrimage but also as focal points of community identity(Salikuddin, 2018). For the training and ritual practice of the Sufis (murids), under the guidance and supervision of a mentor (sheikh, pir, murshid), there were necessary abodes, originally called khanaqahs, which contained ritual halls. These abodes were formed near the khanaqah, in which the revered Sufi used to live, or at the pre-existing grave of the saint. In them, the mausoleum of the saint, the ritual hall-khanaqah, the mosque, the living quarters (hujras) of the preceptor and the disciples (murids), cells for the temporary stay of pilgrims, spaces for household and domestic needs, kitchens, etc. were gradually built around a shady courtyard with a water reservoir (Trimingham, 1971).

The ruler of a vast empire in Central Asia, Amir Temur (1336–1405), who had been a disciple (murid) of several Sufi sheikhs during the early years of his reign, ordered the construction of several modest mausoleums in accordance with local traditions. At the turn of the 14th–15th centuries, Temur began to introduce bold innovative ideas, requiring his court architects to erect larger, and often monumental buildings (McChesney, 2021). During his reign, many significant ancient Sufi complexes of Central Asia were restored or reconstructed. The desire of this powerful ruler to commemorate revered Sufi sheikhs by erecting monumental mausoleums over their graves transformed the course of development of memorial and cultic complexes within his realm. The architecture of the mausoleums, which, along with Sufi khanaqahs, were the main components of such complexes, also underwent a significant evolution during the reign of Amir Temur.

The mausoleum of Nur al-Din Basir is a rare and significant example of sacral architecture of the 14th century, closely connected with the formation of the Temurid building tradition (Figure 1). Its loss in 1880 actually erased a key element of the spiritual heritage from the urban landscape of the Temurid capital of Samarkand. The virtual reconstruction of this monument is of great importance not only for the history of Central Asian architecture, but also for the better understanding of the processes of urban development of Samarkand during the reign of Amir Temur. The reconstruction of this lost mausoleum, based on an interdisciplinary approach, makes it possible to expand our understanding of

© 2026 by MIP

religious structures from the early Temurid period and to restore a missing link in the evolution of mausoleum architecture and the historical topography of the city.



Figure 1*: The Mausoleum of Sheikh Nur al-Din Basir before its destruction, c. 1870s. General view from the south. Source: Turkestan Album, Library of Congress (USA).*

LITERATURE REVIEW

Digital technologies have emerged in the last few decades as a significant instrument of the recording, analysis, and reconstruction of architectural heritage. The intensive growth of 3D modelling, laser scanning, and virtual visualization has contributed greatly to the expanding opportunities in the study of monuments that are partially preserved or even lost altogether. Recent studies are giving more and more attention to the use of these technologies, as well as the creation of integrated methodological frameworks of digital reconstruction.

Among the most common techniques of heritage study is 3D laser scanning, although which the researcher can acquire very precise spatial information of architectural objects. Research indicates that laser scanning is capable of producing point clouds and digital mesh models which are accurate replications of the geometry and shape of historical monuments. Within the framework of Temurid architecture in Central Asia, Milosz, Kesik, and

Montusiewicz (Milosz et al., 2021) worked out a method of scanning large architectural complexes in real conditions, when the number of tourists is great, and the practical issues of information collection are emphasized. The approach to methodology developed further with subsequent studies of the Juma Mosque in Khiva where the use of high-resolution 3D scanning documented intricate interior geometry and generated detailed digital models to be analyzed as architecture(Milosz et al., 2024).

Recent studies also focus on the significance of 3D modelling as an interpretation and reconstruction tool, in addition to information gathering. According to Tokoeva and Kozhonazarova (Tokoeva et al., 2025), computer modelling and virtual reconstruction are the interdisciplinary techniques that unite architecture, cultural studies, and information technologies. Such methods seem to be especially applied in monuments that are either partially or totally lost because they allow re-creating architectural forms, relying on historical records and comparison. Romanova and Poluboyarova (Romanova & Poluboyarova, 2021) (Tokoeva et al., 2025) describe similar methodological principles and suggest a model of virtual reconstruction based on the combination of archival sources, archaeological information, and the techniques of digital modelling.

A different prominent area of research in the modern world is the creation of integrated digital workflows that can be composed of several technologies. The research conducted by Campana et al.(Campana et al., 2025) and Tokarski et al. (Tokarski et al., 2025) shows that the adoption of terrestrial laser scanning (TLS), photogrammetry, and mesh modelling can be used to produce highly precise and visually detailed digital models of architectural heritage. Such techniques are especially significant in recording sites that are inaccessible or endangered so that they can be analyzed scientifically as well as be disseminated virtually. Moreover, the archaeological site of Nisa is one of the studies that suggest the possibility of integrating laser scanning and mobile mapping systems with SLAM technologies to create a comprehensive 3D documentation and enhance digital models into practical and visual forms, including 3D printing and video mapping (Kong, 2025; Spano et al., 2025).

Digital technologies have been particularly important in reconstruction of monuments that had been destroyed. As an example, the research on the Bamiyan Buddha statues enables showing that 3D models can actually assist in studying the fragmented remains and can be used as the foundation to judge the situation of restoration (Toubekis et al., 2017). Likewise, virtual reconstruction projects in Central Asia, including the reconstruction of the ancient city of Karakorum, demonstrate how digital visualization and interactive spaces may be applied to analyze archaeological evidence and create a previous urban platform(Khorloo et al., 2022).

© 2026 by MIP

The second block brings together studies devoted to the use of historical cartography and landscape data (Masson, 1956; Lebedeva, 2001). For the present project, these are particularly significant, since the localization of the mausoleum and the analysis of relief changes were achieved precisely through the combination of old maps, modern satellite imagery, and GIS analysis (Campana et al., 2025; Khorloo). Contemporary scholarship shows that the georeferencing of historical maps, their comparison with current spatial layers of the terrain, and the integration of earlier geodetic data with new remote-sensing data are now recognized methods for reconstructing lost landscapes and historical planning structures. For the reconstruction of outstanding lost monuments of Samarkand, regional studies are especially useful, where GIS is already being applied to identify and graphically reconstruct vanished objects of the Temurid period (Milosz, Kęsik, & Montusiewicz, 2021).

In general, the literature reviewed shows the transition to combined approach of methodology, which also combines data acquisition, modelling, and visualization. These methods prove especially useful in the situations within Central Asia, where numerous monuments were lost, or not documented enough. In that context, the online recreation of the mausoleum of Nur al-Din Basir adds to the literature on Temurid architecture and shows the possible opportunities of digital technologies in the reconstruction of the lost monuments.

RESEARCH METHODOLOGY

The interdisciplinary research methodology, which is the combination of three key elements, was applied to the reconstruction of the lost mausoleum of Nur al-Din Basir in Samarkand:

(1) historical-documentary analysis.
(2) architectural and typological analysis, and
(3) 3D modelling and visualization.

In this way, it is possible to have a systematic combination of archival information, architectural interpretation, and digital reconstruction methods so that the model prepared is both historically reliable and spatially accurate.
Archival Sources and Historical Sources.

The first phase of the study was the gathering and examination of the historical records regarding the mausoleum of Nur al-Din Basir. The major sources were archival photographs, historical accounts of the monument, cartographic resources, and visual records that were kept in the famous Turkestan Album of the nineteenth century. These materials would be of great use as they give good visual and descriptive information of how the monument used to look before it was destroyed.

In the historical analysis, the scholarly works devoted to the history of architecture of Samarkand and the evolution of Temurid architecture were also reviewed. The written accounts of the mausoleum and the mention in the historical literature were thoroughly analyzed to determine important architectural components of the building such as its space layout, ornamentation, and its place in the city.

The archival materials gathered became the empirical reference of the further architectural interpretation and further digital reconstruction of the monument.

The materials obtained were organized and critically compared so as to come up with some consistent architectural features. The visual sources were interpreted by comparison and it was possible to extract the proportional relationships and compositional elements which could be applied in the reconstruction process.

Typical and Architectural Analysis

The second part of the research concerned the architectural review of the mausoleum. The monument structural composition was discussed based on the available visual and textual materials as well as its plan, elevation, the volumetric composition and the decorative elements.

A special focus was put on locating architectural features which can be associated with Temurid mausoleum architecture. The comparative analysis with the other monuments of that time in Samarkand and Central Asia allowed clarifying the most likely architectural shape of the structure and reconstruing its space ratios.

This part of the study also involved the explanations of architectural elements that were present in historical photographs and the recognition of compositional aspects that were common in the Central Asian funerary architecture, e.g. the dome shape, portal composition and organization of decorative facade.

The architectural analysis findings were interpreted into schematic drawings and proportional diagrams, in which, the perspective between the historical interpretation and the digital modelling were in between.

Restoration of the Spatial Composition

The third step was the reconstruction of the space and compositional structure of the mausoleum. The architectural scheme of the monument was created according to the existing historical data and architectural analysis.

The interpretation of the plan and volumetric structure of the monument based on the existing visual documentation became a part of the reconstruction process. Incomplete historical data were utilized where necessary through

© 2026 by MIP

architectural analogies with other similar Temurid monuments to come up with plausible architectural solutions. This type of comparative study enabled the scholars to re-create the overall proportions and the spatial structure of the mausoleum to a reasonably acceptable level of historical fidelity.

This phase offered the conceptual architectural structure which was to be used in the following digital modelling of the monument.

Digital 3D Reconstruction

The last phase of the study was the digital reconstruction of the mausoleum by the methods of three-dimensional modelling. According to the architectural reconstruction that was created in the preceding steps, the architectural 3D model of the monument was prepared with the help of architectural 3D modelling software (including AutoCAD, SketchUp, CorelDRAW).

The space composition, architectural proportions, and structural elements of the monument could be viewed with the help of the digital reconstruction. It was modeled by means of step-by-step reconstruction of the main architectural elements of the monument, such as the building base, the walls, the portal, the dome, and the ornaments.

Digital modelling offers a useful research solution to the visualization of lost architectural heritage and experimentation of architectural hypotheses through historical evidence. The digital model in the given work does not only exist as a visual image of the reconstructed monument, but also as a research tool that is useful in resolving the question about the architectural composition and the spatial structure of the monument in question.

The 3D reconstruction that resulted helps in preservation and interpretation of the architectural heritage of Samarkand and offers a visual make appearance of a monument that is no longer there in the urban architecture.

It relied on the modelling process that was founded on 2D schematic reconstructions transformation into three-dimensional environment. The proportional analysis, the geometrical extrapolation and the comparison with the similar monuments of Temurid were used to reconstruct the architectural elements.

The combination of historical drawings, archival imagery and architectural analysis into the digital modelling environment also guaranteed consistency of the traditional research approaches and digital reconstruction approaches, which enhanced the credibility of the end model.

© 2026 by MIP

ANALYSIS AND DISCUSSION
THE TRADITION OF SUFI BURIALS

Historical overview of Sufi burials
The monumentalization of Sufi burial sites—despite contradicting Islamic prescriptions for modest interment—emerged gradually over several centuries. Historical, archaeological, and topographic evidence demonstrates a clear transformation: from inconspicuous grave mounds to the monumental mausoleums that, by the turn of the fifteenth century, had become dominant features of the urban landscape (Salikuddin, 2018).

In general, in Mawarannahr, according to an unwritten tradition, the burials of saints, including Sufis, were initially performed modestly — as an earthen mound under the open sky — which was later faced with brick in the form of a sagana or a rectangular platform (dakhma). Later, in order to protect the shrine from bad weather and destruction, the Sufi followers arranged a domed canopy (chartak) over the burial, which was square in plan and opened on four sides. Over time, out of reverence for the saint and to ascertain his burial more grandeur in the eyes of the pilgrims, the apertures were closed, leaving in them only one door that provided direct access to the shrine. As a result, by the time of Amir Temur, small-scale chartaks had been already erected, or some chartaks were rebuilt into a mausoleum over the ancient graves of some revered Sufi sheikhs (Abbasova-Yusupova, 2020).

A Historical Overview of the Architecture of Sufi Mausoleums in the Temurid Era
In line with Amir Temur's ambition to concentrate the sacred remains of venerated sheikhs near the imperial capital and to endow their shrines with monumental architecture, several Sufi mausoleums were constructed in Samarkand (Yusupova, 2023). The burial of disciples at the feet of their pirs was a widespread custom: for example, Buyan Quli Khan was buried at the feet of Sheikh Sayf al-Din Bokharzi in Bukhara, while Temur's father Amir Taraghay was reburied beside Sheikh Shams al-Din Kulal in Shahrisabz. This tradition continued into the Temurid dynastic mausoleums, most notably Gur-i Amir, where Temur and his descendants were interred alongside revered sheikhs.

THE MAUSOLEUM OF NUR AL-DIN BASIR
Historical data
Almost simultaneously with the above-mentioned Shahrisabz mausoleum, Temur built the mausoleum of another Sufi sheikh, Nur al-Din Basir in Samarkand. Nur al-Din Basir (d. 1249) was a famous miracle-worker, who was honoured for his wisdom and known as the "Qutb-i Chahardahum (Fourteenth Pole or Axis)".

© 2026 by MIP

Sheikh of the Sufi order of Suhrawardiyya, Nur al-Din Basir was a teacher of another mentor of Amir Temur, Burhan al-Din Sagharji, sometimes referred to as "Khwajah-i Ruhabad." According to the testimony of Abu Tahir Samarqandi, (writing after 1835-6)(Samarqandi, 1898):

Once Amir Temur Guragan asked for help and spiritual favour from his mentor - Sheikh Abu Said ibn Sheikh Burhan al-Din Sagharji, and the Sheikh-Zada recommended him to make ziyarat to the mazar of Nur al-Din Basir. On the basis of this recommendation, Amir Temur Guragan included the mazar of Sheikh Nur al-Din Basir in the limits of the Samarqand citadel and built a high building over it, decorating its dome with a golden ball. ...Amir Temur often visited this mazar and prayed on it.

In Sufi cosmology, Nur al-Din Basir was revered as a *qutb* or "cosmic axis" sustaining the harmony of the universe (Nazarov, 2006). This mystical role elevated his status beyond that of a local saint, transforming his shrine into a site of both spiritual devotion and political symbolism. For Temur, frequenting Basir's tomb was an act of legitimization, linking his imperial authority to sacred charisma.

Some scholars believe that the former, probably smaller mausoleum of Nur al-Din Basir in 1371-72 "was demolished by order of Temur and a new mausoleum was erected a little higher, where the ashes were solemnly conveyed" (McChesney, 2021). Others suggest that the burial place was not disturbed and Amir Temur erected a domed mausoleum over it in 1371-72. In both versions, the new mausoleum of the saint was included within Temur's citadel in Samarkand (McChesney, 2021). It was a large single-chamber building with a tall blue dome on a high cylindrical drum decorated with "very large Kufic bands of religious texts", adorned with a band of tile mosaic and muqarnas. The architecture of the lost mausoleum is reflected in a few unique materials from the late 19th century - a photograph of the monument taken around 1870s (Figure 1), a painting by the famous Russian artist V.A. Vereshchagin (Kök, 2022) from 1869-1870 (Figure 2), and two sets of architectural drawings from the late 19th century (Figure 3).

© 2026 by MIP



Figure 2: *"View of the main street in Samarqand as seen from the citadel in the morning," 1869–1870. Painting by Vasiliy Vereshchagin (1842–1904). Source: State Tretyakov Gallery, Moscow.*

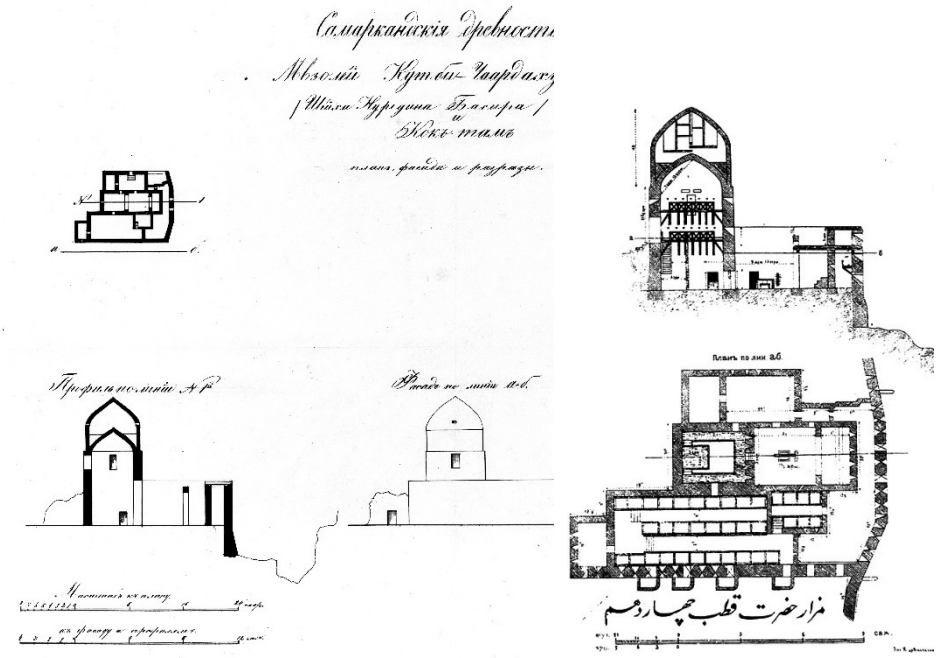


Figure 3: Architectural plans and cross sections of the Nur al-Din Basir mausoleum.

3a*. (to the left) Plan from the Turkestan Album, Library of Congress (Part 1, vol. 2, pl. 128, no. 309).*

3b. *(to the right) Plan of the mausoleum c. 1380 with colonial buildings of the late 19th century. Source: Samariyya*

© 2026 by MIP

In the early 1370s, Temur began constructing and fortifying his fortress, Arki Oliy, in the capital city of Samarkand. Built on a natural hill, the citadel rose prominently above the urban landscape of Samarkand, towering over the surrounding (shakhristan) medieval city (Masson, 1956). The mausoleum was erected on the eastern edge of Temur's citadel, Arki Oliy, overlooking the ravine of Novadon. The single-chamber domed mausoleum of Nur al-Din Basir was built above the ancient burial site of a saint, to which a hall for commemorative prayers (ziyarathana) was later added. The fact that the ziyaratkhana was constructed at a later date is evidenced by the difference in wall thickness compared to the 14th-century mausoleum walls, as well as by its simple architecture and flat beamed roof—features atypical of other Temurid monumental mausoleum structures. The silhouette of the mausoleum—a cubic form with a blue dome on a high drum and expressive epigraphic decoration—was a dominant landmark, particularly visible from the Registan Square to the east of the citadel.(Golombek & Koch, 2017).

In the 1380s, after the death of Amir Temur's mentor Burhan al-Din Sagharji, the ruler built a mausoleum for him, known as Ruhobod, meaning abode of the Spirit. As part of a traditional memorial complex, the mausoleum occupied the eastern side (north-eastern corner) of a courtyard with a water reservoir (hawz) surrounded by living premises (hujras) for Islamic students and pilgrims and other buildings (Zarcone, 2020). The mausoleum of Ruhobod was placed on the same line with the mausoleum of his teacher Nur al-Din Basir discussed above (Pugachenkova & Rempel, 1965). There are several legends, according to which, the body of Sheikh Sagharji, who died in China, was transported on a camel to Samarqand. The camel first went around Basir's mausoleum, then descended lower and finally lay on the place, which turned out to be at a distance, but "at the feet of the Sufi pir" of Nur al-Din Basir.

Subsequently, at the end of the 14th century this sacred line was extended at the request of Amir Temur. A new complex comprising a royal madrasa and a Sufi lodge (khanaqah) was erected "at the feet," but at a considerable distance from the mausoleums of the two sheikhs – Nur al-Din Basir and Burhan al-Din Sagharji by Temur's grandson and heir-presumptive of Chingisid descent, Muhammad Sultan (d. 1403). Desolated by the untimely death of Muhammad Sultan, Temur erected a mausoleum in his honour that was constructed in 1404 to the south of the complex. In the course of the next forty years, it was transformed into the Temurid dynastic mausoleum of Gur-i Amir, in which Temur and the male descendants of his family were interred, together with two revered Sufi sheikhs - Mir Sayid Baraka and Sheikh Omar.

To place these developments into a broader architectural and cultural context, a comparative analysis of selected Temurid mausoleums was conducted. The results, presented in Table 1**,** illustrate the evolution from modest Sufi burials

© 2026 by MIP

to monumental dynastic mausoleums that combined sacred veneration with imperial representation.

Table 1: Comparative features of selected Temurid mausoleums.

Period / Monument	Type of Burial	Dome Construction	Decorative Program	Urban Location	Cult Function
13th c. (Basir, early stage)	Simple burial mound	None	None	At the foot of the citadel, near river	Initial veneration of the saint
14th c. (Mausoleum of Basir)	Cubic *gurkhana*	Dome on a high drum	Kufic friezes, mosaic	Incorporated into fortified citadel	Center of pilgrimage
Rukhobod (14th c.)	Cubic chamber	High dome on a low drum	Simple decoration	Within urban fabric	Sacred center
Gur-e Amir (15th c.)	Monumental mausoleum	Large dome on a high drum	Rich tile decoration	Within urban fabric	Dynastic mausoleum

Source: Compiled by authors based on archival and architectural data.

As shown in Table 1, the progression of architecture from the mausoleum of Nur al-Din Basir to Rukhobod and finally to Gur-i Amir reflects not only increasing monumentality and artistic refinement but also a growing integration of sacred sites into the urban landscape of Samarkand. This evolution underlines the dual function of Temurid mausoleums as centers of pilgrimage and as symbols of dynastic legitimacy.

The destruction of the Nur al-Din Basir mausoleum

In 1878, the Governor-General of the Turkestan region decided to build a new fortress on the site of the ancient citadel of Samarkand (Figure 4). This decision required the demolition of a number of historic buildings, including the mausoleum of Nur al-Din Basir (Kuhn, 1871)(Figure 5). By that time, Russian engineers had already constructed a gunpowder storehouse next to the shrine. The residents of the city were instructed to exhume and reinter the remains of the saint, a task carried out by Qadi Mir Nizam al-Din Khwaja, the son of Mir Abu Ghaffar, who left a written account of this event. The remains of Nur al-Din Basir and his mother were reburied near the Hazrat-i Khizr mosque, at the eastern edge of the Shah-i Zinda necropolis.

The shrine itself was demolished in July 1880 by two successive dynamite explosions, after local residents refused to dismantle it manually, bricks and other construction materials from the ruins were reused in the building of Russian military barracks within the citadel (Vyatkin, 1899). This act of

© 2026 by MIP

destruction underscored the profound rupture between sacred heritage and colonial urban policy, symbolizing both the loss of a revered monument and the imposition of new power structures over Samarkand's sacred landscape.

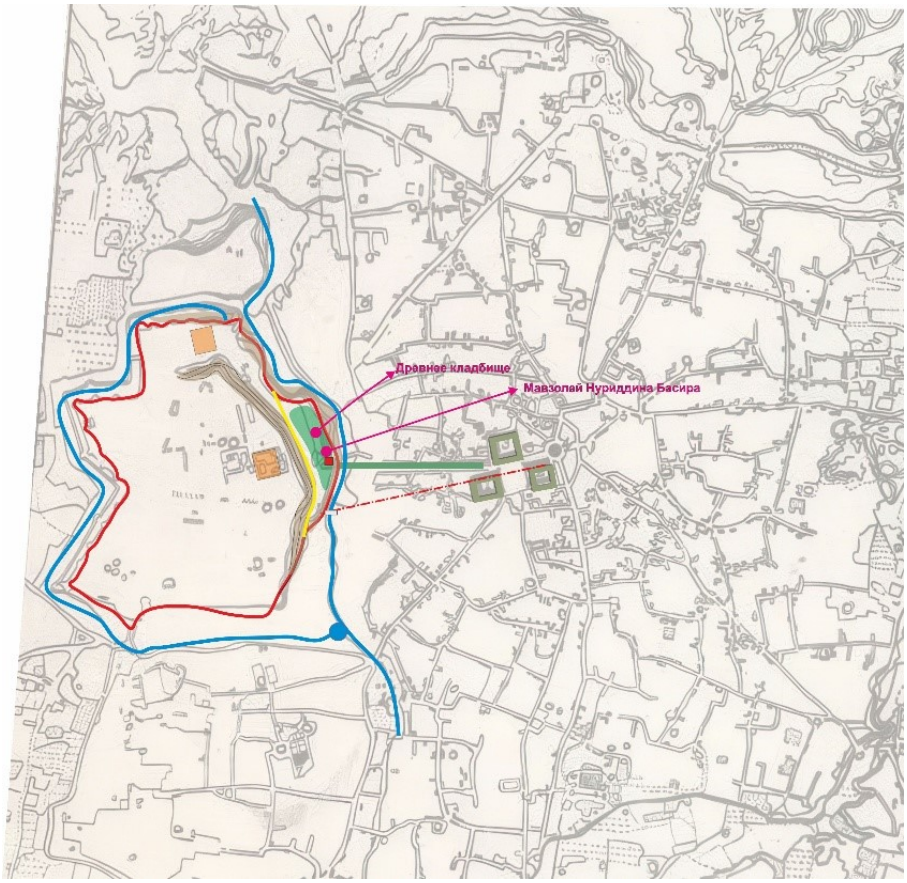


Figure 4: *Location of the mausoleum of Nur al-Din Basir and the ancient cemetery within the Samarkand citadel. Source: Authors' elaboration based on historical maps.*



Figure 5: *The mausoleum of Nur al-Din Basir (left) incorporated into the Russian fortress. Source: Turkestan Album, Library of Congress (USA).*

Topographic reconstruction and localisation

The comparison of the historical plans shows how the defensive wall of Amir Temur's citadel made a protrusion to the east, so that the mausoleum of Nur al-Din Basir was included in the fortified fortress(Buryakova & Lebedeva, 1988). In our opinion, the original place of the burial was at the foot of the citadel hill, on the left bank of the Novadon River. When the citadel was expanded under Temur, its borders were shifted by 18 metres to the east, as a result of which the mausoleum was situated within the walls of the new fortification. Cross-sections of the current relief show the slope of the citadel in the eastern part bordering the medieval city.

Analyses of modern geodetic data allow us to clarify the position of the mausoleum. Despite the fact that the Novodon aryk has now been taken into a collector and diverted underground(Buryakova & Lebedeva, 1988). the Chashma spring itself, located to the north of the mausoleum's presumed position, is preserved. It serves as an important point in the reconstruction of the former landscape: its water level is 8 metres lower than the supposed level of the burial chamber (gurkhana). This indicates a significant artificial build-up of the cultural layer in the area of the citadel through rubble and redevelopment. Moreover, since

© 2026 by MIP

the Temurid period, the ground level has risen by 5–6 meters due to the accumulation of cultural layers, and by an additional 2–4 meters following the destruction of the citadel. According to calculations, the single-chamber mausoleum was located on the western eastern side of the citadel, in the area of modern Dagbit Street, near the pedestrian bridge (Figures 7 and 8). To identify the remains of the foundations of the walls of the mausoleum of Nur al-Din Basir, this very site requires detailed archaeological research.

At the time of the mausoleum's existence, the Navodon River flowed openly at the foot of the citadel terrace, while the Chashma spring corresponded to its historical channel. These hydrological conditions not only determined the site's natural setting but also carried symbolic value, linking the shrine to sources of life and purity in Sufi cosmology.

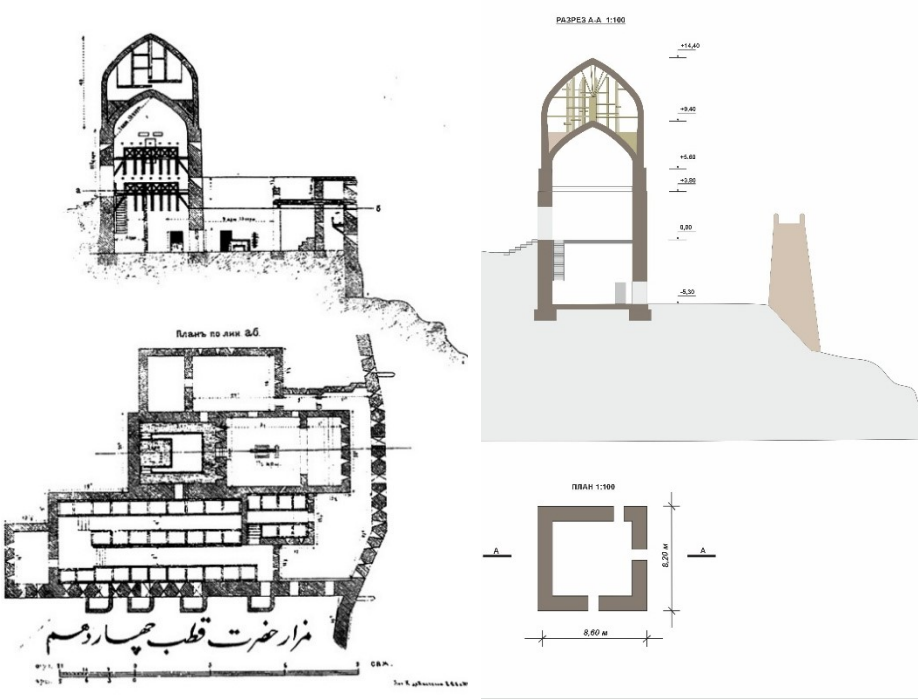


Figure 6: Reconstruction of the Architectural plan and cross section of the Nur al-Din Basir mausoleum

7 ***а.*** *(to the left) plan and cross section presented by Abu Tahir Samarqandi in Samariyya. 1898.*

7 ***в.*** *(to the right) Reconstruction of the cross-section and plan of mausoleum by Fatima Khudaikulova. Scale 1:100.*

A Comparative Analysis of Survey Drawings published in the Turkestan Album and in the text of Samaria, combined with visual and historical sources, has made it possible to reconstruct both the original appearance of the mausoleum of Nur al-Din Basir and to identify the stages of its later transformation within the structure of the Russian military fortress. As a result, the dimensions of the building were determined to be 8.20 m × 8.60 m, with a height of up to 19,70 m to the top of the dome.

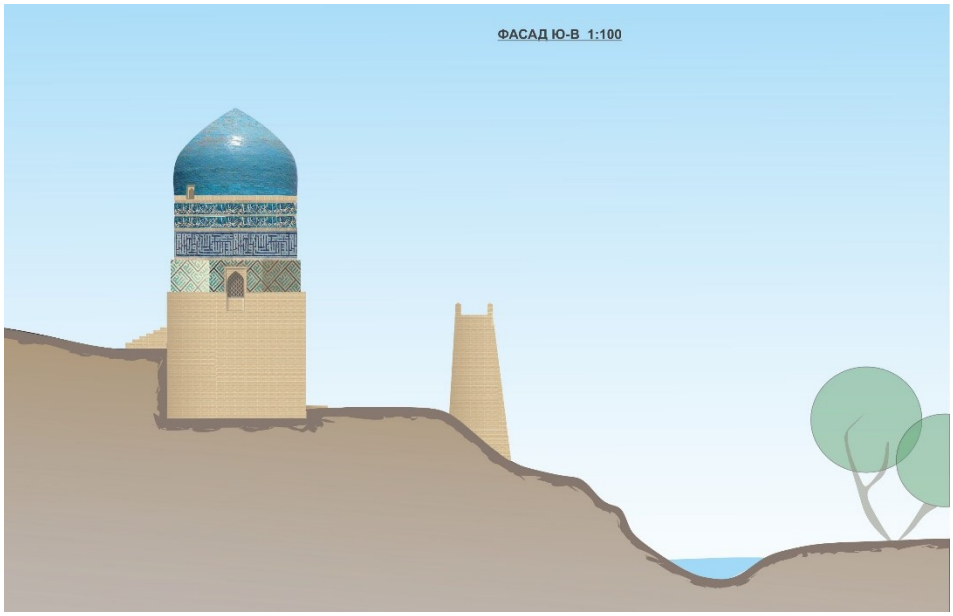


Figure 7: Reconstruction of the Nur al-Din Basir mausoleum south-eastern façade, scale 1:100. © Fatima Khudaikulova.
Source: Author's Development

Landscape Changes and the Localization of the Mausoleum of Nur al-Din Basir. The contemporary landscape in the area of the former Samarkand citadel has undergone significant alterations compared to the landscape of the 14th century. According to the results of geomorphological analysis, the comparison of historical maps, archival cross-sections, and current topographic data, the ground level in the zone of the mausoleum's location has risen by 6–8 meters. This elevation is attributed both to the centuries-long accumulation of cultural layers and to the deliberate raising of the terrain during military and urban development transformations. The most intensive elevation occurred during the demolition of the old fortress walls: construction debris and soil were dumped

© 2026 by MIP

eastward — in the direction of the Novadon Canal, which is now confined to an underground collector (Lebedeva, 2001). These processes substantially deformed the original landscape, complicating the precise identification of historical elevation markers.

Thus, the synthesis of the collected materials has made it possible not only to clarify the location of the lost monument but also to reconstruct its role in the urban landscape of Samarkand from the 14th to the 19th centuries.

Comparative Architectural Analysis of the Nur al-Din Basir Mausoleum

The mausoleum of Sheikh Nur al-Din Basir in Samarkand is a very significant structure of early Temurid architecture where strong links with the preceding traditional architecture of Mawarannahr can be traced. According to the archival drawings and historical photographs, the monument was made up of an almost square burial chamber made of fired brick and overlaid by a smooth dome over a cylindrical drum. The decorative system of the building was rather modest: the lower wall surfaces were simple in architecture, and the main artistic burden was concentrated in upper part of the building, especially, in the drum and the dome. The smooth dome was tiled with turquoise and the Kufic epigraphic band was used in decorating the drum. However, in this mausoleum the decorative program was not yet at the stage of sophistication which the subsequent monuments of the Temurid era were to be.

Structurally, the mausoleum was a one-chamber domed building having a definite space plan. It comprised a single, square-planned chamber containing the burial of the saint. It is likely that the transition from the square to the circular base of the drum was achieved by means of angular arched squinches. These formed an octagonal transitional tier of squinches, upon which the cylindrical drum rested through a system of small additional arches, supporting a tall sphero-conical dome. This kind of structural arrangement square chamber, octagonal, cylindrical drum, and domed superstructure was very common in the architecture of Mawarannahr and was indicative of previous regional construction traditions. The architectural comparison of comparable objects was also a significant part in the interpretation and digital re-construction of the Nur al-Din Basir mausoleum. The fact that the monument has not been preserved in its initial state makes it possible to compare it with typologically similar Temurid mausoleums and thus rely more on the reconstruction of architectural proportions, spaces structure and structural components.

One of the most topical comparisons can be made with the so-called Double-Domed Mausoleum situated on the first platform of the necropolis of Shah-i-Zinda situated in Samarkand. However, contrary to the conventional name of a double-domed building, the monument is actually two-chamber mausoleum with a ziyaratkhana (visit room/ chamber of visitation and prayer) and a gurkhana

© 2026 by MIP

(burial chamber). The ziyaratkhana surrounded by a high dome is architecturally and structurally similar to the Nur al-Din Basir mausoleum. It is also made up of a square room whereby the square base is changed to a drum is done through a system of squinching to create an octagonal zone of transition which supports a cylinder-shaped drum and a dome. Simultaneously, the decorative treatment of Shah-i-Zinda monument is much richer and represents the further evolution of the Temurid architecture and augmentation of the decorative programs.

Close in date of construction, the Rukhobod Mausoleum is a cubic, centric architectural structure without a pronounced portal, with an evenly articulated exterior and a square internal chamber crowned by a dome. The square shape base is replaced by the dome using pendentives which create a transitional zone of octangles. The architectural design is self-restrained, with curved niches, insignificant decoration of the exterior and the use of ceramic panels mostly inside.

The monument combines the pre-Mongol tradition of centric funerary construction with the added magnitude of the Temurid era, which makes the monument a rather unusual type of architecture in Samarkand. It is this aspect that makes it specially applicable when compared to the mausoleum of Nur al-Din Basir.

Whereas the Rukhobod Mausoleum is characterized by a compact and inward-oriented composition and a rather modest treatment of the decoration, the reconstructed shape of the Nur al-Din Basir mausoleum implies a more vertically oriented composition with a dominant silhouette. Unlike the closed and laconic nature of Rukhobod, Nur al-Din Basir mausoleum, erected on an elevated urban landscape, seems to have been more monumental in nature and indeed had a stronger urban function because of its orientation towards visual perception in the space of the Samarkand citadel.

A similar architectural plan to that of the building of Nur al-Din Basir can also be observed in the mausoleum of Chupan-Ata, where the square chamber is likewise covered by a dome set upon a cylindrical drum. But this monument is a later one and is of a more advanced ornamental veneering. The resemblance of the structures is thus, due rather to the architectural and structural frame than to the nature of the ornamental treatment which it receives. Moreover, the drum of the Chupan-Ata mausoleum is considerably higher, which adds a stronger vertical accent to its overall composition.

Still more radical architectural changes may be seen in later Temurid monuments like those of the Gur-e Amir mausoleum at Samarkand and the monumental complex at Khoja Ahmed Yasavi at Turkestan. In these structures, the scale becomes considerably larger, the architecture more monumental, and the domes acquire a ribbed surface. Ribbed domes, characteristic of Iranian architecture, appear here as a result of the participation in the construction of

© 2026 by MIP

Amir Temur's buildings of Iranian and other foreign craftsmen brought by him from the conquered lands. In general, such previously untraditional ribbed and patterned domes become a distinctive feature of the period of the flourishing of Timurid architecture. At the same time, the façades of buildings receive increasingly elaborate and rich treatments, including revetment with glazed ceramics, epigraphic bands, and a complex decorative system. Therefore, the mausoleum of Nur al-Din Basir takes a special place in the history of architectural development of the Temurid era. The monument maintains the structural values of earlier brick construction of Mawarannahr and at the same time illustrates the development of new aesthetic values like a turquoise dome covering, the epigraphic decoration of the drum, and a growing tendency towards monumentality.

Thus, it becomes evident that the mausoleum of Nur al-Din Basir, as one of the earliest memorial structures of the period of Amir Temur, occupies a special place in the evolution of Central Asian architecture of the late fourteenth century. It preserves the constructive principles of the earlier brick architecture of Mawarannahr, yet at the same time demonstrates the emergence of new artistic tendencies and a striving for greater monumentality — expressed in the taller sphero-conical turquoise dome and cylindrical drum, as well as in the large-scale epigraphic decoration of the drum, clearly visible and legible from a distance. For this reason, the monument may be regarded as a characteristic example of early Temurid architecture, reflecting the transition from the preceding local building tradition to the mature style of Temurid architecture.

These findings out of the comparative analysis were directly applied to the 3D digital reconstruction process and offered a typological and proportional framework that enhanced the historical dependability and architectural verisimilitude of the model recreated.

CONCLUSION

The measurements, structure, plan, space arrangement, and ornaments of the Mausoleum of Nur al-Din Basir, lost in the 14th century have been identified due to extensive studies and the application of new techniques of architectural research and reconstruction. An effective hypothesis was formed with respect to the localization of the Mausoleum of Nur al-Din Basir to the east of the citadel- it seems likely, in the direction of the current Dagbit Street, and close to the current pedestrian bridge. The mausoleum was originally located in a high position in the end of a straight street directed to the Registan Square and could be seen far away which predetermined its high memorial, cultic and architecture role in the urban system of Samarkand. The work is also a sign of the formation of the Temurid memorial architecture, which shows how it has grown, being

© 2026 by MIP

simple, single-chamber mausoleums, into multi-component complexes of buildings of a dynasty. This procedure is reflective of larger changes in the spatial organization of Samarkand, in which sacred buildings more and more defined the architectural image of the city as well as their symbolic identity.

The mausoleum was on the border between religious worship and political symbolism as it was among the first monumental-funerary buildings of the Temurid period in Samarkand. Its demolition during the end of the nineteenth century wiped off a fundamental component of the sacred landscape of the city. In addition to the academic contribution, the project proves the practical significance of digital technologies in preserving the heritage. These reconstructions will help bring the masterpieces that have been lost to more people and will contribute greatly to the historical development of the city form and landscape. Furthermore, the 3D model and virtual visualization creation opens the possibilities of preserving the living memory of heritage, as well as educational purposes and creation of cultural tourism.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to the Silk Road International University of Tourism and Cultural Heritage, Samarkand, for providing institutional support. Special thanks are extended to the Samarkand State Museum-Reserve and the Library of Congress of the USA for granting access to valuable archival materials that greatly contributed to this research.

DISCLOSURE STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this article.

REFERENCES

Abbasova-Yusupova, M. A. (2020). Typology of Sufi memorial architecture of Central Asia of Amir Temur's epoch. *History and Archaeology of Turan*, (5), 410–425.

Anarbaev, A. A., & Lebedeva, T. I. (1996). Monuments of Temur's citadel. *Scientific Reports*, (1), Fergana.

Buryakova, E. Yu. (1989). On the planning and fortification of the Samarkand citadel (14th–19th centuries). *Urban Planning and Architecture*, xx(xx), xx–xx. Tashkent.

Buryakova, E. Yu., & Lebedeva, T. I. (1988). The defensive system of Temur's citadel. In *Proceedings of IMKU*.

Campana, S., Ferdani, D., Graf, H., Guidi, G., Hegarty, Z., Pescarin, S., & Remondino, F. (2025). Modern Digitization and 3D Visualization Technologies for Virtual Access to Hard-to-reach or Perished Historical Sites. https://diglib.eg.org/bitstreams/4ed1818d-bea1-4133-b341-a4b9bd733d2a/download

© 2026 by MIP

Golombek, L., & Koch, E. (2017). The Mughals, Uzbeks, and the Temurid Legacy. In A *Companion to Islamic Art and Architecture* (pp. 811–845). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119069218.ch32

Khorloo, O., Ulambayar, E., & Altantsetseg, E. (2022). Virtual reconstruction of the ancient city of Karakorum. *Computer Animation and Virtual Worlds*, *33*(3–4), e2087. https://doi.org/10.1002/cav.2087

Kök, E. (2022). Ressam Vasili Vasilyeviç Vereşçagin'in (1842-1904) Çizgileriyle Temurlu Anıtları: Asya Kültürel Mirasının Belgelenmesi. *Art-Sanat*, (18), Article 18. https://doi.org/10.26650/artsanat.2022.18.1036321

Kong, B. (2025). *Digital Documentation of the Nisa Archaeological site (Turkmenistan): Enhancing the Integration of Laser Scanning Methods for 3D Printing and Video Mapping* [Laurea, Politecnico di Torino]. https://webthesis.biblio.polito.it/38913/

Kuhn, A. L. (1871). *Turkestan Album*. Architectural Part 4.

Lebedeva, T. I. (2001). The late medieval Ark of Samarkand. In T. S. Shirinov (Ed.), *History of material culture of Uzbekistan* (Vol. 32, pp. 202–217).

Man'kovskaya, L. Y. (1980). "Honako, takiya, zavya". In *Typological bases of Central Asian architecture (IX-beginning of the XX century)* (pp. 125–134). Tashkent.

Masson, M. E. (1956). The architectural and planning appearance of Samarkand in the time of Navoi. In *Proceedings of SAGU*.

McChesney, R. D. (2021). *Four Central Asian Shrines*. Brill. https://brill.com/display/title/59906

Milosz, M., Kęsik, J., & Abdullaev, U. (2024). 3D scanning and modeling of highly detailed and geometrically complex historical architectural objects: The example of the Juma Mosque in Khiva (Uzbekistan). *Heritage Science*, *12*(1), 99. https://doi.org/10.1186/s40494-024-01207-3

Milosz, M., Kęsik, J., & Montusiewicz, J. (2021). 3D Scanning and Visualization of Large Monuments of Temurid Architecture in Central Asia—A Methodical Approach. *J. Comput. Cult. Herit.*, *14*(1), 8:1–8:31. https://doi.org/10.1145/3425796

Nazarov, K. (2006). His Lordship Sheikh Zainiddin Kuyi Orifon. In O. Mansur (Ed.), *Shaykh Zainiddin Kuyi Orifon Toshkandiy*.

Pugachenkova, G. A., & Rempel, L. I. (1965). *History of Arts of Uzbekistan*.

Romanova, I. A., & Poluboyarova, N. M. (2021). The Virtual Reconstruction of Historical and Cultural Heritage Monuments of the Vodyansky Settlement. *Scientific Visualization*, *13*(3). https://doi.org/10.26583/sv.13.3.02

Salikuddin, R. K. (2018). *Sufis, Saints, and Shrine: Piety in the Temurid Period, 1370-1507*. http://nrs.harvard.edu/urn-3:HUL.InstRepos:41129127

Samarqandi, A. T. (1898). *Samariyya: Description of antiquities and Muslim shrines of Samarqand* (Vyatkin, Trans.). In *Reference book of Samarkand region* (Vol. 6).

Spano, A., Patrucco, G., Covino, R., Merlo, P., Bonfanti, C., Kong, B., & Karnitckii, I. (2025). STRATEGIE DI DISSEMINAZIONE DEL PATRIMONIO ARCHEOLOGICO: DIGITALIZZAZIONE E VIDEO MAPPING DEL SITO DI NISA VECCHIA. In *Antiche civiltà del Turkmenistan* (pp. 157–169). Gangemi. https://iris.polito.it/handle/11583/3006191

Tokarski, P., Milosz, M., & Kesik, J. (2025). Modern Digitization and 3D Visualization Technologies for Virtual Access to Hard-to-reach or Perished Historical Sites. https://diglib.eg.org/items/c2bd6ac3-5d61-4c44-850b-ca121977e72f

Tokoeva, G. S., Kozhonazarova, Y. M., & Anarbaeva, G. A. (2025). Applying 3D Modeling to Study Historical and Cultural Monuments. In E. G. Popkova (Ed.), *Management of Digital Technologies in the Innovative Economy* (pp. 9–12). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-83331-1_2

Toubekis, G., Jansen, M., & Jarke, M. (2017). Long-term preservation of the physical remains of the destroyed Buddha figures in Bamiyan (Afghanistan) using virtual reality technologies for preparation and evaluation of restoration measures. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *IV-2/W2*, 271–278. ICOMOS/ISPRS International Scientific Committee on Heritage Documentation (CIPA) 26th International CIPA Symposium – Digital Workflows for Heritage Conservation (Volume IV-2/W2) - 28 August–1 September 2017, Ottawa, Canada. https://doi.org/10.5194/isprs-annals-IV-2-W2-271-2017

Trimingham, J. S. (1971). *The Sufi Orders in Islam*. Clarendon Press.

Vyatkin, V. L. (1899). *Reference Book of the Samarkand Region* (Issue VI). Samarkand.

Yusupova, M. (2023). Ḥaẓīra Memorial Complexes in Mawarannahr: Evolution and Architectural Features (pp. 222–241). https://doi.org/10.1163/9789004540996_012

Zarcone, T. (2020). Sufism, tombs and convents. In *Routledge Handbook on Sufism*. Routledge.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 458 – 475

STREET CHARACTER AND URBAN IDENTITY: DEFINING PHYSICAL DESIGN PARAMETERS OF BUILDING APPEARANCE IN THE HISTORIC URBAN FABRIC OF KUALA KANGSAR PERAK MALAYSIA

Wan Norisma Wan Ismail[1], Elina Mohd Husini[2], Fadli Arabi[3], Norsafiah Norazman[4], Shakhboz Mustafoev Shukhratovich[5]

[1,2,3]*Faculty of Engineering and Built Environment,*
UNIVERSITI SAINS ISLAM MALAYSIA
[4]*School of Housing, Building and Planning,*
UNIVERSITI SAINS MALAYSIA
[5]*Faculty of Architecture,*
TASHKENT UNIVERSITY OF ARCHITECTURE AND CIVIL ENGINEERING

Abstract

Streets are vital public spaces that shape the identity and character of towns, especially in historically significant areas like Kuala Kangsar, the royal town of Perak, Malaysia. Yet, modern architecture, unregulated renovations, and vehicular encroachment have altered traditional streetscapes, threatening their cultural and architectural heritage. This study aims to establish physical design parameters to define and preserve street character within Kuala Kangsar's historic urban fabric. Focusing on Istana, Laksamana, and Shahbandar Streets, it employs a mixed-methods approach: qualitative data from in-depth interviews (n=21), field observations, and archival analysis, and quantitative data from structured questionnaires (n=330). Triangulated analysis identifies two key dimensions shaping street character, appearance and function with buildings and landscape as primary influences. Basic statistical analysis of the survey responses, including descriptive frequency analysis and correlation assessment between building appearance attributes and public perception, was conducted to support the qualitative findings. This paper emphasizes building appearance, highlighting its role through attributes like attractiveness, visibility, and human scale. Findings, validated via expert focus group discussions (n=6), inform nine key design guidelines. The study contributes to urban design theory and policy by promoting heritage-sensitive street development in historic towns.

Keywords: street character, urban identity, urban fabric, physical, parameters

[1] Corresponding author. Email: norisma@usim.edu.my

INTRODUCTION

Streets, as one of Lynch's (1960) five core urban elements, are fundamental not only as movement corridors but also as key determinants of a city's experiential and cognitive image. In Malaysia's royal towns, streets within the historic urban fabric embody rich historical narratives, architectural heritage, and culturally significant spatial configurations (Sulaiman et al., 2007). Unlike generic newer developments, these streets exhibit distinctive physical qualities, including legibility, permeability, attractiveness, human scale, and comfort, that collectively forge unique urban character and reinforce local identity (Shamsuddin, 2011; Ja'afar, 2014). Consequently, streets hold critical importance in urban design theory and the preservation of place identity in heritage contexts, making their physical character essential to informing sensitive urban policies that safeguard historically significant towns (Sulaiman, 2000; Idid, 1995; Tiesdell & Adams, 2021; Roslan et al., 2023).

PROBLEM STATEMENT

Street design challenges in Malaysia's royal towns reflect growing concerns over the loss of urban identity due to rapid development. Studies by Shukri et al. (2017, 2018) and Harun et al. (2015) reveal that urbanisation has weakened the historical and cultural fabric of these towns, while Shamsudin et al. (2018) stresses the need for design guidelines to protect their heritage. In Kuala Kangsar, preserving heritage buildings, landscapes, and traditional crafts is vital to maintaining local identity (Che Leh et al., 2013; Berita Harian Online, 2016). Similar threats are seen in Seri Menanti and Klang (Harun et al., 2015; Arshad, 2015). While research often prioritises heritage buildings, Samadi and Yunus (2012) caution that neglecting the cultural and spatial qualities of streets may lead to further identity erosion. In contrast, Maharani Town in Johor demonstrates how well-planned upgrades can enhance infrastructure while preserving historic street character (Utusan Malaysia, 2012).

SCOPE OF STUDY

This study focuses on the physical dimensions of streets as key contributors to character and identity in Malaysia's royal towns. While urban design also involves social and psychological aspects (Sulaiman, 2012), physical elements such as built form, spatial structure, and active use are central to shaping place identity (Ja'afar, 2014; Shamsuddin & Sulaiman, 2002; Mulyadi, 2008; Shirvani, 1985; Moughtin & Mertens, 2003; Tuan, 1977). Pedestrian activity further enhances street vitality and meaning (Voltolini, 2006; Gehl, 2010; Jacobs, 1993). Thus, this study limits its scope to physical attributes that define street character in royal towns.

© 2026 by MIP

CASE STUDY

Kuala Kangsar, Malaysia's oldest Royal Town, is selected as the case study for its rich historical, cultural, and physical heritage. The study focuses on three key streets: Istana, Laksamana, and Shahbandar, chosen for their civic, commercial, and public roles. Istana Street, the royal civic spine, features landmarks such as the royal palace and mosque, reflecting the Malay monarchy's grandeur (Harun et al., 2005; Shamsuddin et al., 2018). Laksamana and Shahbandar Streets, located near the Perak River, function as vibrant commercial and social hubs. The town's landscape, royal crafts, heritage industries, and street-based cultural practices contribute to a distinctive and lively streetscape. As highlighted by Mehta (2013), Lynch (1960), and Jacobs (1993), such activity-rich environments define street character and reinforce their role as public spaces tied to urban memory and identity.

METHODOLOGY

This study adopts a mixed-methods approach as the most suitable strategy for addressing the research questions (Creswell, 2009). By combining qualitative and quantitative analyses, it allows for a comprehensive investigation of physical street character, in line with past studies on urban form and identity (Sulaiman et al., 2007; Shamsuddin, 1997). Its relevance is further supported by recent research, including Berta et al. (2018), who emphasize the value of integrating spatial and stakeholder data for heritage evaluation, and White et al. (2023), who apply immersive methods to capture community perceptions.

Data collection involved field observations, interviews, document analysis, literature review, and structured questionnaires, with expert focus groups used for validation. Quantitative data obtained from 330 questionnaire respondents were analysed using descriptive statistics and correlation analysis to examine relationships between perceived street character and specific building appearance attributes such as façade continuity, skyline quality, and signage design. These statistical results provide additional empirical support for the qualitative interpretations derived from interviews and visual observations. The methodological framework established here forms the basis for the subsequent analysis, where both visual and perceptual dimensions of street character are evaluated in detail. The analysis section presents the synthesis of these findings. All visual documentation presented in Figures 2-11 and comparative summaries in Tables 1-3 are directly referenced in the analysis to clarify how empirical observations support the identified street character attributes.

LITERATURE REVIEW

Urban street character is largely shaped by physical components, which form a core dimension of environmental identity alongside behavioural, psychological, and social aspects (Sulaiman, 2012). This study focuses on the physical components that shape street character, recognized as a key contributor to urban identity (Sulaiman, 2012; Ja'afar, 2014). Streets, as basic elements of urban structure, derive their character from the interplay of buildings, landscapes, and networks, each assessed through appearance and function (Ja'afar, 2014; Al-Obeidy & Dabdoob, 2017). These include seven elements: building form, landscape, location, image, street pattern, visual quality, and activity (Moughtin & Mertens, 2003; Appleyard, 1980). Functional aspects are shaped by the intensity and diversity of activities, which contribute to place identity and a vibrant public realm (Gehl, 2010; Carmona et al., 2003). Although studies specific to royal towns are limited, many of these settlements are historic urban centres where physical heritage remains critical in defining unique street character (Shamsuddin & Sulaiman, 1999).

STREET CHARACTER FORMATION THROUGH BUILDING APPEARANCE AND PHYSICAL ELEMENTS

Building Appearance Components

Building appearance is shaped by a range of interrelated physical components, including building type, location, height, scale, form, age, condition, structural system, setbacks, façade elements, roof design, signage, and overall visual quality which collectively influence the distinctiveness, legibility, visibility, and attractiveness of streets (Ja'afar, 2014; Shamsuddin, 2011; Abaszadeh, 2011). Architectural features such as historic façades, cultural landmarks, and landscapes are critical in defining a street's identity. Core physical variables, like façade design (doors, windows, arcades, balconies), building scale, articulation, rhythm, human scale, rooflines, and heritage elements, work together to create a coherent and memorable streetscape. These attributes, which directly shape street character through attractiveness, visibility, and human scale, are systematically assessed in this study using established urban design measurement techniques, as outlined in the conceptual framework (Figure 1).

© 2026 by MIP

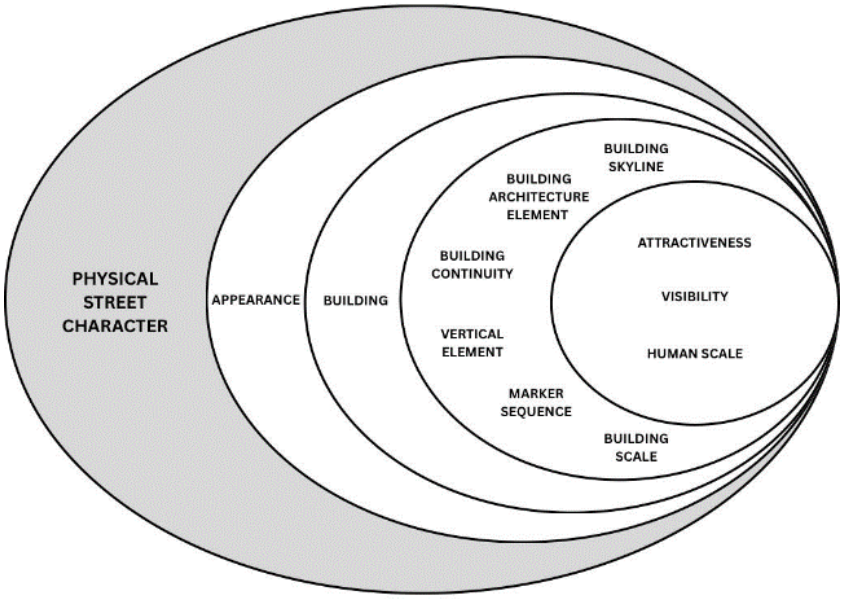


Figure 7: Conceptual Framework
Source: Author

ANALYSIS AND DISCUSSION

Drawing on the mixed-methods data collected, the following section discusses how building appearance influences street character in terms of three key attributes: attractiveness, visibility, and human scale. Each attribute is unpacked based on qualitative insights and visual documentation from the case study areas. References to Figures and Tables are provided throughout the discussion to clearly demonstrate how visual evidence supports the analytical findings.

The study identifies that the appearance aspects of building components contribute to the physical street character in the Royal Town of Kuala Kangsar through three key attributes: (i) attractiveness (ii) visibility and (iii) human scale. Table 1 outlines the data collection techniques employed for each physical characteristic and demonstrates how different research instruments support each analytical dimension discussed in this section.

Table 1: Appearance of building components based on research techniques

Physical Character and Element	Qualitative			Quantitative
	Visual Survey	Interview	Historical Document	Questionaire Survey
Attractiveness				
Architectural Design of Buildings (location, function, age, architectural style, architectural detailing, visual quality)	√	√	√	√
Building Skyline Quality (location, function, age, height, roof shape and size, design, visual quality)	√	√	√	√
Continuity of Building Appearance (Façade and Signage) (location, function, building size & openings, height, design, building lines and rhythm, horizontal and vertical articulation, visual quality)	√	√	√	√
Visibility				
Vertical Elements (location, function, architectural style, size, height, building age, visual quality)	√	√	√	√
Civic Building Appearance (location, function, size, form, architectural style, visual quality)	√	√	√	√
Marker Sequences (location, function, architectural style, visual quality)	√	√	√	√
Human Scale				
Building Scale (function, size of front openings, number of units, block length, distance between intersections, building sidewalk)	√	√	-	√
Enclosure Space (function, street width, building height, viewing angle)	√	√	-	√

Source: Author

ATTRACTIVENESS

The study revealed that the attractiveness of a street is associated with three key elements: (i) architectural design of buildings, (ii) quality of the building skyline, and (iii) continuity of building appearance.

Architectural Design of Buildings

Architectural design plays a significant role in enhancing street attractiveness and shapes the physical character of the royal town's streets. It is influenced by factors such as building function, location, age, style, detailing, and visual quality of civic landmarks and traditional shophouses. This character is achieved through: (i) the Royal Palace, strategically sited on elevated or riverside locations, whose historic age, distinctive style, and heritage status create a monumental landmark, reinforcing spatial hierarchy and historical identity; (ii) the Royal Mosque, Gallery, and Museum, located on prominent sites, which contribute unique architectural features and royal imagery that enrich visual quality and enhance place recognition; and (iii) traditional mixed-use shophouses whose dual function, detailed craftsmanship, and heritage value strengthen local identity and streetscape memorability. These elements are spatially represented in the map of Kuala Kangsar (Figure 2) and further celebrated through diverse architectural

© 2026 by MIP

detailing as illustrated in Figure 3, which highlights ornamental façade elements and heritage motifs reflected in local commemorative stamp designs.

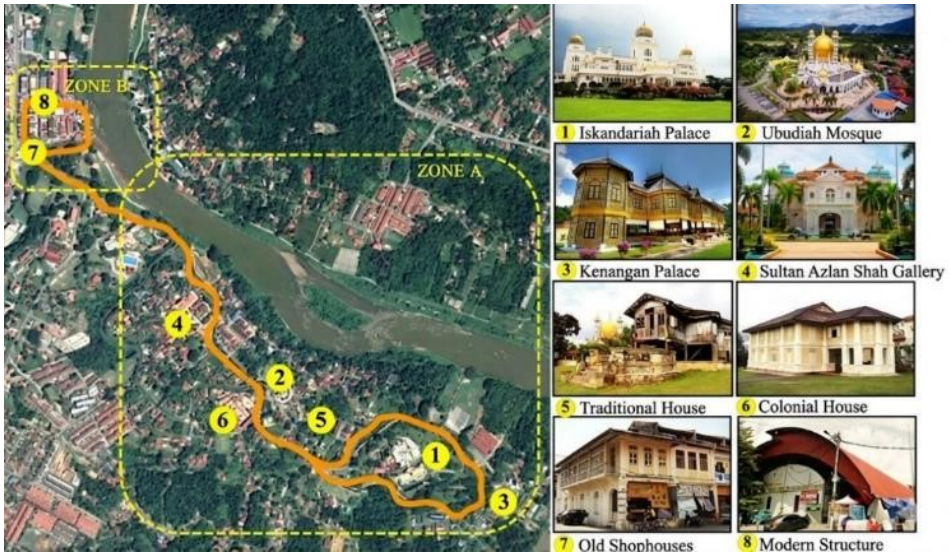


Figure 2: Map of Kuala Kangsar highlighting attractive buildings and their locations.
Source: Author



Figure 3: Architectural detailing is commemorated through stamp design.
Source: Lubis A.R. et al. (2010), Kuala Kangsar Public Library

Building Skyline Quality

The analysis highlights that the building skyline quality, essential for street attractiveness, is shaped by landmark structures embodying the royal identity, such as the Royal Palace, Mosque, Gallery, and Museum, and mixed-use buildings like traditional shophouses. This is achieved through: (i) the Royal Palace's dominant presence on elevated terrain, where its scale, distinct architectural style, and roof form create a clear, memorable landmark that anchors the skyline and reinforces local identity; (ii) the Royal Mosque, Gallery, and Museum, contributing to the skyline composition via their civic prominence, varied height, and distinctive roof forms, strategically placed on terraces or hills to enhance visual harmony; and (iii) mixed-use buildings maintaining controlled

height and consistent rooflines, preserving visual rhythm and coherence. These skyline relationships are illustrated in Figure 4 through cross-sectional views of Zones A and B, allowing comparison between civic landmarks and surrounding commercial buildings in terms of height, location, and architectural form.

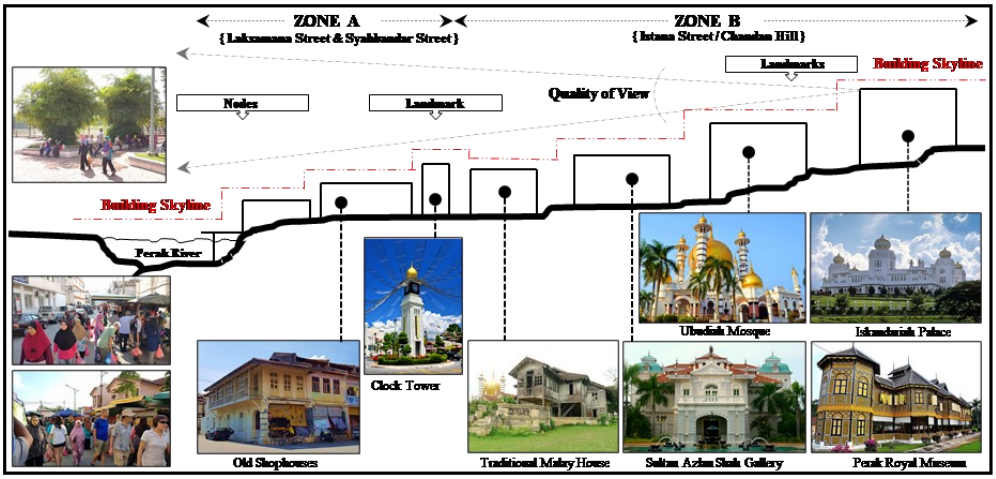


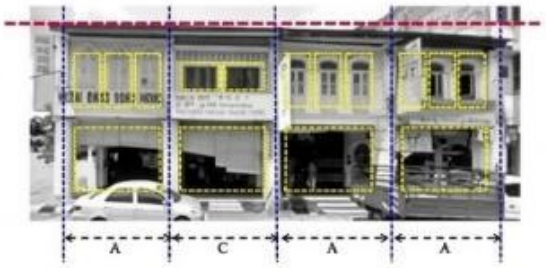
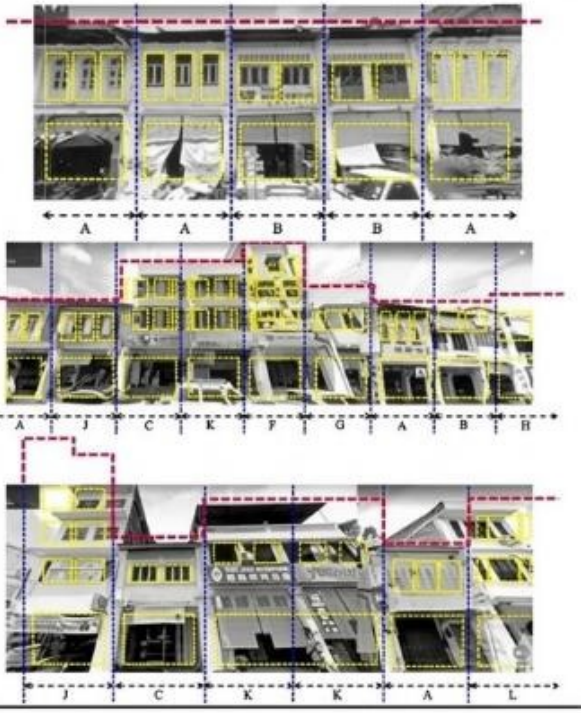
Figure 4: Cross-sectional view of Zones A and B illustrating skyline variations by function, location, height, roof form, and towers.
Source: Author

Building Façade Continuity

The analysis reveals that façade continuity, critical for street attractiveness, depends on building function, design, size and openings, height consistency, architectural rhythm, articulation, and façade control. This is achieved through: (i) uniform façade design in traditional shophouses, where consistent height, aligned architectural lines, and coherent openings create a harmonious streetscape that reinforces local identity; and (ii) incorporation of royal imagery in new commercial or mixed-use façades to maintain aesthetic continuity and emphasize the cultural uniqueness of the royal town. As demonstrated in Table 2, traditional shophouses in Zone B exhibit stronger façade alignment and rhythm compared with newer commercial units. Disruptions in façade continuity, illustrated in Figure 5, reduce the visual cohesion of the street environment and weaken its architectural identity.

© 2026 by MIP

Table 2: Comparison of the continuity in traditional shophouse appearances in Zone B.

Type	Element	Building Façade Appearance
(i) Old Shophouse (Original)	▪ Continuity of façade architectural style (colonial influence) ▪ Uniform building height ▪ Repetition of typical units ▪ Consistency in building lines and rhythm ▪ Uniformity in form and size of openings (miximum of 2 types) ▪ Consistency in horizontal and vertical articulation	
(ii) Old Shophouses (Modified)	▪ Lack of continuity in facade architectural style (loss of colonial influence) ▪ Inconsistent building height ▪ Absence of repeating typical units ▪ Disruption in building lines and rhythm ▪ Irregularity in form and size of openings (more than 6 types) ▪ Lack of consistency in horizontal and vertical articulation	

Source: Author

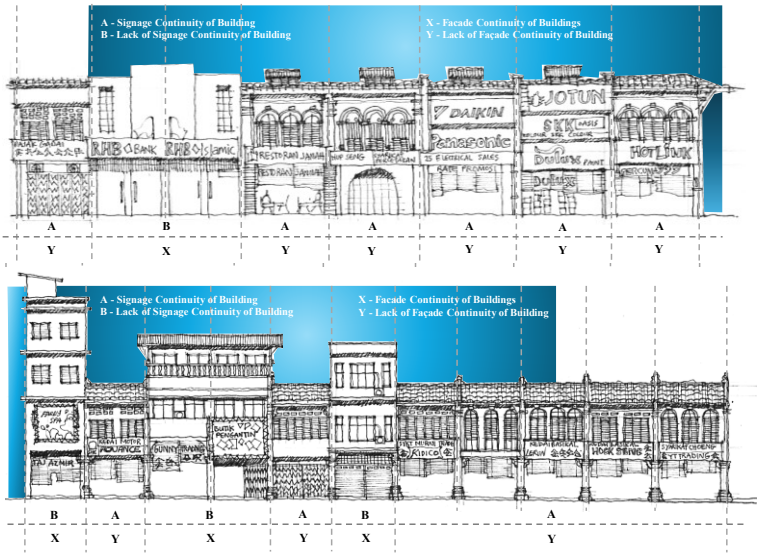


Figure 5: The lack of facade continuity with adjacent units reduces street attractiveness in Zone B.
Source: Author

Signage Design

Results indicate that signage continuity, essential for enhancing street attractiveness, is influenced by location, design, quantity, type, size, and color. This is achieved through: (i) strategic placement, ideally above façades with balanced proportions, legible typography, and cohesive color schemes that support pedestrian readability and reinforce the royal town identity at a human scale; and (ii) traditional signage forms, such as carved names on façades or shutters, which preserve architectural coherence and cultural continuity. Poorly positioned or oversized signage undermines aesthetic harmony (Figure 6), while traditional models support visual consistency and historic character (Figure 7).



Figure 6: Improperly placed, oversized, and excessive signage disrupt façade continuity, streetscape harmony, and reduce the building's architectural aesthetic.
Source: Author

© 2026 by MIP



Figure 7: Traditional signage design enhances building facade aesthetics (i-iii) and preserves the continuity of historic building appearances (iv).
Source: Author and Lubis et al. (2010)

VISIBILITY

The study found that street visibility is influenced by three key elements: (i) vertical elements (ii) the visual prominence of civic buildings, and (iii) the sequential arrangement of urban markers.

Vertical Elements

The analysis reveals that vertical elements significantly enhance street visibility, spatial legibility, and wayfinding within Zones A and B of the Royal Town (Figure 8). This is achieved through: (i) the integration of towers or minarets with key royal landmarks, such as the Royal Palace and Royal Mosque, whose strategic location, scale, and architectural style amplify visual clarity and reinforce the Royal identity; and (ii) the presence of non-civic vertical features, like clock towers situated at intersections or roundabouts, which serve as urban reference points and aid pedestrian orientation. Collectively, these vertical markers strengthen visual connectivity and spatial recognition, enriching the streetscape character of the royal town.



Figure 8: Vertical elements: Iskandariah Palace tower (i), Ubudiah Mosque minaret (ii), and Kuala Kangsar Clock Tower (iii) enhance visual clarity and define the royal town's streetscape.
Source: Author

Civic Building Appearance

The analysis highlights the visual prominence of key Royal civic buildings as central to shaping street design and reinforcing the character of the royal town. Table 3 summarises the comparative attributes of these civic buildings in terms of architectural form, height dominance, and landmark visibility. This is achieved through: (i) the strategic siting of the Royal Palace on elevated terrain, making it the dominant landmark, with its substantial scale and distinctive architecture that embodies royal identity; (ii) the positioning of the Royal Mosque, Gallery, and Museum near the palace or on hills, enhancing visibility and recognition through their size, unique forms, and Royal symbolic features. Together, these buildings create highly visible urban markers that differentiate the royal town, strengthening its localized street character and sense of place (Table 3).

© 2026 by MIP

Table 3: Comparison of civic building appearances contributing to visibility.

Civic Building	Location Size Age	Shape/ Form	Architectural Style	Historical Document
Iskandariah Palace	Peak of Chandan Hill 17220.35 sq feet 86 years	 A symmetrical form combining a rectangle and a square.	 A combination of Indo-Islamic 'Saracenic' architecture and Middle Eastern architectural styles.	 Astana Negara (1933)
Ubudiah Mosque	Chandan Hill 4305.56 sq feet 102 years	 A symmetrical form combining an octagon and a square.	 Islamic 'Saracenic' architecture and Moorish carving artistry.	 Ubudiah Mosque (1917)
Sultan Azlan Shah Gallery	Chandan Hill 6725.35 sq feet 116 years	 An asymmetrical form combining multiple rectangular shapes.	 A combination of Moorish, Indian, and Nusantara architectural styles.	 Ulu Palace (1903)
Perak Royal Museum	Bukit Chandan 93 tahun	 An asymmetrical form symbolizing a keris blade sheathed in its scabbard.	 Hardwood construction, woven bamboo walls (tepas), and diamond-shaped wooden roofing.	 Kenangan Palace (1926)

Source: Author

Marker Sequence

The study finds that marker sequences, which enhance street visibility, are shaped by building location, function, and architectural style. This is realized through: (i) civic royal buildings such as the Royal Palace, Royal Mosque, and Royal Gallery acting as visual markers; (ii) their strategic placement along curved or winding roads, creating a sequential visual experience that improves street

legibility and recognizability. Figure 9 illustrates this spatial sequence, where the SAS Gallery, Ubudiah Mosque, and Iskandariah Palace appear progressively along the winding road, reinforcing visual continuity and orientation for street users.



Figure 9: The presence of SAS Gallery, Ubudiah Mosque, and Iskandariah Palace along the winding road forms a marker sequence that enhances street visibility.
Source: Author

Building Scale

The study highlights that a human-scaled street environment is influenced by building function, unit size, block length, intersection distance, and the presence of covered walkways. This environment is shaped through: (i) mixed-use buildings, such as traditional shophouses, where narrow frontages and elongated layouts increase the number of units per block, enhancing street rhythm and visual interest at the pedestrian scale; (ii) block lengths with intersection distances under 100 meters, which correspond to pedestrian movement speeds, promoting walkability and street vitality; and (iii) continuous, weather-protected walkways (kaki lima) of appropriate height and width, which enhance pedestrian comfort, safety, and connectivity (Figure 10).

© 2026 by MIP



Figure 10: Five-foot ways with human-scaled height and narrow, sheltered widths support pedestrian activity, creating a vibrant and character-rich streetscape.
Source: Author

Enclosure

The study identifies spatial enclosure as a key element of a human-scaled streetscape, influenced by building function, height, and street width. This quality is achieved through: (i) mixed-use buildings such as traditional shophouses, which, when aligned with narrow streets, create a defined spatial character; (ii) a height-to-width ratio where taller buildings along narrow streets enhance visual enclosure; (iii) viewing angles over 45°, which improve façade legibility and spatial clarity; and (iv) active pedestrian presence, reinforcing the street's vibrancy and public function. As shown in Figure 11, the strongest spatial enclosure occurs when building height meets or exceeds street width, complemented by wide viewing angles and active street-level use.



Figure 11: The best spatial enclosure occurs when building height matches or exceeds street width, with a 45° viewing angle and active street-level use.
Source: Author

CONCLUSION

This study confirms that the appearance of building components significantly shapes street character in the historic urban fabric of Kuala Kangsar, particularly through the attributes of attractiveness, visibility, and human scale. By identifying and analyzing key physical elements such as architectural style, façade continuity, skyline quality, signage, spatial sequencing, and enclosure, this research establishes a coherent set of design parameters grounded in the local

royal identity. Statistical analysis of public perception further supports the qualitative findings, demonstrating consistent relationships between building appearance attributes and perceived street character. These findings have direct policy implications for local authorities and urban designers, particularly in guiding development control, conservation zoning, and façade improvement initiatives. The nine design parameters developed can serve as a reference framework for heritage-based development plans, ensuring that visual coherence and traditional elements are integrated into future urban interventions. Municipal councils may adopt these guidelines to inform planning approvals, while heritage departments can use them to evaluate and retrofit existing streetscapes sensitively. This study not only advances urban design scholarship but also provides actionable insights for policymakers, planners, and conservationists seeking to protect and revitalize historic streetscapes without compromising their cultural integrity.

LIMITATIONS AND FUTURE RESEARCH

While this study offers a context-specific framework, its scope is geographically limited to Kuala Kangsar, which may restrict generalizability to other royal towns. Additionally, the visual assessment of architectural features and spatial qualities involves interpretative judgment, introducing an element of subjectivity. Future research could explore cross-town comparative analyses across different royal towns or expand into urban regeneration scenarios, where adaptive reuse and new development require sensitive integration with heritage contexts. Furthermore, longitudinal studies could assess how these parameters influence the success of conservation efforts over time.

DISCLOSURE STATEMENT

The authors declare that there are no conflicts of interest. No funding was received that could have influenced the outcome of this research.

REFERENCES

Abaszadeh, F. (2011). *Characterization of Streets Physical Elements in Iran* (Doctoral Dissertation).

Ahamad, A. (2004). *Kajian bagi mengenalpasti karakter fizikal dan sosio-budaya bandar: kajian kes Melaka Bandaraya Bersejarah* (Doctoral dissertation, UTM).

Alexander, C. (1977). *A Pattern Language: Towns, Buildings, Construction*. Oxford University Press.

Al-Obeidy, M. S., & Dabdoob R. M. (2017). Reviewing on Street Attributes in Influencing the Sense of Place and Place Attachment. *Int. J. Adv. Res* (IJAR).

Appleyard, D. (1980). Livable Streets: Protected Neighborhoods? *The ANNALS of the American Academy of Political and Social Science*, *451*(1), 106-117.

© 2026 by MIP

Berita Harian Online (2016). *Kuala Kangsar Kekal Sejarah Seiring Pembaharuan*.

Carmona, M., Tiesdell, S., Heath, T., & Oc, T. (2003). *Public Space Urban Space: The Dimension of Urban Design*.

Che Leh, F., Yeop Yunus, N. K., Razak, A., Abidin, A. Z., & Omar, B. (2013). Pemasaran dan kepenggunaan tempat untuk pembangunan pelancongan di Kuala Kangsar.

Creswell, J. W. (2009). Mapping the field of mixed methods research.

Gehl, J. Cities for People (2010). *Historic Cities: Issues in Urban Conservation*, *8*, 241.

Harun, N. Z., Fairuz, D. N., & Nordin, N. A. (2015). The Roles of Urban Heritage in Determining the Image of the Royal Town of Sri Menanti, Negeri Sembilan. *PLANNING MALAYSIA JOURNAL*, *13*(5).

Idid, Z. A. (1995). *Pemeliharaan warisan rupa bandar: panduan mengenali warisan rupa bandar berasaskan inventori bangunan warisan Malaysia*. Badan Warisan Malaysia.

Ja'afar N. H. (2014). *Karakter Fizikal Jalan Tradisional; Kajian Kes Di Melaka Bandaraya Bersejarah* (Doctorate Thesis). Universiti Teknologi Malaysia, Skudai, Johor.

Ja'afar, N. H., Sulaiman, A. B., & Shamsuddin, S. (2012). The Contribution of Landscape Features on Traditional Streets in Malaysia. *Procedia-Social and Behavioral Sciences*, *50*, 643-656.

Ja'afar, N. H., Sulaiman, A. B., & Shamsuddin, S. (2011). Traditional Street Activities in Kuala Lumpur City Centre. *International Journal of Multidisciplinary Thoughts*, *2*(1), 93-105.

Jacobs, A. B. (1993). *Great Streets*.

Jacobs, J. (1993). *The Death and Life of Great American Cities*. Modern Library

Lynch K. (1960). *Image of the City*. The MIT Press, Cambridge, Massachusetts and London, England.

Manley, S., & Guise, R. (1998). Conservation in The Built Environment. *Introducing Urban Design: Interventions and Responses. Longman, London*.

Mehta, V. (2013). *The Street: A Quintessential Social Public Space*. Routledge.

Moughtin, C. & Mertens M. (2003). *Urban Design: Street and Square*. Third Edition. Amsterdam. Elsevier

Mulyadi, L. (2008). *Karektor dan Konsep Susun Atur Ruang Bandar Bersejarah Cakranegara Indonesia* (Doctoral dissertation, Universiti Teknologi Malaysia).

Samadi, Z., & Yunus, R. M. (2012). Physical and Spiritual Attributes of Urban Heritage Street's Revitalization. *Procedia-Social and Behavioral Sciences*, *36*, 342-349.

Shamsuddin, S. (1997). *Identity of Place: A Case Study of Kuantan Town Centre, Malaysia* (Doctoral dissertation, University of Nottingham).

Shamsuddin, S., & Sulaiman, A. B. (1999). *The Importance of Securing the Sense of Place in the Planning and Design of Cities in the 21st Century-the Malaysian Experience*. Universiti Teknologi Malaysia.

Shamsuddin, S., & Sulaiman, A. B. (2002). *The Role of Streets in Influencing the Sense of Place of Malaysian Towns and Cities*. Universiti Teknologi Malaysia.

Shamsuddin, S., Sulaiman, A. B. (2002). Urban Landscape Factors That Influenced the Character of George Town, Penang UNESCO World Heritage Site. *Procedia-Social and Behavioral Sciences*, *50*, 238-253.

Shukri, S. M., Wahab, M. H., Amat, R. C., Taib, I., & Rozaly, M. Z. M. (2018). Definition and Physical Attributes that Characterise Settings of Malay Royal Towns in Malaysia. *International Journal of Engineering & Technology*, *7*(3.9), 55-58.

Shukri, S. M., Wahab, M. H., Ibrahim, M. A., & Rozaly, M. Z. (2017). Sd 26-Physical

Sulaiman, A. B. (2000). *Urban Design Method-Theory and Practice: A Case Study in Malaysia, University of Nottingham, Nottingham* (Doctoral, Ph. D. Thesis).

Sulaiman, A. B., Shamsuddin, S., Norbienna, S. L., Anwar, M., & Awam, J. K. (2007) Konsep Baru Model Bandar Berasaskan Kepada Rupa Bentuk Bandar Tradisional.

Tuan, Y. F. (1977). *Space and Place: The Perspective of Experience*. University of Minnesota Press.

Venturi, R. (1966). *Complexity and Contradiction in Architecture*. New York: Museum of Modern Art. *Architectural theory*.

Voltolini, P. (2006). *Street Vending and The Use of Public Spaces In New York City*. State University of New York College of Environmental Science and Forestry.

Worskett, R. (1970). *The character of Town*.

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 476 – 494

INCREASING ALLEY COGNIZANCE TO IMPROVE COMMUNITY SAFETY IN KUALA LUMPUR: A CRITICAL STUDY OF REVITALISED URBAN ALLEY

Wan 'Iffah Wan Ahmad Nizar, Nor Syahila Ab Rashid, Wan Norisma Wan Ismail, Nurul Syala Abdul Latip, Noor Hayati Ismail, Azhani Abd. Manaf

Department of Architecture,
UNIVERSITI SAINS ISLAM MALAYSIA

Abstract

Urban alleys are often overlooked yet hold significant potential for transformation within densely populated cities where public spaces are scarce. This research explores the creation of a branding and wayfinding framework aimed at enhancing public awareness and community safety in alleyways in Malaysia. Drawing on urban design principles, spatial perception, and place-making concepts, the study employs a multi-phase approach that includes a literature review, field observations, participatory workshops, and experimental simulations. Findings from the study reveal several challenges, such as poor spatial clarity, a lack of cohesive visual language, and insufficient user-centered signage. These issues contribute to negative perceptions and the underuse of these alley spaces. Workshops conducted with local residents, municipal officials, and urban design experts provided valuable insights into the socio-cultural factors influencing how these alleys are used and perceived. This information guided the development of a branding and wayfinding framework that incorporates visual identity systems, navigational aids, and design strategies tailored to the local context and community needs. Although this framework is specifically tailored for Malaysian urban environments, its underlying principles can be adapted to other similar high-density areas. This study adds to the discourse on alley revitalization and offers practical strategies for integrating underappreciated urban spaces into broader plans for inclusive, human-centered city planning.

Keywords: Urban Alleys, Wayfinding, Branding, Community Safety, Place-Making, Micro-Urban Design

[1] Corresponding author. Email: wan.iffah@usim.edu.my

INTRODUCTION

Urban alleys frequently emerge as a significantly overlooked dimension of urban infrastructure, typically associated with issues of safety, cleanliness and relevance to urban life. Within the past few years, in the Malaysian urban context, revitalization efforts aimed at rejuvenating these spaces have begun to gain traction, particularly in the densely populated areas like Kuala Lumpur. However, these endeavours remained disjointed and sporadic and largely fragmented due to the lack of comprehensive guiding frameworks. The prevailing approach tends to prioritize art-based beautification initiatives, which while visually appealing, one might argue, often fail to address essential underlying issues such as connectivity, spatial legibility and community safety (Papaioannou et al. (2020); Global Designing Cities Initiative (2024)).

Central to this discourse is the fundamental research question of how enhancing public cognizance and understanding of urban alleys can contribute to improved community safety outcomes. While urban safety is often traditionally associated with crime statistics and surveillance infrastructure, recent research has shifted focus towards perceived safety, particularly within urban spaces such as alleys. In this framework, community safety is less about actual incidences of crimes, but more deeply tied to the perception of space, surroundings, understanding of spatial layout and user confidence in navigating the areas (Barker et al., 2023)– all of which directly related to wayfinding and alley cognizance in building user perception. Numerous studies indicate that disorienting, unmarked, or fragmented environments can heighten feelings of insecurity, even in regions with low crime (Türkseven Doğrusoy and Zengel, 2017; Kawshalya, et.al, 2022). This shift in perspective emphasizes the importance of examining spatial factors that influence community safety.

Moreover, pervasive negative perceptions surrounding alleys often stem from a confluence of factors, including anecdotal hearsay, detrimental media portrayals, and isolated negative experiences that color public sentiment. These perceptions not only influence individual behavior but also manifest as systemic barriers that discourage investment in and utilization of these vital urban spaces (Ellis, 2022). Evidence suggests that enhancing spatial understanding and instituting effective wayfinding strategies could substantially alleviate these concerns and catalyze a more positive engagement with alley environments.

LITERATURE REVIEW

The Interplay Between Alley Cognizance and Community Safety

Modern urban research increasingly suggests that how we feel in a city has less to do with actual crime statistics and more to do with how well we can "read" our surroundings. Askarizad et al. (2024) point out that the discomfort many feel in

© 2026 by MIP

narrow lanes stems from spatial ambiguity—the anxiety of not knowing where a path leads or who "owns" the space. Similarly, Ryan and Hill (2022) demonstrated that the presence of wayfinding elements such as signage, directional cues, and identifiable landmarks greatly enhances perceived safety in urban green spaces. These findings are buillt on Kevin Lynch's landmark work on legibility; if a space is easy to navigate and mentally map, it feels safer. In this study, "Alley Cognizance" refers to this very awareness–the public's ability to recognize, navigate, and trust these lanes as essential, safe shortcuts rather than hidden, high-risk voids. It includes the ability to recognize, navigate, and engage with alleys, as well as understanding their roles such as shortcuts, cultural pathways, or commercial areas while feeling oriented and safe in these spaces.

Cities like Melbourne and Seoul existing rejuvenation strategies further showcase the effectiveness of integrating wayfinding and branding strategies to enhance public perception and utilization of urban alleys. Particularly, in Seoul's urban revitalization efforts, it emphasizes the importance of place-naming, cohesive signage systems, and recognition of spatial patterns, thereby fostering both identity and navigability (HCMA, 2024). Such design strategies address cognitive barriers that often deter individuals from exploring these spaces, which are frequently shrouded in uncertainty (Jonas, 2021) due to its ambiguity in status of ownership. Also, cognitive mapping research substantiates the notion that individuals experience heightened vulnerability in areas lacking mental visualization or predictability, underscoring the necessity for spatial clarity. This concern is particularly relevant to existing Malaysian urban alleys, where inadequate naming, signage, and visual cues create a psychological disconnect, despite robust physical connectivity.

Global benchmarks like Melbourne and Seoul have turned this theory into practice by using branding to clear the "shroud of uncertainty" that often surrounds back lanes. In Seoul's revitalization, the focus wasn't just on cleaning up, but on spatial storytelling through place-naming and cohesive signage. This is particularly relevant to the Malaysian context, where a lack of formal naming or visual cues often creates a psychological disconnect, leaving residents feeling vulnerable in spaces that are physically well-connected but mentally "blank."

Urban design literature increasingly recognises alleys as vital micro-urban elements that, when designed effectively, can enhance walkability, bolster urban resilience, and foster a sense of local cultural identity. Nizar (2020) highlights that the roles of alleys in urban contexts are identified as essential to the five needs of a city: 1) walkable space, 2) social space, 3) passage of expression, 4) channel for cultural exhibition and local economic growth, and 5) utility needs. And for the alleys to play their role effectively, focusing on relevant urban design elements are fundamental, emphasizing on the form and function of

the alleys, their visibility, and branding, which consequently enhance walkability, resilience, and identity.

Regional Perspectives: Alley Rejuvenation in Southeast Asia

In Southeast Asia, the revitalization of alleys (or lorong) often involves a delicate balance between modern tourism and local heritage. In Singapore's Kampong Gelam, the Urban Redevelopment Authority transformed utilitarian back lanes into "Art Lanes," proving that vibrant murals and consistent paving do more than beautify—they increase "eyes on the street" by drawing in foot traffic. Similarly, Bangkok's "Hidden Bangkok" initiative in the Talat Noi district used community-led street art and heritage signage to break down cognitive barriers. By turning a confusing maze into a curated experience, the project reduced the perceived "threat" of the unknown.

Even in Ho Chi Minh City, "alley greening" projects have shown that when residents place potted plants and shared seating in their hẻm (alleys), the space begins to look "cared for." This visual cue of stewardship is a powerful deterrent to anti-social behavior, as it signals that the community is actively watching and claiming the space.

The Three Pillars of Revitalization

To understand how an alley moves from "neglected" to "navigable," this research looks at three overlapping layers: Urban Design, Spatial Perception, and Placemaking.

Urban Design acts as the physical foundation. According to Nizar (2020), for an alley to truly function, it must meet five basic urban needs: it must be walkable, social, expressive, culturally relevant, and functional for utilities. In Kuala Lumpur, design elements like lighting and surface quality are the first steps in creating "passive surveillance." When an alley connects two busy streets with clear sightlines, it naturally feels safer because users feel visible rather than trapped.

Spatial Perception is the "software" of the user experience. It's about how environmental cues—like a specific color of paint, a recurring texture, or a well-placed lamp—guide a person through a space without them needing a map. Wayfinding isn't just about signs; it's about spatial rhythm. Research in Manila's high-density corridors suggests that even simple visual consistency, such as a unified color scheme at alley entrances, can significantly boost a user's "predictability" of the path ahead, lowering their stress levels.

Finally, Placemaking provides the human soul. This is where the community takes ownership through personal touches like shopfront decorations or shared seating. Successful placemaking, as seen in projects like San Francisco's Clarion Alley or the greening projects in Belfast, turns a "passage"

© 2026 by MIP

into a "destination." When an alley hosts a mix of users—vendors, children, and the elderly—it proves that the space is inclusive. This sense of belonging is the ultimate form of security; it transforms a narrow back lane into a trusted communal asset.

Table 1: Domains of Alley Cognizance and Community Safety based on Literature Review

	Urban Design	Spatial Perception	Place-making	Review Points
Turkseven Dogrusoy and Zengel, (2017)	/	/		
Kawshalya, et.al (2022)		/		
HCMA (Vancouver, 2024)	/	/	/	Strategy emphasizes naming, signage, visual cues, and social spaces
Ellis (2022)		/		
Askarizad et al. (2024)	/	/	/	Alleys connected to main streets improve network intelligibility and walkability.
Ryan and Hill (2022)	/	/		
Bellingham Alley Guidelin es (2021)	/	/		Recommends compatible materials, lighting, and clear pedestrian access
Lim & Pae (2021)	/	/	/	Named laneways with signage enhance usability and cultural identity
Jonas (2021)		/		Alley greening improves social use and perception of safety
Kim & Lee (2020)		/	/	
Sustainable Urban Design Guidelines (2022)	/	/	/	

Source: Tabulated by Author, 2025

Table 1 shows that spatial perception is one of the most vital elements in rejuvenation efforts. Thus, this study draws on the three interconnected theoretical domains that inform the conceptual underpinning of the research: i) urban design, ii) spatial perception, and iii) place-making. Each of these domains contributes to understanding how underutilised urban spaces, such as alleys, can be reimagined through thoughtful design interventions.

1) Urban Design Elements

Urban design directly influences alley usability by improving walkability, visual coherence, and public identity. Well-connected alleys, especially those linking residential blocks to key urban paths, promote foot traffic

and passive surveillance; both which are critical for perceived safety (Askarizad et al., 2024). The Institute of Transportation Engineers (ITE, 2023) recommends context-sensitive approaches for alleys, highlighting lighting, surface quality, and enclosure to boost spatial comfort and clarity. Municipal guidelines, such as Bellingham's alley redevelopment strategy, emphasize benches, planters, and consistent paving as tools to support both movement and pause (City of Bellingham, 2014).

Complementing this, urban resilience frameworks suggest alleys become more legible and inclusive when local culture is reflected in their design. In Miami, alley upgrades that include motifs, murals, and shaded seating improved both environmental adaptability and public engagement (Crociati, 2020). The Los Angeles Urban Design Principles (2020) similarly stress that integrating heritage and visual continuity reduces spatial anonymity and encourages ownership. These strategies underscore how thoughtful alley design strengthens spatial cognition and, in turn, fosters community safety.

Re-*Branding*

Revitalising alleys presents an opportunity to rebrand these often-overlooked spaces by emphasising their physical, sensory, and symbolic identities. Effective branding, using visual language and cultural references, can challenge negative perceptions, align alleys with local narratives, and reintegrate them into the urban fabric.

2) Spatial Perception

Effective wayfinding and legibility are central to how individuals navigate and feel within urban environments. Spatial perception shapes mental maps and determines how users identify, interpret, and move through a place (Lynch, 1960). In alley contexts, features like clear signage, consistent visual cues, and intuitive visibility at entrances or junctions are essential to reduce confusion and anxiety (Arthur & Passini, 2002; Hölscher et al., 2013). When such features are absent, users may avoid the space altogether, regardless of actual safety.

Studies on urban legibility suggest that well-placed landmarks, lighting, and spatial rhythm (repetition in textures, colors, and materials) increase cognitive clarity and perceived safety, especially in less formal or secondary spaces like alleys (Montello, 2005; Nasar & Jones, 1997). For instance, the Seoul alley regeneration projects incorporated coordinated lighting and cultural iconography to guide users, making alleys more welcoming at night (Jung et al., 2021). In summary, reinforcing spatial perception through wayfinding elements not only improves user comfort but transforms alleys into navigable, functional extensions of the urban grid.

© 2026 by MIP

Environmental Cues

Wayfinding literature further develops this understanding by emphasising the importance of environmental cues such as signage, spatial organisation, lighting, and colour in supporting movement and orientation within complex urban settings. Poorly designed environments often cause confusion, lower usage, and perceptions of insecurity, especially in secondary or peripheral areas like alleys. Conversely, well-coordinated wayfinding systems improve not only navigational clarity but also boost user confidence and spatial inclusivity.

Research highlights that environmental cues such as signage, spatial organisation, lighting, and colour are essential for effective movement and orientation within complex urban spaces. When these elements are poorly implemented, users often face confusion, decreased usage, and increased perceptions of insecurity, particularly in peripheral areas like alleys (Hölscher et al., 2019; Townscape and Wayfinding, 2023). On the other hand, cohesive wayfinding systems; featuring clear signage, visible landmarks, strategic lighting, and visual consistency not only enhance navigational clarity but also foster user confidence and promote inclusive spatial access (Segd, 2024; Hölscher et al., 2019).

3) Place-making

The third theoretical pillar, place-making, highlights the social and cultural aspects of spatial transformation. Drawing on the work of scholars like Jane Jacobs and William H. Whyte, place-making promotes human-centred design that reflects community values and encourages social cohesion. Successful place-making involves participatory processes, where local stakeholders actively shape the identity and function of shared spaces.

Place-making emphasizes designing urban alleys to foster social interaction and reflect community values, which encourages local ownership and sustained use. Observing social interaction zones, which are areas where people can convene, pause, or converse, helps evaluate whether an alley supports everyday communal activities (Borini & Campioli, 2024). The presence of community signage or art, such as murals or posters, indicates local engagement and identity- building, as demonstrated in Belfast's green alley projects that blend environmental resilience with community narratives (Alley Greening Project, 2023). Assessing maintenance and cleanliness reveals community stewardship and the alley's perceived safety: well-maintained spaces typically attract more consistent usage and care (Alley Greening Project, 2023).

Resident and business involvement is demonstrated through personal touches like shopfront decorations, shared seating, or community art, which foster a sense of belonging and reduce neglect. Examples such as San Francisco's

Clarion Alley show how murals reflect collective identity (Clarion Alley Mural Project, 2024). Observing diverse user presence which include children, elderly, vendors also indicates whether alleys serve everyday life or merely function as attractions (Borini & Campioli, 2024).

Table 2: Domains of Alley Cognizance and Community Safety in this study

Theoretical Domain	**Core Focus**	**Relevance to Alley Design**
Urban Design	Form and function of urban spaces, visibility and branding	Enhances walkability, resilience, identity
Spatial Perception	Wayfinding, legibility, mental mapping	Improves spatial navigation and user comfort
Place-Making	Social interaction and community values	Encourages ownership and sustained use

Source: Tabulated by Author, 2025

RESEARCH METHODOLOGY

The research adopts a multi-dimensional approach to examine the revitalization of urban alleys in Malaysia, grounded in a triangulation of qualitative and empirical methods. To establish a robust theoretical foundation, a comprehensive literature review and policy analysis were conducted, utilizing academic databases, peer-reviewed journals, and institutional reports. This phase was critical for identifying existing policy gaps and articulating the intersection between urban design, spatial perception, and placemaking. Rather than viewing these as isolated concepts, the study integrates them into a singular framework where physical design interventions (placemaking) are evaluated through their ability to enhance user "readability" (spatial perception), which ultimately fosters a heightened sense of communal security (urban design).

Additionally, participatory workshops engaged local communities, municipal authorities, and urban design professionals to explore the socio-cultural dimensions of alley usage. These workshops incorporated focus group discussions, participatory mapping, semi-structured interviews, community feedback forms, and interactive design charettes to gather diverse perspectives.

Case Selection

A qualitative observational study was conducted in five revitalised alleys across two key areas in Kuala Lumpur where five alleys were selected as the basis for fieldwork due to their varying degrees of placemaking efforts, visibility, and physical interventions: 1) Central Market Area: i) Lorong Panggung, ii) Lorong

© 2026 by MIP

Bandar 21, and iii) Kwai Chai Hong. And 2) Bukit Bintang Area: i) Jalan Rembia Street Art, and ii) Wall Art Changkat Art Lane.

Each of these revitalised alley cases provides varying degrees of wayfinding clarity, artistic expression, and public accessibility, making them suitable comparative examples for examining the impact of placemaking and urban storytelling within limited city spaces. To increase cognizance of alleys for community safety, observations were aligned with the theoretical domains using specific indicators:

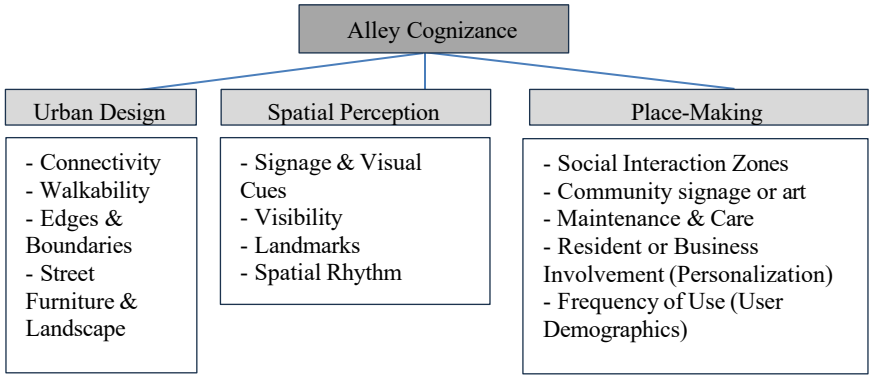


Figure 1: Indicators of Alley Cognizance for the Five Selected Alleys
Source: Author's Record (2025)

These indicators served as the foundation for site assessments, complemented by participatory workshops with local residents and businesses to explore their perceptions, behaviours, and feedback. Thus, to ground these theories in reality, field observations were conducted across five purposively selected alleys in Kuala Lumpur, categorized into two primary clusters: the Central Market Area (Lorong Panggung, Lorong Bandar 21, and Kwai Chai Hong) and the Bukit Bintang Area (Jalan Rembia Street Art and Wall Art Changkat Art Lane). These sites were selected due to their varying degrees of placemaking maturity and visibility, offering a rich comparative landscape for examining urban storytelling. Observations were structured around specific indicators of alley cognizance, using tools such as spatial mapping, pedestrian flow tracking, and environmental audits. This empirical data provided a "tangible" map of how spatial rhythm and physical legibility influence how a space is navigated.

The "intangible" dimensions of the research were captured through participatory workshops, which served as a bridge between professional planning and local lived experience. Participants were selected via purposive sampling to

ensure a balanced representation of three distinct cohorts: local residents and business owners (primary users), municipal authorities from DBKL (policy enforcers), and urban design professionals (technical experts). These workshops employed interactive design charettes and participatory mapping to collect qualitative data on user perceptions, emotional resonance, and cultural identity. By identifying specific "comfort zones" and "blind spots" through community feedback, these sessions directly influenced the development of the branding and wayfinding framework, ensuring that proposed navigational cues are rooted in the community's collective memory and cultural context.

The resulting data were synthesized through a dual-lens analytical framework that balances "Alley Cognizance" with "Community Safety." The first lens emphasizes the readability of the space –the degree to which an alley is recognizable and understandable –while the second lens focuses on user perception, evaluating whether individuals feel oriented and secure. By integrating these two perspectives, the research provides a comprehensive understanding of how both tangible design interventions and intangible community values shape the performance of revitalized alleys within an urban Islamic context. This integrative approach ensures that the findings are not merely architectural observations, but a reflection of the socio-cultural pulse of the city.

Analytical Framework

The analysis was performed through a dual-lens framework:

Table 3: Dual-lens Analytical Framework

Category	Description
Alleys' Cognizance	Emphasizing on "readability" of the alley – the degree to which an alley space is recognizable, understandable, and navigable by its users, visibility, physical legibility, spatial rhythm, and pedestrian accessibility.
Community Safety	Informed through the lens of user perception (perceived safety) which is shaped by user experience, whether they feel oriented, informed, and secure navigating the alleys–approachable, familiar, and trusted, thus contributing to a stronger sense of communal security.

This integrative framework enables a comprehensive understanding of how both tangible design and intangible values shape the perception and performance of revitalised alleys within an urban Islamic context.

ANALYSIS AND DISCUSSION

Field Observation

The selected sites consist of two main clusters: the Bukit Bintang art lanes (Jalan Rembia and Changkat Street Art) and the Central Market alleys (Lorong Panggung, Lorong Bandar 21, and Kwai Chai Hong).

© 2026 by MIP

Generally, the alleys in Kuala Lumpur and these two specific areas are well-connected. Most of the alleys in these locations fall within the 'collector' category (Nizar, 2020), referring to routes that gather numerous streets and link them to other main roads in the hierarchy. They serve as primary local distributors to their immediate surroundings and connect deeper routes to arterial junctions, making them more connective rather than isolated or separate from the network. This illustrates the immense potential of implementing a rejuvenation strategy for a network of alleys that enable visitors to explore the city in a more intimate atmosphere through the alleys – aligning with the field observation findings, these alleys primarily serve as tourist attractions rather than everyday urban routes.

Bukit Bintang's alleys focus mainly on art-led revitalisation, showcasing vibrant murals but minimal infrastructural upgrades beyond surface-level aesthetics. Conversely, the Central Market cluster demonstrates a wider variety of design approaches, with more consideration given to the context. While Lorong Bandar 21 suffers from poor maintenance, Lorong Panggung incorporates cultural motifs within its Indian temple context, and Kwai Chai Hong functions as a well-planned space with coordinated furnishings and activity-driven spatial design. Despite these revitalisation efforts, the absence of a unified visual identity and lack of navigational aids hinders their effectiveness in fostering alley recognition and enhancing overall community safety.

Urban Design

As seen in Figure 2, both Bukit Bintang and Central Market show a solid underlying network of physical connections, but this is weakened by a lack of visual cues. In Bukit Bintang, surface upgrades and aesthetic improvements through murals are noticeable; however, the absence of directional signs, consistent paving, and clear thresholds creates a disjointed experience. The alleys feel like isolated pockets rather than an interconnected system. In the Central Market area, the alleys are in mixed condition: Kwai Chai Hong stands out with thoughtful activity-based design and quality street furniture, while Lorong Bandar 21 remains poorly maintained, reducing its potential as a safe and accessible route. These inconsistencies highlight how design interventions, when not planned holistically, fail to convey the continuity and purpose of alley networks, thereby limiting their effectiveness in improving both awareness and community safety.

© 2026 by MIP

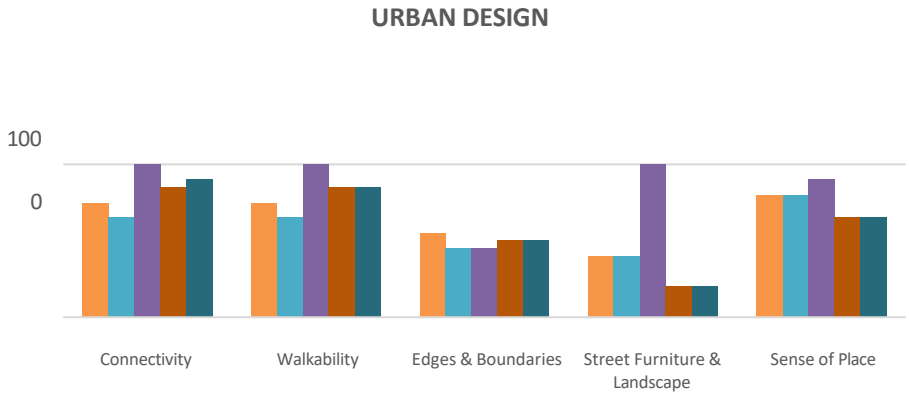


Figure 2: Urban Design Elements of Five Selected Alleys
Source: Author's Record (2025)

Spatial Perception

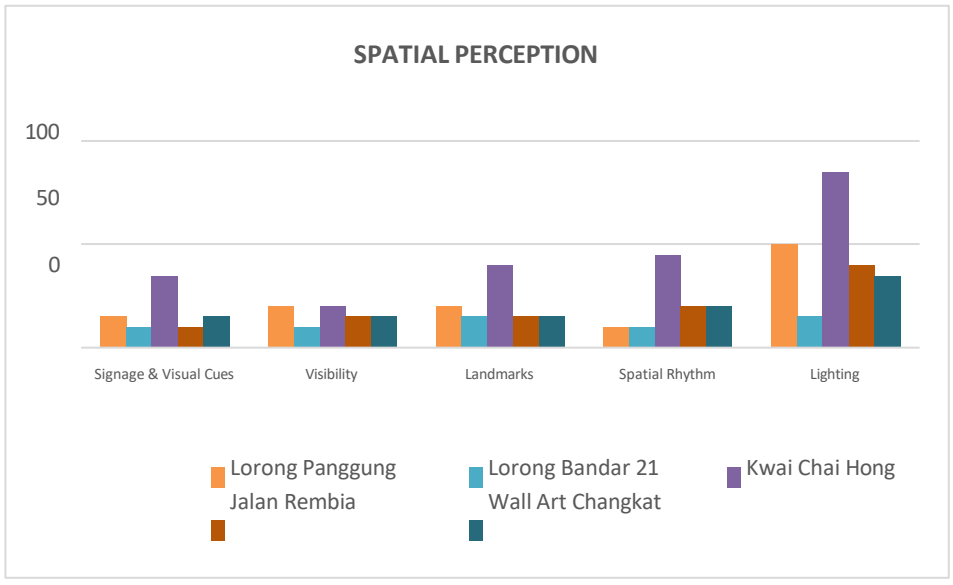


Figure 3: Spatial Perception of Five Selected Alleys
Source: Author's Record (2025)

Similarly, spatial perception, as shown in Figure 3, in both Bukit Bintang and Central Market alleys is severely hindered due to the cumulative absence of key navigational and cognitive cues. Signage is often inconsistent or

© 2026 by MIP

entirely missing, and frequently generic and unhelpful, offering little guidance for unfamiliar users. It is recorded that only Lorong Bandar 21 has a signage indicating the alley's name at its entrance, but it is almost always obscured by vendors lining up along the boundary of the space. Other alleys lack any signage showing their names, and there is very little signage providing information about what occurs inside the alleys.

Landmarks such as distinctive lighting fixtures, archways, or culturally symbolic art pieces are important for anchoring spatial memory, which are seldom used or poorly placed. Entrances feel unwelcoming and lack clear indicators of direction or connectivity, leading to confusion and discouraging exploration.

The studied rejuvenated alleys also lack a cohesive visual rhythm across surfaces, lighting, and materials, resulting in disjointed experiences that impair mental mapping with no clear indication of the end or their connection to the revitalised alleys nearby the selected ones. This widespread ambiguity reduces user comfort and fosters perceptions of these alleys as unsafe, unfamiliar, and socially disconnected from the surrounding urban environment, further discouraging pedestrians from using them or perceiving them positively.

Place-Making

Interestingly, place-making data of the five selected alleys shown a more diverse read. While Bukit Bintang art lanes are visually striking due to their vibrant murals, they lack opportunities for meaningful public interaction. The absence of social spaces such as benches, shaded areas, or communal gathering zones greatly limits social engagement, reducing the alleys to mere backdrops for photographs.

Central Market alleys show a greater sense of personalisation, with local cultural elements incorporated into shopfronts and decorations. However, they also suffer from insufficient infrastructure to support stationary social activities. There are few, if any, designated zones for lingering, communal exchange, or informal use by residents and visitors alike. As a result, people tend to pass through these alleys quickly, viewing them as visual attractions rather than integral parts of their daily urban lives. The significant absence of spatial-perception elements, such as clearly defined social spaces or interactive street furniture, contributes to the perception that these alleys are transient, decorative, and disconnected from the broader aims of community building and everyday utility.

© 2026 by MIP

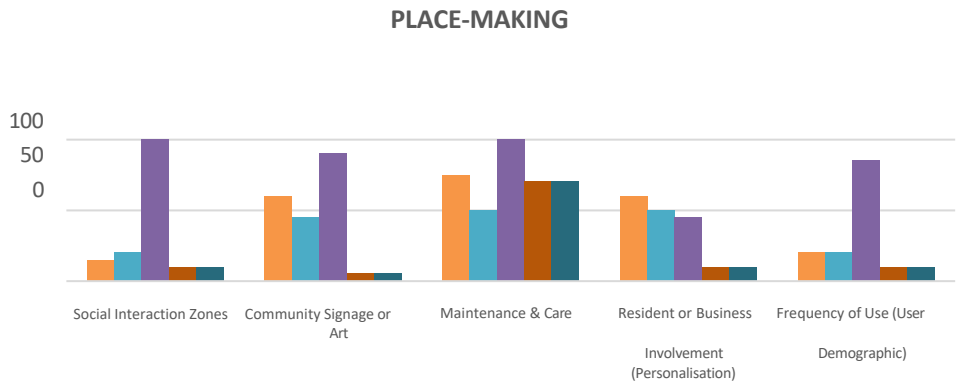


Figure 4: Place-Making of Five Selected Alleys
Source: Author's Record (2025)

Among the five selected rejuvenated alleys, Kwai Chai Hong appears to attract the highest number of users daily, comprising both visitors and residents. The graph in Figure 4 illustrates a correlation between social interaction zones and user frequency, where designated spaces for social interaction allow pedestrians and visitors to linger and explore the alleys comfortably. With more people lingering around and using them, the alley is perceived as safer and more comfortable to use. Furthermore, Kwai Chai Hong's larger scale, in terms of urban design (as shown in Figure 2), spatial perception (as shown in Figure 3), and place-making (as shown in Figure 4), contributes to a higher user frequency compared to the other alleys.

Participatory Workshop Insights

To supplement the site observations, a community workshop was organised with residents from the Bukit Bintang and Central Market areas, specifically surrounding the selected revitalised alleys including residents, business owners, and frequent visitors, with local authorities also present. The aim was to gather direct feedback on the public's perception of revitalised alleys and the improvements they consider necessary.

Findings from the workshop revealed a recurring sentiment: most revitalised alleys currently serve more as attractions than as active parts of the urban circulation network. While residents recognised the visual enhancements and artistic value, many expressed that these spaces are not used for navigating or exploring the city, hence the low number of users. The participants pointed out that even during peak visitor hours, movement within the alleys is very limited, where they usually come just to take pictures and then leave without lingering or visiting the nearby businesses. The absence of furniture, landscapes, and greenery

© 2026 by MIP

was mentioned several times as the reason, alongside the lack of signage or information given to the visitors and users. Moreover, the alleys are mainly utilised by those already familiar with them, and even then, users highlighted their lack of convenience due to unclear connectivity and the absence of rest areas or social spaces.

Participants also felt that the revitalised alleys did not significantly benefit local businesses or reflect the local culture. Where cultural expression was present, it was seen as insufficient or superficial. The most critical concern voiced was the lack of ownership and identity, where residents felt that the alleys did not belong to them, as they lacked names, narratives, or any reflection of the community's heritage. Instead, the alleys felt staged for outsiders, serving decorative purposes without fostering a genuine sense of pride or belonging.

Key Elements for Wayfinding and Branding Framework

Based on the workshop insights, several key elements emerged as essential for inclusion in any future alley revitalisation framework or guideline:

Table 4: Key Elements for Wayfinding and Branding Framework

Category/ Element	Description / Offences
Naming & Identity	Clearly defined alley names that reflect either connectivity, specific activities, or historical context. Participants noted that generic names such as "Street Art" fail to communicate place identity or cultural value, often reducing the alleys to superficial attractions.
Comprehensive Signage & System	A wide range of signage is needed; directional signs to show pathways, informational signs to indicate functions and nearby landmarks, and contextual signs to explain history or purpose, all strategically placed throughout the alley network.
Cohesive Visual Cues & Branding	Establishing a cohesive visual identity using color schemes, repeated motifs, or symbolic references tied to local heritage. These visual strategies should also reinforce connectivity between different alleys, forming a unified system rather than isolated interventions.
Anchoring Landmarks	The use of physical markers such as gateway arches, symbolic sculptures, or thematic lighting to clearly indicate the start and end of alley journeys, aiding memory and orientation.
Mapping Tools Integration	On-site map boards, printed brochures, and digital tools to communicate connectivity, functions, and destination points effectively to both locals and visitors. Integrating digital and interactive mapping tools such as Augmented Reality (AR), Virtual Reality (VR) and QR codes as part of gamification in exploring the city and alleys were mentioned to be highly desirable by the residents.

Category/ Element	Description / Offences
Supportive infrastructure	The inclusion of street furniture, landscaped areas, and proper lighting to support stationary activities and encourage informal social interaction. These elements help activate the alley space and improve perceptions of comfort and safety, with Kwai Chai Hong serving as a notable benchmark.

Source: Tabulated by Author (2025)

These key elements as tabulated in Table 4 are identified as crucial to include, if not as the starting point, for rejuvenating efforts in revitalising alleys in densely populated areas like Kuala Lumpur. The feedbacks from the workshop align with the observation where Kwai Chai Hang receives a high number of users, with almost all of the key elements present in the alley, demonstrating the potential for revitalised alleys to be fully utilised by visitors exploring the city and to foster a sense of belonging for locals when implementing the framework.

It is also shown that rejuvenation efforts for alleys need to be approached as a network and planned accordingly, even if the alleys are developed in phases or by different stakeholders individually. With the installation of wayfinding and branding frameworks, the rejuvenated alleys will not feel fragmented or disjointed, but instead will be more recognised, visible, used, and perceived as safe and comfortable spaces to utilise through the cohesive visual and wayfinding elements in the alley networks.

RECOMMENDATIONS FOR FURTHER STUDY

While this research provides a foundation for revitalizing alleys in Kuala Lumpur, there are two key areas that deserve further exploration to ensure these strategies work long-term and in different places.

First, there is the question of scalability. Every city has its own unique "DNA," and what works in the heart of Kuala Lumpur might need to be adapted for the historic lanes of George Town or the busy industrial corridors of Jakarta. Future research should test this "Alley Cognizance" framework in other urban environments with different socio-cultural backgrounds. This would help determine if the way people perceive safety and navigation is a universal human response or if it's heavily shaped by local traditions and architecture.

Second, the economic factors behind these projects need closer look. Design ideas are essential, but the reality of implementation often comes down to funding. It would be valuable to explore how different financial models—whether they are city-led grants, private investments, or community crowdfunding—impact how the framework is actually put into practice. Understanding the link between a project's budget and its social success will help planners move from small-scale "art lanes" to sustainable, city-wide urban networks.

© 2026 by MIP

CONCLUSION

The key elements listed in Table 4 are essential for alley awareness—the public's ability to perceive, use, and feel safe within these spaces. When alleys are designed with clear form, pedestrian-friendly infrastructure, and cultural identity, they change from neglected back-ways into valued connectors and community areas. This change boosts perceived safety, promotes frequent use, and encourages local stewardship, creating positive cycles of community involvement and resilience.

Moreover, widespread negative perceptions of alleys often stem from a combination of factors, including anecdotal hearsay, harmful media portrayals, and isolated negative experiences that influence public opinion. These perceptions not only affect individual behaviour but also create systemic barriers that hinder investment in and use of these important urban areas (Ellis, 2022). Studies suggest that improving spatial understanding and implementing effective wayfinding strategies could significantly reduce these concerns and encourage a more positive interaction with alley environments.

Learning from existing successful revitalisation projects, Successful revitalization projects show that the best results come from a structured plan rather than random upgrades. Instead of treating alleys as isolated shortcuts, these initiatives integrate them into a larger urban network by focusing on safety, community involvement, and clear identity. By using tools like consistent branding, better navigation, and dedicated social spaces, these projects make the environment easier to understand. This "readability" reduces spatial anxiety and significantly boosts how safe and welcome people feel in the space.

ACKNOWLEDGEMENT

This research is supported by Universiti Sains Islam Malaysia (USIM) through the Geran Kumpulan Penyelidikan (KUP) USIM **(PPPI/KUP/FKAB/USIM/14223).**

This research was funded by the Ministry of Higher Education (MOHE) under the Fundamental Research Grant Scheme Early Career Researcher (FRGS-EC) with reference number **FRGS-EC/1/2024/SSI12/USIM/02/1.**

REFERENCES

Arthur, P., & Passini, R. (2002). *Wayfinding: People, signs, and architecture*. McGraw-Hill.

Askarizad, R., Heidari, A. A., & Khalili-Araghi, S. (2024). Configuration analysis of alleyways in Mediterranean cities and their impact on urban mobility. *Journal of Urban Planning and Development, 150*(1), 04023045. https://doi.org/10.1061/JUPDDM.0000701

Borini, F. M., & Campioli, A. (2024). Community engagement in alley design: Evaluating urban micro-spaces for social sustainability. *Journal of Urbanism, 17*(2), 143–160. https://doi.org/10.1080/17549175.2023.2259175

City of Bellingham. (2021). Reactivating Downtown Alleys. https://cenv.wwu.edu/files/2022-11/2021%20ReActivating%20Downtown%20Alleys%20-%20City%20of%20Bellingham.pdf

City of Los Angeles, Department of City Planning. (2020). Urban Design Principles. https://planning.lacity.gov/odocument/3198c428-4cba-49eb-8155-c302d12b177a/UrbanDesignPrinciples.pdf

Clarion Alley Mural Project. (2024). Retrieved from https://clarionalleymuralproject.org

Crociati, J., & KoDA, M. (2020). The Space Between. University of Miami, School of Architecture. https://www.arc.miami.edu/_assets/pdf/the-space-between_jake-crociati_koda.pdf

Ellis, C. (2022). Urban infrastructure and the perception of neighbourhood. *Urban Studies Journal*. Retrieved from https://www.researchgate.net/publication/375281650_Urban_Infrastructure_and_the_Perception_of_Neighbourhood

Global Designing Cities Initiative. (2024). Case study: Laneways of Melbourne, Australia. In *Global Street Design Guide*. Island Press. Retrieved from https://globaldesigningcities.org/publication/global-street-design-guide/streets/pedestrian-priority-spaces/laneways-and-alleys/case-study-laneways-of-melbourne-australia/

HCMA Architecture + Design. (2024). Vancouver's Awesome Alleys: A five-year strategy. HCMA. Retrieved from https://hcma.ca/wp-content/uploads/2024/07/Vancouvers-Awesome-Alleys-Strategy-Report.pdf

Hölscher, C., Meilinger, T., Vrachliotis, G., Brosamle, M., & Knauff, M. (2013). Up the down staircase: Wayfinding strategies in multi-level buildings. *Journal of Environmental Psychology, 33*, 103–114. https://doi.org/10.1016/j.jenvp.2012.10.002

Institute of Transportation Engineers. (2010). *Designing walkable urban thoroughfares: A context-sensitive approach* (Recommended Practice). ITE. https://www.naturewithin.info/Roadside/ITE%20Walkable%20Urban%20Streets.pdf

Jung, S. J., Lee, M. K., & Kim, H. J. (2021). Strategies for alley regeneration in Seoul: Focusing on lighting and symbolic design elements. *International Journal of Urban Sciences, 25*(3), 457–474. https://doi.org/10.1080/12265934.2020.1860519

Lynch, K. (1960). *The image of the city*. MIT Press.

Montello, D. R. (2005). Navigation. In P. Shah & A. Miyake (Eds.), *The Cambridge handbook of visuospatial thinking* (pp. 257–294). Cambridge University Press.

Nasar, J. L., & Jones, K. M. (1997). Landscapes of fear and stress. *Environment and Behavior, 29*(3), 291–323. https://doi.org/10.1177/001391659702900301

Papaioannou, O., Papagiannakis, A., & Hatziprokopiou, P. A. (2020). Mental maps and representations of the city centre of Thessaloniki: Inhabitants' perceptions and

© 2026 by MIP

stereotypes of the urban landscape and daily mobility. *European Journal of Geography, 11*(4), 22–35. https://doi.org/10.48088/ejg.o.pap.11.4.22.35

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 495 – 509

PILOT STUDY FINDINGS ON MULTI-GENERATIONAL HOUSING ENVIRONMENT PREFERENCES FEATURES FOR QUALITY OF LIFE AND ACTIVE AGEING IN MALAYSIA

Hafiszah Ismail[1], Kushairi Rashid[2], Nor Rima Muhamad Ariff[3], Mariam Felani Shaari[4] and Aifaa Nur Syahirunnisaa Zakariya[5]

[1,2,3,4,5]*Faculty of Built Environment,*
UNIVERSITI TEKNOLOGI MARA (UiTM), SHAH ALAM

Abstract

The rise in Malaysia's ageing population has increased the need for housing environments that can support both ageing in place and multi-generational living. This study aims to assess the reliability of a newly developed framework that focuses on the features of housing environments which contribute to the quality of life for the active ageing community. A pilot study was conducted to assess the internal consistency of the survey instrument, which was developed based on physical and social housing features identified through an in-depth literature review. A total of 31 respondents from different generational groups in Shah Alam participated in the study. The findings showed strong internal reliability across most sub-features, including Accessibility and Walkability, Communal Areas, Assisted Technology Integration, Community Engagement, and Health and Well-Being. However, the Personal Privacy sub-features revealed a lower reliability score. Overall, the results demonstrate the instrument's potential to guide a better housing design, policy making, and further research in creating inclusive, age-friendly environments that support intergenerational connection and support active ageing.

Keywords: Multi-Generational, Housing Preferences, Quality of Life, Active Ageing, Reliability Analysis

[1] Corresponding author. Email: hafiszah@uitm.edu.my

INTRODUCTION

Malaysia is experiencing a significant demographic transition, with the proportion of the elderly aged 60 years and above expected to double by the year 2040 (DOSM, 2020; Aclan et al., 2023). This shift brings important implications for housing and urban development, particularly in ensuring that older adults can age safely, comfortably, and actively within their communities. The World Health Organisation (2020) has emphasised the importance of the active ageing concept that promotes continued participation, health, and security in later life. A key element of active ageing lies in the suitability of the living environment, especially as more families across Malaysia adopt multi-generational housing arrangements due to cultural traditions, rising living costs, and limited urban housing options (Arshard et al., 2023).

Living with multiple generations under one roof offers many benefits, such as emotional support, caregiving convenience, and shared expenses. However, it also introduces challenges, particularly in ensuring that the home environment meets the diverse needs of different age groups, especially for the elderly (Gawlak et al., 2021). For older residents, issues such as safety, accessibility, privacy, and opportunities for social interaction become crucial considerations (Aripin et al., 2024). Although various studies have explored general features of elderly-friendly housing, there remains a lack of specific, evidence-based understanding of which housing characteristics contribute most to quality of life in a multi-generational context. This can be supported by a previous study by Bahuri et al (2022) on a deficiency in awareness regarding active ageing among the population, which may negatively impact various domains of the quality of life, including physical, psychological, social relationships, and environmental factors.

The objective of this study is to validate a framework of housing environment preferences aimed at supporting the quality of life for the active ageing community in Malaysia. By focusing on both physical and social features of the housing environment, the study offers a structured instrument that can guide future research, inform design practices, and shape age-inclusive housing policy.

LITERATURE REVIEW

The Generations

Generations can be defined as cohorts of persons or separate groups of the population that can be differentiated by the year they were born (Ismail et al., 2020). Each cohort is subject to unique life events that impact their perspective of the world. It is important to understand that each generation's perceptions and attitudes provide valuable insights into societal trends and their consumer

behaviours for fostering intergenerational understanding and collaboration in addressing contemporary challenges (Vuković, 2023). Thus, this study attempts to review Malaysia's generations with four age groups as referenced by Ismail et al., (2020), namely, Baby Boomers (1946-1961), Generation X (1962-1976), Millennials or Generation Y (1977-1991), and Generation Z (1992-2006) due to sharing a common research context, i.e. housing environment. Table 1 shows different terms and names used to represent each cohort group across different authors.

Table 1: Generations Classification

Authors	Generations Name	Year Born
Reed & Conisbee., (2006). Ismail et al., (2020)	Baby Boomers	1946 – 1961
	Generation X/Gen-X	1962 – 1976
	Generation Y/Gen-Y	1977 – 1991
	Generation Z/Gen-Z	1991 – 2006
Fuchs et al., (2024)	Baby Boomers	1946 – 1964
	Generation X	1965 – 1980
	Generation Y/Millennials	1981 – 1995
	Generation Z/iGen/Centennials	1996 – 2012
National Human Resources Centre, (2022); The Centre for Generational Kinetics (2024)	Silent Generations/Traditionalist	Before 1946
	Baby Boomers	1946 – 1964
	Generation X	1965 – 1976
	Generation Y/Millennials	1977 – 1995
	Generation Z/iGen/Centennials	1996 and after/2015

The Concept of Quality of Life

The World Health Organisation defines Quality of Life (QoL) as "an individual's view of life concerning his or her objectives, aspirations, standards, and worries, and in the context of the culture and value system in which he or she lives". As people grow older, their QoL is closely related to their levels of independence, autonomy, and healthy life expectancy (Lak et al., 2020). QoL is also commonly linked with Health-Related Quality of Life (HR-QoL) due to its efforts for achieving optimal health status (Bujang et al., 2023). This concept has recently been used to guide policy for ageing in many Southeast Asian communities, including the Malaysian government, which has actively supported several initiatives for healthy living, especially in the health sector (Loke et al., 2020).

Active Ageing Community

Successful ageing, productive ageing, and healthy ageing are other terms that are often used with "active ageing" due to their definitions that overlap with each other (Nassir et al., 2015; Paul et al., 2012; Chalise, 2023). In 2002, the World Health Organisation (WHO) defined "active ageing" as "the process of optimising

© 2026 by MIP

opportunities for health, participation, and security to enhance the quality of life as people age". Active ageing is a holistic approach that encourages older individuals to remain physically active, socially engaged, and economically productive. As people age, relocation and housing transition have become significant issues in consideration of Ageing in Place, AIP (Chou & Kröger, 2022). This concept is indirectly beneficial in maintaining physical health, mental well-being, and social connections to ensure a fulfilling life in later years.

Housing Policies for the Elderly

In Malaysia, the increasing trend of the ageing population has led the government to introduce various policy initiatives to improve the quality of life for the ageing population. The National Policy for Older Persons and the accompanying National Plan of Action highlight the significance of active ageing, where older persons need to have the ability to live independently in society. Within the policy guidelines, the housing environment is considered to play a vital role in supporting the concept of ageing in place. Previous studies have indicated the significance of the housing environment in supporting the quality of life for elderly in the country. For example, housing environment is considered to be an essential factor in supporting the quality of life for older people in the country (Ismail et al., 2020; Arshard et al., 2023). Despite the policy initiatives undertaken by the government to improve the quality of life for the ageing population in the country, limited studies have been conducted to investigate the significance of the housing environment in supporting multi-generational living arrangements for the ageing population.

Multi-Generational Housing Environment Preferences Features for Quality of Life and Active Ageing

The development of this framework was created using Arksey and O'Malley's (2005) scoping review methodology. This method also allows the inclusion of many different research designs, which suits the aim to give an overview of the Multi-Generational Housing Environment Preferences Features for Quality of Life (QoL) and Active Ageing. The physical features focus on designs that enhance the activities generated within the daily living routine, the ability to afford and facilitate daily life in the community; the ability to conduct day-to-day activities in place, diversity in keeping habitual lifestyle, and connectivity with social network (Ling et al., 2023). While social features focus on fostering community engagement, trust, and mutual support among residents (e.g., interaction with neighbours, social activity participation, support from friends and community), to encourage place attachment, and contribute to life satisfaction (He & Jiang, 2023; Alipour & Meshkimi, 2024). The physical and social environment of the housing units and the surrounding neighbourhoods

would influence older adults' well-being by affecting their functional status (Nayak et al., 2023; Xu et al., 2024; Sharifi et al., 2024).

RESEARCH METHODOLOGY

This study employs a mixed-method approach, combining both qualitative and quantitative techniques through an exploratory sequential design to develop the framework of Multi-Generational Housing Environment Preferences Features for Quality of Life and Active Ageing in Malaysia. As part of the initial phase of this research, a pilot study was conducted to examine the reliability and validity of the quantitative survey instrument, which is essential in social science research to ensure data accuracy and consistency (Stewart, 2024). For this study, total of 31 respondents participated in the pilot study, which is considered adequate for the purpose of preliminary instrument testing. A pilot study typically uses a smaller sample size, which is often fewer than 30 respondents, for assessing the reliability of a questionnaire to preserve the larger population for the real survey (Bujang et al., 2024). Thus, the sample size is appropriate for measuring the reliability of the research instrument.

Although the study integrates both qualitative and quantitative methods, this paper specifically focuses on reporting the findings from the pilot study phase. The purpose of this pilot study is to refine and validate the questionnaire before the main data collection. Data collection for the pilot study was carried out from 1st to 20th April 2025 using an online survey via Google Form. A total of 31 respondents residing in Shah Alam participated in the study. The sample includes individuals from multiple generational cohorts, enabling a preliminary understanding of the variety of age in housing environment preferences.

RESULT AND FINDINGS

Respondents' Profile

A pilot study was conducted involving a total of 31 respondents to test the reliability and clarity of the research instrument. The respondents' profiles are summarised to provide context for the preliminary findings (Table 2).

Table 2: Respondents' Profile

Respondents' Profile		
Genders	**Frequency (*f*)**	**Percentage (%)**
Male	17	54.8
Female	14	45.2
Total	**31**	**100**
Generations		
Baby Boomer (1946 – 1961)	-	-

© 2026 by MIP

Respondents' Profile		
Generation X (1962-1976)	4	12.9
Generation Y (1977-1991)	4	12.9
Generation Z (1992-2006)	23	74.2
Total	**31**	**100**
Marital Status		
Never Married	21	67.7
Married	9	29.0
Separated	-	-
Divorced	1	3.2
Widowed	-	-
Total	**31**	**100**
Employment Status		
Self-employed	2	6.5
Government employee	9	29.0
Private employee	13	41.9
Unemployed	1	3.2
Retired	-	-
Students	6	19.4
Total	**31**	**100**
Household Income		
Category 1 (RM5,250 and below)	25	80.6
Category 2 (RM5,251 – RM11,819)	5	16.1
Category 3 (RM11,820 – above)	1	3.2
Total	**31**	**100**

The sample was 54.8% male (n=17) and 45.2% female (n=14), indicating a reasonably even gender distribution. The generational breakdown shows a dominant representation of Generation Z (1997–2009), comprising 74.2% of the total respondents. The remainder of the sample includes equal representation from Generation Y (1977–1996) and Generation X (1965–1976), each accounting for 12.9%, and the Baby Boomer cohort (born 1946–1964) was not represented at all, emphasising the youthful profile of the study. This youthful profile of respondents is consistent with the demographic trend in Shah Alam, which has a relatively young and growing population, driven by its status as an education hub and residential city for young families and working adults (Department of Statistics Malaysia, 2023).

In terms of marital status, 67.7% reported never having been married, 29.0% were married, and 3.2% indicated that they were divorced, documenting the sample's concentration of individuals in early life phases. Regarding employment, the largest segment was private sector workers, comprising 41.9%, followed by government employees with 29.0%. Students comprised 19.4% of the participants, and 6.5% were self-employed. Only one participant, with 3.2%

indicated unemployment, and none reported retirement, which again aligns with the sample's overall youthful character.

Household income data shows 80.6% identified with Category 1 (RM2,500 and below), pointing to a low-income demographic. A smaller segment, 16.1%, reported earnings within Category 2 (RM2,501–RM11,580), and a single respondent, 3.2% classified in Category 3 (RM11,580 and above). This income pattern reinforces the presence of students and those in the early stages of their careers within the sample.

In summary, the pilot data show a mostly young, single, and low-income respondent base. While the pilot successfully tested the instrument's clarity and reliability, the generational gap suggests a need for thoughtful sampling strategies and approaches in the main study to ensure adequate representation from older adults, particularly those from the Baby Boomer cohort who are central to the investigation on active ageing.

Internal Consistency Reliability

To assess the reliability of the instrument, Cronbach's Alpha measurement was used in this pilot study. The instruments refer to the main features and sub-features for the framework of Multi-Generational Housing Environment Preferences Features for Quality of Life and Active Ageing in Malaysia, which was derived from the literature review. According to Mola & Shaw (2024), previous studies suggest a value range for Cronbach's alpha of 0.70, representing the reliability of the instrument. The internal consistency reliability of the items (Table 3) was measured by a Likert Scale between 1 (not relevant at all) and 5 (most relevant). The data collection entry was analysed using SPSS version 29.0 (IBM SPSS Statistics, 2022).

Table 3: Questionnaire Design of Likert Scale

Main features and Sub-features – The Framework of Multi-Generational Housing Environment Preferences Features of Quality of Life for Active Ageing Community in Malaysia		
Physical Features		
Sub-features	**Question**	**Items**
Accessible & Walkability	Q1	Entrance: Step-free entrances with ramp provision facilitate smooth and safe entry
	Q2	Entrance: Wide hallways to allow ease of movement for multiple users
	Q3	Entrance: Wide doorways are designed to provide seamless access
	Q4	Bathroom: Equipped with sturdy handrails
	Q5	Bathroom: The shower area is designed without curbs (curb-less area), reducing the risk of tripping
	Q6	Bathroom: Non-slip flooring to minimise the chances of slipping

© 2026 by MIP

Main features and Sub-features – The Framework of Multi-Generational Housing Environment Preferences Features of Quality of Life for Active Ageing Community in Malaysia		
Physical Features		
Sub-features	**Question**	**Items**
	Q7	Bathroom: Ample circulation space for wheelchair movement
	Q8	Bathroom: Toilets are elevated to an appropriate height to make sitting and standing easier, catering to the needs of the elderly
	Q9	Bathroom: Ramps are installed to ensure accessibility for those with mobility challenges
	Q10	Kitchen: Countertops, cabinets, and appliances are designed for easy access, ensuring comfort and safety while working.
	Q11	Kitchen: Non-slip flooring to minimise the chances of slipping
	Q12	Kitchen: Ample circulation space for wheelchair movement
	Q13	Staircase: Non-slip flooring materials and contrast design to prevent accidents and ensure stability
	Q14	Staircase: Handrails provided along the steps to reduce the risk of falls and make it more accessible
	Q15	Staircase: Wider stair treads (steps) offer more space for feet, reducing the risk of missteps
	Q16	Lighting: Adequate lighting to improve accessibility, ensure safety and comfort
Communal Areas	Q17	A spacious kitchen to encourage socialising and shared activities
	Q18	A spacious living room to encourage socialising and shared activities
	Q19	A spacious dining space to encourage socialising and shared activities
	Q20	Additional spaces (i.e., garden, patio, lounges, etc) to encourage socialising and shared activities
Personal Privacy	Q21	Extra space for a small pantry (kitchenette) for privacy and independence
	Q22	Additional private areas for relaxation or hobbies areas
Assisted Technology Integration	Q23	High-speed internet for ensuring seamless communication, access to online services, and smart home functionality
	Q24	Home alarm security systems ensure the safety of residents
	Q25	Emergency button to easily call for assistance during critical situations

Main features and Sub-features – The Framework of Multi-Generational Housing Environment Preferences Features of Quality of Life for Active Ageing Community in Malaysia		
Social Features		
Sub-features	**Question**	**Items**
Community Engagement	Q1	A social venue (i.e., community centre, multipurpose hall, etc) offering a comfortable and inclusive shaded space for intergenerational activities (i.e., gatherings, celebrations, or casual meetups).

Main features and Sub-features – The Framework of Multi-Generational Housing Environment Preferences Features of Quality of Life for Active Ageing Community in Malaysia		
	Q2	An outdoor environment (i.e., courtyard, garden, etc) designed to be accessible and engaging for all ages provides an enhancement of community connections.
	Q3	Shaded seating area to provide comfort and protection from the sun, allowing individuals to relax and socialise
Health & Well-being	Q4	Inclusive Playground: Sensory garden elements to create a therapeutic environment.
	Q5	Inclusive Playground: Sensory playground (i.e., playground and exercise equipment) for all ages and needs.
	Q6	Proximity to healthcare services to obtain medical care, monitor health conditions and provide treatment as needed.
	Q7	Mutual Support: Provide volunteer assistance and emotional support during challenging times.
	Q8	Mutual Support: Provide transportation when needed (i.e., appointments or social activities).
Accessibility & Walkability	Q9	Pathways: Wide pathway to ensure access and comfort for wheelchairs, strollers, and walkers.
	Q10	Pathways: Non-slip and flexible surfaces to provide stable and safe walking areas (i.e., Synthetic Flexi-Step Surfaces, Rubberised Mats).
	Q11	Pathways: Ramps with the provision of handrails for easy access.
	Q12	Separate mobility lanes for scooters, wheelchairs, and bicycles reduce conflicts with pedestrians, ensuring safer movement for older adults and children.
Safety & Security	Q13	A well-monitored CCTV surveillance system to prevent crime, ensuring resident safety, of communal and outdoor spaces.
	Q14	Adequate lighting in outdoor areas is essential to improve visibility at night and create a secure living environment for all age groups.
	Q15	Well-organised waste disposal system with designated recycling bins and scheduled garbage collection prevents hygiene-related issues, pests, and pollution.
	Q16	Strategic landscaping, noise barriers, and sound-absorbing materials help minimise external noise disturbances, creating a peaceful and comfortable outdoor environment for all residents.

The findings of this pilot study revealed that the overall instrument demonstrates excellent internal consistency, as evidenced by a Cronbach's Alpha value of 0.990 across 41 items (Table 4). The reliability analysis for Physical features (25 items) (Table 5) also shows a high value ($\alpha = 0.978$). Within this feature, the sub-features for Accessibility and Walkability (16 items) show strong reliability ($\alpha = 0.975$), while Communal Areas (4 items) also achieve acceptable reliability ($\alpha = 0.839$). On the other hand, Personal Privacy (2 items) records a low reliability score ($\alpha = 0.350$), indicating inconsistency among the items. It

© 2026 by MIP

reveals that the items may not adequately capture the construct due to the design structure of the items, which included mixed response formats such as both dichotomous (Yes/No) and ordinal (Likert scale), leading to distorted or misleading alpha values. This highlights a need for item refinement or expansion to enhance the measurement quality and statistical validity of the personal privacy sub-features. Lastly, Assisted Technology Integration (3 items) presents excellent internal consistency with $\alpha = 0.942$.

Table 4: Reliability Analysis for Overall

Reliability Analysis for Features - Overall					
Case Processing Summary				**Cronbach's Alpha**	**N of items**
Respondent			**%**		
Cases	Valid	31	100	.990	41
	Excluded	0	0		
	Total	31	100		

Table 5: Reliability Analysis for Physical Features

Reliability Analysis - Physical Features		
Sub-Features	**Cronbach's Alpha**	**N of items**
Accessibility and Walkability	.975	16
Communal Areas	.839	4
Personal Privacy	.350	2
Assisted Technology Integration	.942	3
Physical Features	**.978**	**25**

Meanwhile, for social features, the instrument also demonstrated excellent internal consistency, with an overall Cronbach's Alpha value of 0.988 across 16 items (Table 6). This indicates that the items used to measure the social features of the multi-generational housing environment are highly reliable. The sub-features for Community Engagement (3 items) showed a strong reliability score of $\alpha = 0.980$, reflecting the consistency of responses in measuring interactions and participation within the community setting. Health and Well-Being (5 items) also performed well with a Cronbach's Alpha of $\alpha = 0.952$, suggesting that the items successfully capture respondents' perceptions of health-related support, services, and psychological well-being within the housing environment. Similarly, Accessibility and Walkability (4 items) attained a reliability coefficient of $\alpha = 0.964$, indicating that social connectivity and ease of movement within the neighbourhood are being measured reliably.

Lastly, Safety and Security (4 items) demonstrated excellent internal consistency of α = 0.954, supporting the consistency of items related to perceptions of physical safety, protection from crime, and feelings of security in the housing context. These findings suggest that most of the instruments are reliable for measuring the constructs intended in this study.

Table 6: Reliability Analysis for Social Features

Reliability Analysis - Social Features		
Sub-Features	**Cronbach's Alpha**	**N of items**
Community Engagement	.980	3
Health and Well-Being	.952	5
Accessibility and Walkability	.964	4
Safety and Security	.954	4
Social Features	**.988**	**16**

ANALYSIS AND DISCUSSION

The pilot study participants were found to be predominantly younger in age, especially those belonging to Generation Z, as they formed 74.2% of the participants, while there were no participants from the Baby Boomer cohort in this paper. Such a demographic distribution may not allow the pilot study to fully reflect the housing environment preferences of older adults in Malaysia who are currently undergoing the ageing in place experience. Nevertheless, the main aim of a pilot study is not to obtain a representative demographic distribution of participants this study aims to explore housing environment preferences in relation to support active ageing in the future. Thus, the perspectives of younger generations are also considered relevant in this study. Individuals from Generation Z represent the future of ageing population, and their perspectives are considered to provide early insights into their future housing environment preferences in a multi-generational housing living arrangement. However, in this main study, a more targeted approach in obtaining participants will be undertaken to ensure a more balanced demographic distribution of participants, especially those from the Baby Boomer generation, in order to more closely reflect the perspectives of the active ageing community in Malaysia.

The pilot study findings provide essential insights into both the reliability of the instrument and the demographic context that may influence how respondents interpret the survey items. The overall reliability of the instrument was found to be excellent, with a Cronbach's Alpha score of .990 across 41 items, indicating a high level of internal consistency. This is further supported by strong reliability scores for both the physical features (α = .978) and social features (α =

© 2026 by MIP

.988) constructs. These results suggest that the items were clearly understood and consistently rated by respondents. However, Personal Privacy sub-features reported a lower Cronbach's Alpha of .350, indicating weak internal consistency. One potential explanation lies in the inconsistency of response formats, as the items included both dichotomous (Yes/No) and ordinal (Likert scale) response types. A mixed response structure likely contributed to distorted or misleading reliability values as seen in this case. To address this, the items should be revised to use a similar response format, ideally the Likert scale, to enhance the clarity, consistency, and reliability of the sub-construct in the main study.

CONCLUSION

This pilot study successfully analysed the framework of Multi-Generational Housing Environment Preferences Features to enhance the Quality of Life for the Active Ageing in Malaysia. By employing an exploratory sequential mixed-method approach, the research validated the proposed instrument through a pilot test involving 31 respondents from various generational groups in Shah Alam. The findings revealed excellent internal consistency across most of the housing environment features, particularly within the Physical (i.e., Accessibility and Walkability, Communal Areas, Personal Privacy, and Assisted Technology Integration) and Social features (i.e., Community Engagement, Health and Well-Being, Accessibility and Walkability, and Safety and Security). Sub-features such as Accessibility and Walkability, Communal Areas, Assisted Technology Integration, Community Engagement, and Health and Well-Being were found to be reliable, demonstrating their relevance in supporting inclusive, age-friendly, and multi-generational living environments. These findings emphasise the value of integrating both physical and social features into housing design to promote active ageing and improve the quality of life for diverse generational groups.

While the overall instrument showed high reliability, the Personal Privacy sub-feature recorded low internal consistency, highlighting the need for further refinement in questionnaire design to better reflect the needs of privacy in shared, multi-generational living environments. This feedback will guide minor revisions to enhance the consistency and relevance of the questionnaire before proceeding to the main study. The pilot study sample was mostly composed of younger respondents. This youth-dominant composition aligns with the demographic profile of Shah Alam, a city known for its large population of young working-age people, driven by its role as a commercial, administrative and educational hub. While this reflects the local context, it also reveals limitations in capturing the perspectives of older adults, particularly those approaching or experiencing ageing in place. Therefore, more attention will be given to including a wider range of age groups, especially older adults from the Baby Boomer generation, to ensure the framework truly reflects the real-life experiences and

housing preferences of Malaysia's ageing population in multi-generational living environments.

In the subsequent stage, a full-scale quantitative survey will be conducted using the revised instrument and a larger, more diverse sample. This will allow for further validation of the framework and strengthen its applicability across various socio-demographic contexts. Overall, the study aims to contribute meaningful insights that can guide future research, policy formulation, and housing design practices that respond to the challenges and opportunities of multi-generational living in an ageing Malaysian society.

ETHICAL CONSIDERATION

This study was conducted with established ethical standards for research involving human participants. Ethical approval was granted by the UiTM Research Ethics Committee under reference number REC/04/2025 (PG/MR/202). All respondents were fully briefed on the purpose and scope of the research, and informed consent was taken. Participation was entirely voluntary, with the option to withdraw at any time. Confidentiality protocols were maintained to ensure the privacy and anonymity of all respondents throughout the study.

ACKNOWLEDGEMENT

The authors wish to express their heartfelt gratitude to the Ministry of Higher Education for funding this research under the Fundamental Research Grant Scheme (FRGS) Grant No. FRGS/1/2023/SS10/UITM/02/24. Appreciation is also extended to the Research Management Centre (RMC) of Universiti Teknologi MARA (UiTM) for its valuable support in administering the grant. The authors further acknowledge the contributions and assistance of all individuals and institutions whose support has been provided throughout this study.

REFERENCES

Aclan, R., George, S., Block, H., Lane, R., & Laver, K. (2023). Middle aged and older adult's perspectives of their own home environment: A review of qualitative studies and meta-synthesis. *BMC Geriatrics*, *23*(1). https://doi.org/10.1186/s12877-023-04279-1

Alipour, S., & Meshkini, A. (2024). Dream housing: Exploring effective factors on housing livability in the neighbourhood from the perspective of residents. *Environmental Development*, *101067*. https://doi.org/10.1016/j.envdev.2024.101067

Aripin, D., Osman, M. M., Rabe, N. S., Shuhaimi, A. a. A., & Suaree, N. a. S. M. (2024). Residents' perception on management bodies' service deliverables: The case of

© 2026 by MIP

affordable strata housing in Klang Valley, Malaysia. *Planning Malaysia*, *22*. https://doi.org/10.21837/pm.v22i34.1597

Arshard, W. N. R. M., Samsudin, P. Y., Khamaruzaman, A. R., & Yusof, A. F. (2023, December 1). Satisfaction with elderly facilities in multigenerational family living in Kuala Lumpur. https://myjms.mohe.gov.my/index.php/ajress/article/view/24453

Bahuri, N. H. A., Rizal, H., Said, M. A., Myint, P. K., & Su, T. T. (2022). Active ageing awareness and quality of life among pre-elder Malaysian public employees. *International Journal of Environmental Research and Public Health*, *19*(15), 9034. https://doi.org/10.3390/ijerph19159034

Bujang, M. A., Lai, W. H., Hon, Y. K., Yap, E. P. P., Tiong, X. T., Ratnasingam, S., Kim, A. R. J., Husin, M., Jee, Y. Y. H., Ahmad, N. F. D., & Haniff, J. (2023). Measuring population health and quality of life: Developing and testing of the significant quality of life measure (SigQOLM). *Heliyon*, *9*(12), e22668. https://doi.org/10.1016/j.heliyon.2023.e22668

Bujang, M. A., Omar, E. D., Foo, D. H. P., & Hon, Y. K. (2024). Sample size determination for conducting a pilot study to assess reliability of a questionnaire. *Restorative Dentistry & Endodontics*, *49*(1). https://doi.org/10.5395/rde.2024.49.e3

Chalise, H. N. (2023). Healthy ageing: A basic concept. *Asian Journal of Population Sciences*, *2*(1), 124–128. https://doi.org/10.3126/ajps.v2i1.51096

Chou, Y. C., & Kröger, T. (2022). Ageing in place together: Older parents and ageing offspring with intellectual disability. *Ageing & Society*, *42*(2), 480-494. https://doi.org/10.1017/S0144686X20001038

Department of Statistics Malaysia. (2020). *Population projections, Malaysia, 2010–2040*.

Fuchs, O., Lorenz, E., & Fuchs, L. (2024). Generational differences in attitudes towards work and career: A systematic literature review on the preferences of generations X, Y and Z. *11*, 54-71.

Gawlak, A., Matuszewska, M., & Skórka, A. (2021). Housing expectations of future seniors based on an example of the inhabitants of Poland. *Buildings*, *11*(7), 305. https://doi.org/10.3390/buildings11070305

He, Z., & Jiang, C. (2023). Aging in place or institutionalization? A multiscale analysis of independent-living older adults from four large cities in China's Yangtze River Delta. *Innovation in Aging*, *7*(3). https://doi.org/10.1093/geroni/igad014

Ismail, H., Muhamad Halil, F., Zainan Abidin, A. W., & Hasim, M. S. (2020). The elderly (senior) housing preferences among generations in Malaysia. *Environment-Behaviour Proceedings Journal*, *5*(13), 145–154. https://doi.org/10.21834/e-bpj.v5i13.2102

Lak, A., Rashidghalam, P., Myint, P. K., & Baradaran, H. R. (2020). Erratum: Correction to: Comprehensive 5P framework for active aging using the ecological approach: An iterative systematic review. *BMC Public Health*, *20*, 101.

Ling, T., Lu, H., Kao, Y., Chien, S., Chen, H., & Lin, L. (2023). Understanding the meaningful places for aging-in-place: A human-centric approach toward inter-domain design criteria consideration in Taiwan. *International Journal of Environmental Research and Public Health*, *20*(2), 1373. https://doi.org/10.3390/ijerph20021373

Loke, Y. J., Lim, E. S., & Senadjki, A. (2020). Health promotion and active aging among seniors in Malaysia. *Journal of Health Research*, *35*(5), 444–456. https://doi.org/10.1108/jhr-07-2019-0148

Mola, D. W., & Shaw, D. (2024). Assessing the reliability of the talent development environmental questionnaire: A pilot study. *International Journal of Research - GRANTHAALAYAH*, *12*(3). https://doi.org/10.29121/granthaalayah.v12.i3.2024.5584

Nassir, S., Leong, T. W., & Robertson, T. (2015). Positive ageing: Elements and factors for design. In *Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction* (pp. 264–268). https://doi.org/10.1145/2838739.2838796

National Human Resource Centre. (2022, June 29). *A guide to multigenerational workforce*. https://nhrc.com.my/resource-centre/a-guide-to-multigenerational-workforce/

Nayak, S. R., Dash, S. P., Amin, P. S., & Priyashantha, K. G. (2023). A review on intergenerational cohousing: A possible living option for elderly and youth. *New Design Ideas*, *7*(3), 535-556.

Paúl, C., Ribeiro, O., & Teixeira, L. (2012). Active ageing: An empirical approach to the WHO model. *Current Gerontology and Geriatrics Research*, *2012*, 382972. https://doi.org/10.1155/2012/382972

Reed, R. G., & Conisbee, N. (2005). Identifying linkages between generations and community development - the effect on residential and retail property. ResearchGate. https://www.researchgate.net/publication/242673472_Identifying_linkages_between_generations_and_community_development__the_effect_on_residential_and_retail_property

Sharifi, S., Mosafer, H., Rahmati, M., Khorzoughi, K. B., & Parandeh, A. (2024). Dwelling characteristics and mental well-being in older adults: A systematic review. *Heliyon*, *e37676*. https://doi.org/10.1016/j.heliyon.2024.e376

Stewart, L. (2024, December 6). Purposive sampling in qualitative research. ATLAS.ti. https://atlasti.com/research-hub/purposive-sampling

Sundram, S., & Romli, N. (2023). A pilot study to test the reliability and validity of the research instrument. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *8*(3), e002149. https://doi.org/10.47405/mjssh.v8i3.2149

Vuković, M. (2023). Generational differences in behavioral factors affecting real estate purchase intention. *Property Management*, *42*(1), 86–104. https://doi.org/10.1108/pm-11-2022-0088

World Health Organization. (2020). *Decade of healthy ageing: 2020–2030*. https://www.who.int/initiatives/decade-of-healthy-ageing

Xu, S., Zhang, T., Fukuda, H., He, J., & Bao, X. (2024). Comprehensive study of residential environment preferences and characteristics among older adults: Empirical evidence from China. *Buildings*, *14*(7), 2175. https://doi.org/10.3390/buildings14072175

Received: 11th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 510 – 524

SMART HOME FEATURES TO ENHANCE ELDERLY WELL-BEING AND QUALITY OF LIFE IN MALAYSIA: A SCOPING REVIEW

Hafiszah Ismail[1], Aida Wati Zainan Abidin[2] and Noor Harzana Harrun[3]

[1]*Faculty of Built Environment,*
[2]*Faculty of Computer and Mathematical Science,*
UNIVERSITI TEKNOLOGI MARA (UiTM), SHAH ALAM
[3]*Klinik Kesihatan Bestari Jaya,*
MINISTRY OF HEALTH MALAYSIA, BESTARI JAYA

Abstract

This paper examines smart home features designed for elderly-friendly housing environments, aiming to improve the quality of life and well-being of older adults through technology. Using Arksey and O'Malley's (2005) scoping review framework, 9 peer-reviewed studies published between 2021 and 2025 were systematically reviewed. The findings categorise smart home features into five key themes: (1) Safety and Security, (2) Health Monitoring, (3) Comfort and Accessibility, (4) Social and Cognitive Well-Being, and (5) Energy Efficiency. The review emphasises the significance of designing a housing environment with the integration of technologies that are adaptable to the physical, psychological, and social needs of elderly users. This paper provides a current synthesis of smart home research related to ageing populations. It offers a framework that can guide housing design, innovation, and policy, and user-centred design practices in ageing societies. Although not limited to a single country, the findings are especially relevant for rapidly ageing societies like Malaysia. Further validation from domain experts and stakeholders is needed to confirm the relevance and applicability of the identified smart home features in actual implementation contexts.

Keywords: Smart home technology, Quality of Life, Well-being, Elderly, Scoping review

[1] Corresponding author. Email: hafiszah@uitm.edu.my

INTRODUCTION

Malaysia is experiencing a significant demographic shift, with the elderly population expected to reach 15.3% by 2030, qualifying the country as an "aged nation" (Jailani et al., 2023). According to WHO projections on an ageing population, these demographic changes make the development of elderly-friendly environments more critical than ever (WHO, 2024). As the ageing population grows, so does the urgency to develop living environments that ensure safety, independence, and improved quality of life and overall well-being as they age (Tu & Zhou, 2025). Ageing in place, supported by assistive technologies, has become a preferred approach due to its benefits in autonomy and emotional well-being.

Effective implementation of smart home technology in Malaysia requires consideration of unique socio-cultural factors, affordability, and the digital readiness of the elderly. Wearable and IoT-based devices designed for the Malaysian context have already demonstrated promising results in reducing energy costs and enhancing user control of home appliances, reflecting the feasibility of scalable, elderly-friendly smart solutions (Zaman et al., 2021; Phua et al., 2021).

In Malaysia, studies have shown that the elderly place high importance on emergency contact systems and basic home automation, which are among the most desired smart features in senior-friendly living spaces (Tan et al., 2021). Indirectly, it lines up with the Malaysian government's smart city and ageing policy initiatives to support the development of inclusive smart environments aligned with sustainable development goals (Jailani et al., 2023). These systems are increasingly seen as part of holistic strategies to support independence and well-being in later life.

This paper aims to explore how smart home features can be tailored to the elderly's quality of life and well-being. The main findings on the significant smart home features for the elderly: (1) Safety and Security, (2) Health Monitoring, (3) Comfort and Accessibility, (4) Social and Cognitive Well-Being, and (5) Energy Efficiency, contributes to extension of knowledge on ageing-in-place and elderly quality of life in specifically. This finding innovates future-ready design elements for the elderly-friendly housing environments that align with the Sustainable Development Goals on Smart Cities.

Although the previous studies have explored on how to use the smart technologies for elderly, there are several gaps remain in the existing literature. From the review, many studies mostly focus on the technical development of smart devices rather than examining how these technologies contribute to the overall well-being and quality of life of elderly individuals. In addition, the existing literature often investigates individual technologies such as health monitoring systems or security devices without providing a comprehensive

© 2026 by MIP

synthesis of smart home features that support ageing in place. The literature has also focused on international contexts without a critical analysis of the relevance of smart home technologies for the ageing population of Malaysia. Therefore, a scoping review is required to synthesise on current research and identify key smart home features that can enhance elderly well-being and quality of life, particularly in the context of elderly-friendly housing environments.

LITERATURE REVIEW

Smart Home Technologies for the Elderly

Smart home technologies provide significant benefits for the elderly by enabling safer and more independent living environments. This feature offers innovative solutions tailored to support ageing individuals by integrating tools such as fall detection systems, voice-controlled devices, and remote health monitoring systems (Tu & Zhou, 2025; Alhmoud & Ismail, 2024). This allows older adults to control electrical appliances with minimal physical effort, significantly reducing their energy costs while maintaining convenience and autonomy (Zaman et al., 2021). More advanced smart home systems integrate fall detection, biometric monitoring, and remote communication tools that can help to prevent accidents and enable faster emergency response. According to a previous study by Aggar et al. (2022), the integration of technology into healthcare is increasing, and Smart Home technology should be considered as a healthcare strategy to support older people living at home. These technologies not only assist in daily living, but also contribute to reducing accidents, increasing security, and supporting mental and physical well-being, particularly for elderly people who are socially isolated or living alone (Wang et al., 2024; Seven & Dirik, 2023).

Quality of Life and Well-Being for the Elderly

The World Health Organisation (WHO) defines quality of life (QoL) as "*an individual's perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards, and concerns.*" To specifically evaluate the Quality of Life of the elderly, WHO developed the WHOQOL-OLD module, which concerns crucial health-related issues in old age (Liu et al, 2020). These include the main domains of QoL, physical health, psychological state, social relationships, independence, and environmental conditions.

© 2026 by MIP

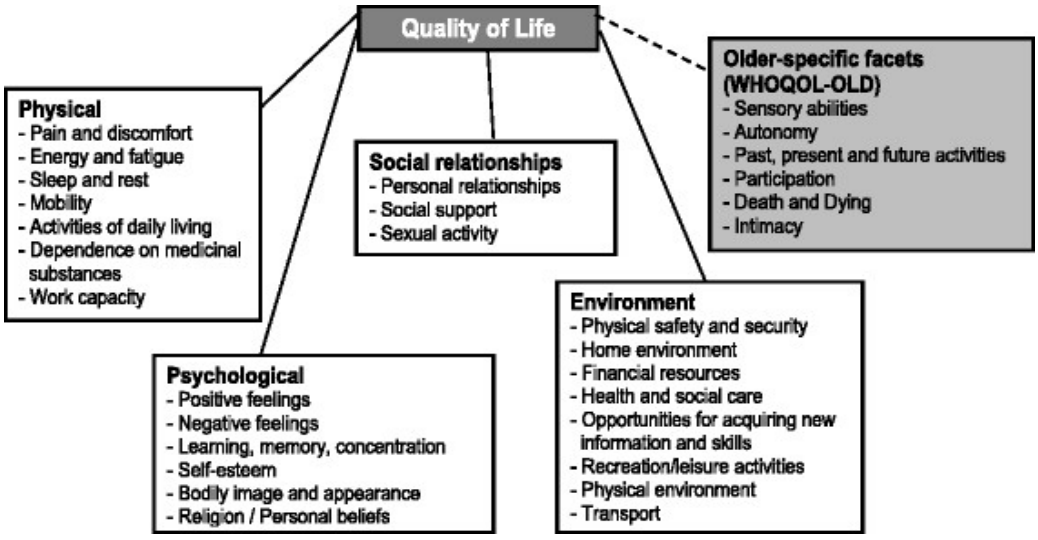


Figure 1: WHOQOL-BREF and WHOQOL-OLD

The well-being of elderly individuals encompasses not only physical health but also emotional, psychological, and social dimensions (Ooi et al., 2021). The implementation of smart home technologies has a strong positive influence on the overall QoL and well-being of elderly populations. One major factor is the sense of autonomy and security provided by systems such as emergency contact alerts, which are highly valued by the previous study (Tan et al., 2021). Furthermore, environmental and social factors such as neighbourhood safety and opportunities for independent living play a critical role in perceived life satisfaction, as found in studies of elderly residents across Malaysia (Jaffer et al., 2023). To support this, previous studies have shown evidence that psychological health scored highest among the QoL domains, indicating that emotional well-being and mental engagement are central to elderly life satisfaction (Kuppusamy, 2024). Integration of smart applications designed to support elderly productivity, emotional engagement, and social interaction has been proposed as tools for improving broader aspects of well-being in ageing populations (Nasution & Ibrahim, 2021).

RESEARCH METHODOLOGY

Scoping Review Methodology

This study employed a scoping review methodology to systematically explore the qualitative evidence on smart home features that support elderly quality of life and well-being in a housing environment. Scoping reviews are designed to map the conceptual boundaries and key themes in an emerging research field. This

© 2026 by MIP

approach is especially relevant when dealing with diverse types of data and study designs, or when aiming to clarify working definitions and identify knowledge gaps (Arksey & O'Malley, 2005). The objective of this scoping review was to comprehensively itemise what features are considered meaningful and beneficial for elderly life satisfaction.

Following the established framework by Arksey and O'Malley (2005), this review went through four iterative stages: (1) identification of relevant studies, (2) screening for eligibility based on predefined inclusion criteria, (3) assessment of full texts for topical relevance, and (4) final inclusion of articles for synthesis and thematic analysis. Each step was proposed to ensure transparency and rigour, allowing for reproducibility and consistency in mapping the information.

Identification

A broad search was conducted across academic databases such as Scopus and Web of Science. The search strategy utilised Boolean operators and specific key terms to maximise precision. This search was selected for its wide coverage of peer-reviewed journals in healthcare, technology, architecture, and social sciences. Keyword combinations were used in this scoping review, as shown in Table 1.

Table 1: Keyword searching strategy for the scoping review

Themes	Search Terms
Population	"elderly"
Concept	("smart" OR "technology") AND ("features" OR "elements" OR "attributes")
Context	"Quality of life" AND "elderly friendly" AND ("home" OR "housing")

A total of 90 records were retrieved after executing the initial database queries. To maintain relevance and currency, search filters limited the results to peer-reviewed journal articles that were published between 2021 and 2025. This limitation yielded a total of 33 relevant articles.

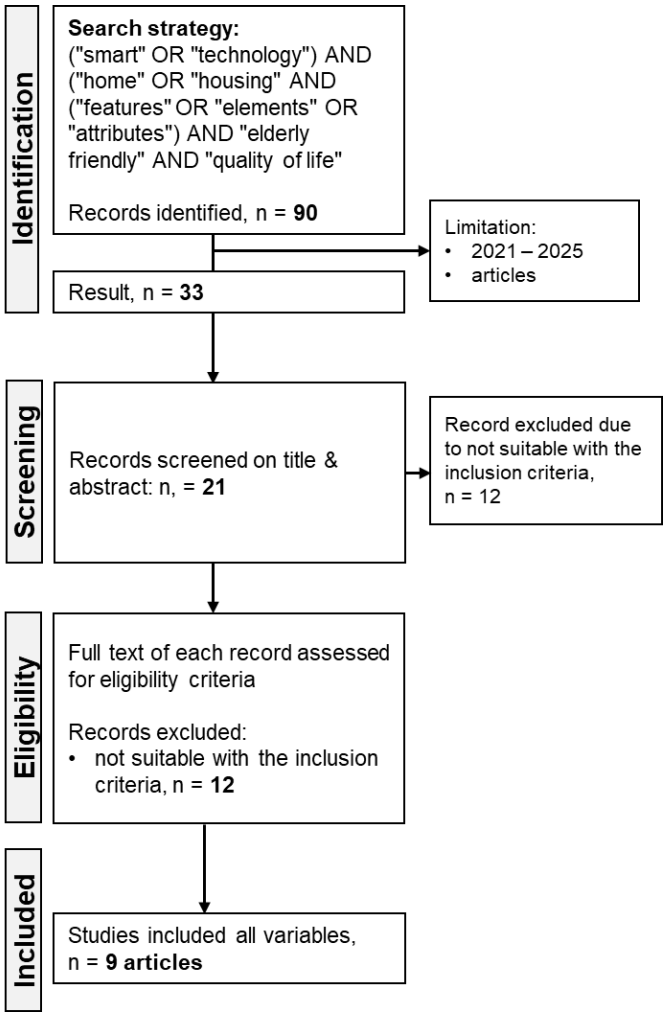


Figure 2: Flow diagram of the study selection process

Screening

Initial screening involved title and abstract review to determine initial eligibility. This process was guided by predefined inclusion and exclusion criteria. Studies were excluded if they were focused on purely technical aspects without human subject perspectives or unrelated environments. This process led to the removal of 12 articles, leaving 21 studies that met the basic relevance criteria. These articles were then subjected to a more detailed full-text evaluation in the eligibility stage. The criteria of inclusion and exclusion for the search are presented in Table 2.

© 2026 by MIP

Table 2: Criteria of Inclusion and Exclusion

Inclusion	Exclusion
• Population aged 60 years and older, including caregivers where relevant. • Direct relevance to smart home technologies in supporting elderly well-being. • Addresses quality of life, usability, acceptance, or daily-life impacts.	• Studies without a focus on older adults or without disaggregated data. • Focusing on technical specs without user context. • Lacks relevance to human experience or quality of life.

Eligibility

Each of the 21 full-text articles was examined. As a result, 12 were excluded after thorough assessment. The reasons for exclusion included findings that were not relevant to the scope of the study and nonfulfillment of the previously established inclusion criteria.

Inclusion

9 articles were ultimately included in this review. These studies met all the inclusion criteria. 9 selected studies represent a diversity of regional contexts (e.g., South Korea, China, Jordan, Taiwan), research designs (e.g., grounded theory, field surveys, simulation), and smart home technologies (e.g., voice assistants, environmental sensors, digital companions, health monitors). Table 3 summarises the Smart Home Features for the Elderly Quality of Life and Well-Being explored within 9 studies.

© 2026 by MIP

Table 3: Summary of the Scoping Review

Smart Home Features for the Elderly's Quality of Life and Well-Being in Malaysia									
Main Features and Sub-Features	Jo et al., 2021	Wang et al. ,2023	Oh., 2024	Alhmoud & Ismail., 2024	Shie et al., 2024	Zhou et al., 2024	Zhao & Li., 2024	Yang et al., 2025	Tu & Zhou., 2025
Safety and Security									
Intelligent door locks (e.g., Entry door camera, blinking entry screen, door sensors, automatic doors)	•	•	•					•	•
Automatic lighting	•	•	•					•	•
Floors sensor detection	•	•	•					•	•
Health Monitoring									
Medication reminders	•		•	•	•	•	•		
Activity tracking	•		•	•	•	•	•		
Smart medical services	•		•	•	•	•	•		
Comfort and Accessibility									
Smart appliances and interfaces (e.g., voice control)			•						
Smart lighting			•						
Voice control			•						
Smart curtains			•						
Social and Cognitive Well-Being									
Communication tools			•			•		•	
Video calling			•			•		•	
Memory games			•			•		•	
Digital companions			•			•		•	
Energy Efficiency									
Solar panels			•	•					
Equipment checks			•	•					
Heating and cooling automation			•	•					
Smart meters			•	•					

ANALYSIS AND DISCUSSIONS

This paper provides qualitative insights into how older adults engage with smart home technologies and how such features influence their daily routines, health behaviour, and their emotional well-being safely. The findings (Table 3) were thematically coded and analysed into five (5) themes: (1) Safety and Security, (2) Health Monitoring, (3) Comfort and Accessibility, (4) Social and Cognitive Well-

© 2026 by MIP

Being, and (5) Energy Efficiency. With the assistance of AI, Figure 2 was generated to illustrate the synthesised themes.

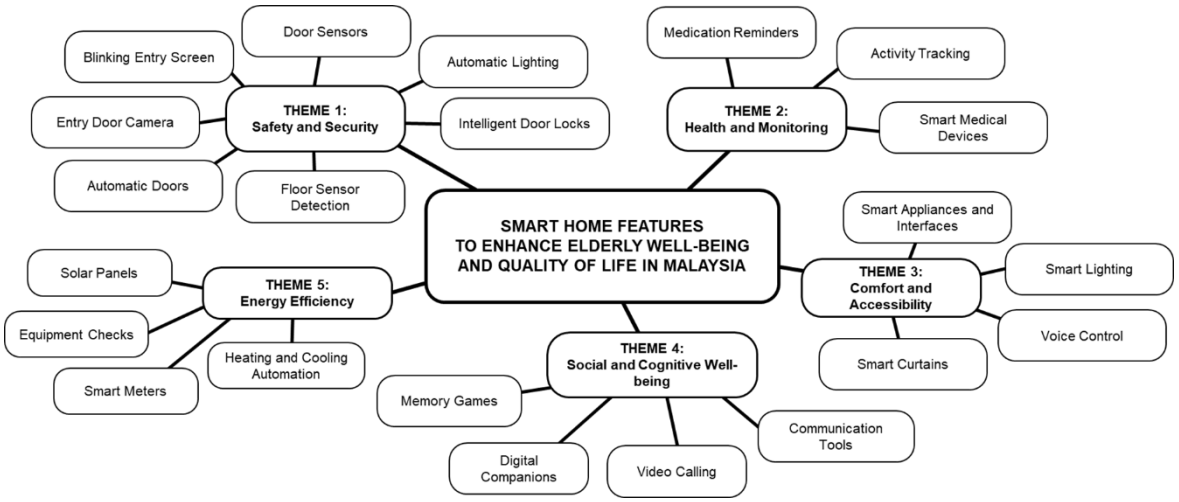


Figure 2: Smart Home Features to Enhance Elderly Well-Being and Quality of Life

Safety and Security

Recent papers (2021-2025) reveal that Safety and Security features for Elderly Smart Home are Intelligent door locks (e.g., Entry door camera, blinking entry screen, door sensors, automatic doors), Automatic lighting, and Floors sensor detection. The findings consistently emphasised the importance of Safety and Security features that prevent falls, facilitate emergency response, and reduce environmental hazards. Fall detection systems, including floor sensors, wearable alert devices, and automatic alarms, were the most frequently cited technologies for fostering independence while maintaining safety for the elderly, especially for individuals living independently or managing chronic health conditions (Oh, 2024; Tu & Zhou, 2025).

Besides these, sensor-enabled doors, intelligent locks, and entry door cameras were also valued, offering both physical and psychological reassurance by providing a safe, comfortable, and convenient living environment for the elderly (Wang et al., 2023). Automatic lighting systems, especially motion detection, were seen as a powerful tool for preventing accidents (Oh, 2024). These features highlight how smart home systems serve not just as passive structures but as active participants in ensuring security and autonomy for ageing individuals.

Health Monitoring

Next, recent paper (2021-2025) also shows Health Monitoring features for Elderly Smart Home are mediation reminder, activity tracking and smart medical services. Health-related smart technologies emerged as a second major theme, reflecting the growing interest in real-time monitoring of older adults' physical condition. Smart medical devices such as wearable blood pressure monitors, pulse sensors, and biomedical tracking systems enable elderly users to monitor their health metrics without frequent clinical visits (Jo et al., 2021). Such systems were reported to allow users by providing them with greater insight and control over their daily health management (Oh, 2024; Shie et al., 2024).

Additionally, medication reminders and activity tracking systems were highly praised for improving medication adherence and reducing caregiver or healthcare professional burden to detect any abnormalities (Mohammed et al., 2019, as cited in Oh, 202). These reminders helped structure daily routines and minimise the risk of missed doses, especially among users with cognitive decline or multiple medications. Notably, user preference leaned toward minimally intrusive solutions that blended into the home environment to avoid any excessive data input, which could discourage use. This aligns with a broader trend toward ambient assisted living systems that passively gather data while preserving user dignity and comfort (Alhmoud & Ismail, 2024).

Comfort and Accessibility

Regarding the Comfort and Accessibility features for Elderly Smart Home, there is only one (1) study stated the significant on smart appliances and interfaces, smart lighting, voice control and smart curtains in Elderly Smart Home features. Smart technologies that prioritised user comfort and followed principles of universal design were especially considered beneficial by older adults. These features were recognised for their inclusivity in accommodating diverse abilities and supporting independent living. Smart appliances, including voice-controlled lighting, automated curtains, and climate control systems, stood out as features that reduced physical strain and enabled effortless environmental adjustments (Oh, 2024). These findings also expressed a strong preference for interfaces designed for clarity, including devices with large text, simple navigation menus, and tactile feedback. These design features not only made appliances easier to use but also reduced feelings of frustration and dependency on others (Wang et al., 2023).

Social and Cognitive Well-Being

Three (3) papers (2021-2025) from the recent papers show the Social and Cognitive Well-Being features for Elderly Smart Home are communication tools, video calling, memory games and digital companions. Smart home systems also

© 2026 by MIP

played a critical role in enhancing the social engagement and emotional well-being of older adults' overall quality of life. Technologies such as communication tools, including video calling platforms, voice messaging systems, and smart assistants, were recognised in reducing loneliness and maintaining social connections, especially during periods of isolation (Oh, 2024; Ren & Chai, 2025). These systems, whether through reminders, voice interactions, or routine guidance, were perceived as supportive and comforting presences, especially for individuals living alone. While not always explicitly framed as tools for mental health, these technologies performed essential roles in preserving emotional expression, memory stimulation, and a sense of companionship.

Energy Efficiency

Lastly, there are two (2) study from the recent papers (2021-2025) shows the Energy Efficiency features for Elderly Smart Home are solar panels, equipment checks, heating and cooling automation and smart meters. Although often overlooked in discussions of eldercare, energy management systems were valued for their contributions to comfort, cost control, and environmental sustainability. Devices such as solar panels and intelligent energy meters allowed elderly users to maintain comfortable indoor conditions while minimising utility bills (Oh, 2024; Alhmoud & Ismail, 2024). Moreover, automated heating and cooling systems that adjusted to room occupancy or time of day were appreciated for reducing the need for manual control (Jo et al., 2021; Oh, 2024; Alhmoud & Ismail, 2024). Their integration into elderly-friendly smart homes reflects a holistic approach that includes financial security and environmental stability as dimensions of quality of life.

CONCLUSION

This paper synthesised qualitative findings, allowing for a deeper understanding of the lived experiences and technology preferences of older adults. This scoping review outlined five themes of smart home technology that hold potential for supporting the ageing process: (1) Safety and Security, (2) Health Monitoring, (3) Comfort and Accessibility, (4) Social and Cognitive Well-Being, and (5) Energy Efficiency. These categories reflect not only functional needs but also psychological and emotional dimensions essential for ageing in place. The present study makes a significant contribution to the body of knowledge by bringing together the available knowledge under five important categories of smart home technology for the well-being and quality of life of the elderly. Therefore, the present review creates a better understanding of the integration of smart homes with elderly-friendly housing, which is significant for the aging society of Malaysia.

© 2026 by MIP

The reviewed studies highlight that older adults value technologies that are intuitive, non-intrusive, and responsive to changing physical and cognitive conditions (Oh, 2024; Shie et al., 2024; Tu & Zhou, 2025). Devices that automate routine tasks, monitor health metrics passively, and support communication without requiring high digital literacy are more likely to be adopted and sustained over time (Oh, 2024; Shie et al., 2024). Equally important are features that foster emotional well-being, such as digital companionship, social connectivity, and personalised environmental control, which collectively enhance users' sense of autonomy, mobility, and comfort (Ren & Chai, 2025; Alhmoud & Ismail, 2024).

These findings include important implications for design practice. Smart home technologies must move beyond focusing solely on technical performance and instead adopt a user-centred design approach. This includes making the systems easy to use, allowing users to adjust settings to their preferences, and ensuring the technology aligns with their cultural background and values (Tu & Zhou, 2025). Effective implementation of smart home technologies depends on adequate education and training for both older adults and their caregivers. Advanced systems may fail to deliver meaningful outcomes if users are not properly guided in their use. Therefore, training interventions must be tailored to accommodate varying levels of digital literacy. This is especially important in underserved or rural communities, where access to support and familiarity with technology may be limited (Oh, 2024).

Despite the useful insights generated from this scoping review, several limitations should be acknowledged. It should be noted that this review only identified nine studies, and this could limit the overall scope of this review. In addition, this review only focused on studies published in two databases: Scopus and Web of Science. Most of these studies were carried out in different countries, such as South Korea, China, Jordan, and Taiwan. Thus, this unavailability of studies on Smart Home Features in Malaysian context shows the research gap especially focussing on the elderly needs that will be addressed with the preliminary findings based on the conceptual framework derived from the scoping reviews findings of this paper.

Future reviews may benefit from using multiple databases, expanding inclusion criteria, and integrating quality assessment tools to enhance the comprehensiveness of the findings. This review highlights several areas for future research, such as longitudinal studies to evaluate how smart home technologies influence the elderly's quality of life and well-being over time. Researchers should examine how socioeconomic status, education, and living arrangements affect adoption patterns and preferences. Investigating these contextual factors will contribute to more equitable and sustainable integration of smart technologies into elderly housing.

© 2026 by MIP

In addition, the findings of this study offer a practical implication of practice for multiple stakeholders especially to the policymakers in Malaysia from the conceptual framework on the Smart Home features for Elderly derived from this study. The tabulated smart home features significantly will serve as guidance for both, the Ministry of Housing and Local Government and real estate developers in ensuring the success delivery of age-friendly living environments provision with user-centred smart home technologies, that support independent living of ageing community in Malaysia. Accessible homes for the elderly housing consumers can be improved with the new innovations of smart home features based on the focussed determinations between the needs and preferences of the elderly as the end-users for inclusive smart housing supporting the Sustainable Development Goals (SDG) smart cities initiatives.

Finally, the main findings are aligned with the aim of this study, which explores smart home features tailored to the needs for the elderly's quality of life and well-being. With the focus on dignity, independence, and ease of use, the smart technologies play a meaningful role in facilitating older people to live well as they aged. Therefore, future studies should actively engage with the experts, caregivers, and older adults to evaluate whether these smart home features fulfil the needs based on the elderly daily living experiences. Stakeholders' involvement in relevant future studies is crucial to ensure the smart home solutions are not only technically effective but also market-driven, user-friendly, and supportive for the older adults' actual lifestyles. Besides that, more detailed research in extension from this study can be conducted to benefit other categories of elderly based on the frailty. For example, further study on smart home features for dementia or post stroke patients among elderly that will be useful for the design of safer home environment.

ACKNOWLEDGMENT

The author(s) would like to thank the Fundamental Research Grant Scheme (FRGS), Ministry of Higher Education, for funding this research under Grant No. FRGS/1/2023/SS10/UITM/02/24. The authors would also like to extend their appreciation to Research Management Unit (RMC), Universiti Teknologi MARA (UiTM) for related administration of the grant.

REFERENCES

Aggar, C., Sorwar, G., Seton, C., Penman, O., & Ward, A. (2022). Smart home technology to support older people's quality of life: A longitudinal pilot study. *International Journal of Older People Nursing, 18*(1). https://doi.org/10.1111/opn.12489

Alhmoud, H. H., & Ismail, M. R. (2024). Enhancing interior environmental quality in bedrooms of Jordanian elderly housing. *International Journal of Civil Engineering, 11*(5), 77–95. https://doi.org/10.14445/23488352/ijce-v11i5p109

Jaffer, U., Che Mohd Nasril, C. M. N., Ahmed, M., Osman, R., Kamari, A., Kamarudin, N., Juvono, N., Arif, N., & Zulkarnain, S. (2023). The evaluation of Quality of Life (QOL) among senior citizens living at an old age home on the Malaysian East Coast. *International Journal of Education, Psychology and Counseling, 8*, 839–853. https://doi.org/10.35631/IJEPC.852063

Jailani, S. F. a. K., Omar, E. N., Yunus, N. M., Maon, S. N., & Hassan, N. B. M. (2023). Exploring mobility of the elderly in urban public spaces and transportation facilities. *Advances in Social Sciences Research Journal, 10*(6.2), 215–222. https://doi.org/10.14738/assrj.106.2.15017

Jo, T. H., Hoon, J., MA, & Cha, S. H. (2021). Elderly perception on the internet of Things-Based integrated Smart-Home system. *Sensors, 21*(4), 1284. https://doi.org/10.3390/s21041284

Kuppusamy, B. (2024). Quality of life of Malaysian older adults of Indian community: a pilot study. *International Journal for Multidisciplinary Research, 6*(5). https://doi.org/10.36948/ijfmr.2024.v06i05.28000

Liu, J., Yu, W., Zhou, J., Yang, Y., Chen, S., & Wu, S. (2020). Relationship between the Number of Noncommunicable Diseases and Health-Related Quality of Life in Chinese Older Adults: A Cross-Sectional Survey. *International Journal of Environmental Research and Public Health, 17*(14), 5150. https://doi.org/10.3390/ijerph17145150

Nasution, A. I., & Ibrahim, J. (2021). Realizing the Well-Being of Senior Citizen By Developing Smart Application: A Conceptual Model. *Journal of Information Technology and Computer Science, 6*(1), 96–106. https://doi.org/10.25126/jitecs.202161281

Oh, M. (2024). Importance of design in smart Digitalization: Smart Living Environments for the aging Korean Elderly. *Buildings, 14*(12), 3748. https://doi.org/10.3390/buildings14123748

Ooi, P. B., Ong, D. L. T., Peh, S. C., Ismail, S. F., Paramanathan, S. a. M. S., Lee, A. S. H., Soon, L. K., & Chan, N. N. (2021). Active aging, psychological well-being and quality of life of elderly and pre-elderly Malaysians during movement control periods. *Educational Gerontology, 47*(8), 353–368. https://doi.org/10.1080/03601277.2021.1983295

Phua, K. C. K., Goh, W. W., & Marjani, M. (2021). Control home appliances through internet of things to assist elderly in their daily routine. *MATEC Web of Conferences, 335*, 04005. https://doi.org/10.1051/matecconf/202133504005

Ren, M., & Chai, N. (2025). Resilience Renewal Design Strategy for aging communities in traditional historical and cultural districts: Reflections on the practice of the Sizhou'an community in China. *Buildings, 15*(6), 965. https://doi.org/10.3390/buildings15060965

Seven, F., & Dirik, M. (2023). The effect of smart home technology on the quality of life of the elderly. *International Conference on Scientific and Innovative Studies, 1*(1), 50–59. https://doi.org/10.59287/icsis.574

Shie, A., Xu, E., Ye, Z., Meng, Q., & Wu, Y. J. (2024). Sustainable Innovative design of Elderly-Friendly smart medical products: an integrated model. *Sustainability, 16*(17), 7580. https://doi.org/10.3390/su16177580

© 2026 by MIP

Tan, B. C., Lau, T. C., Khan, N., Tan, W. H., & Ooi, C. P. (2021). Elderly customers' open innovation on Smart Retirement Village: what they want and what drive their intention to relocate? *Journal of Open Innovation Technology Market and Complexity, 7*(4), 207. https://doi.org/10.3390/joitmc7040207

Tan, B. C., Lau, T. C., Khan, N., Tan, W. H., & Ooi, C. P. (2021). Elderly customers' open innovation on smart retirement village: What they want and what drive their intention to relocate? *Journal of Open Innovation Technology Market and Complexity, 7*(4), 207. https://doi.org/10.3390/joitmc7040207

Tu, E., & Zhou, Y. (2025). A grounded theory based kano model to develop age-friendly housing retrofit strategies for older people in China. *Journal of Asian Architecture and Building Engineering, 1–21*. https://doi.org/10.1080/13467581.2025.2455037

Wang, F., Qi, Y., & Liu, J. (2023). Innovative research on the design of aging-friendly interior space in the context of computer simulation. *Applied Mathematics and Nonlinear Sciences, 9*(1). https://doi.org/10.2478/amns.2023.2.00870

Wang, Y., Sun, H., Xu, S., Xia, Q., Ge, S., Li, M., & Tang, X. (2024). Smart home technologies for enhancing independence of living and reducing care dependence in older adults: A systematic review. *Journal of Advanced Nursing*. https://doi.org/10.1111/jan.16569

World Health Organization: WHO. (2024, October 1). Ageing and health. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

Yang, J., Yang, T., & Li, L. (2025). Analysis of user behavior and satisfaction under the elderly adaptation mode of an APP based on the fuzzy-IPA model. *Scientific Reports, 15*(1). https://doi.org/10.1038/s41598-024-84526-6

Zaman, H. B., Ahmad, A., & Aw, K. S. (2021). Energy efficiency through a wearable device for the elderly based on the Integrated Smart Neighbourhood Framework of Malaysia 5.0 model. In *Lecture notes in computer science* (pp. 642–654). https://doi.org/10.1007/978-3-030-90235-3_55

Zhao, Y., & Li, J. (2024). Opportunities and challenges of integrating artificial intelligence in China's elderly care services. *Scientific Reports, 14*(1). https://doi.org/10.1038/s41598-024-60067-w

Zhou, C., Guo, J., Zhang, Y., Huang, T., & Kaner, J. (2024). A home health management app designed in the post-epidemic era using empirical evidence based on the demand collection of elderly users. *Humanities and Social Sciences Communications, 11*(1). https://doi.org/10.1057/s41599-024-03042-0

Received: 11th November 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 525 – 540

HOMEOWNERSHIP CHALLENGES FOR MIDDLE-INCOMES GROUP IN SMART CITY BATU KAWAN, PULAU PINANG

Norazmawati Binti Md. Sani @ Abd. Rahim[1], Nurin Anis Syazwani Mohamad Yazan[2]

[1,2]*School of Housing, Building and Planning,*
UNIVERSITI SAINS MALAYSIA

Abstract

Batu Kawan has been designated as a Smart City by the Penang State Government, placing it alongside other major Malaysian smart city developments such as Cyberjaya and Iskandar Puteri, which have similarly experienced rapid urban growth and population inflows. As observed in these smart cities, accelerated development in Batu Kawan has been accompanied by a sharp rise in housing prices for both existing and new units, indirectly creating homeownership challenges for the middle-income (M40) group. This study was conducted using a quantitative approach to identify the level of affordability for smart city in Batu Kawan, Pulau Pinang and to examine the homeownership challenges for smart city in Batu Kawan, Pulau Pinang. A total of 100 Malaysian respondents who live and work in the area participated in the survey through structured questionnaires. The data collected were analysed using descriptive statistics, cross-tabulation and mean score analysis. The findings revealed that the level of housing affordability using HAR stood at 28.7%, within the 30% affordability benchmark, yet a notable share of respondents still faced unaffordability. The findings reveal that the main challenge is the mismatch between house prices and income (mean = 4.37, σ = 0.71), reflecting an affordability gap among the M40 group.

Keywords: Homeownership Challenges, Middle-income Group, Smart City

[1] Corresponding author. Email: norazmawati@usm.my

INTRODUCTION

The Batu Kawan Smart City development in Pulau Pinang represents a transformative shift in Malaysia's urban landscape, characterized by advanced infrastructure, digital connectivity and premium real estate. However, the benefits of such development are not equally accessible, particularly for middle-income households (M40), who often face a tension between affordability and exclusion. According to the Department of Statistics Malaysia (2022), the median monthly household income in Pulau Pinang is RM5,409 (RM64,908 annually), which would suggest an affordable housing threshold of approximately RM195,000 based on the conventional affordability rule that housing should cost no more than three times annual income. In contrast, property prices in Batu Kawan range from RM382,500 to RM601,782, exceeding the affordability threshold by two to three times (NAPIC, 2021).

From the perspective of urban economics and housing affordability theory, housing stress occurs when prices rise faster than household income, a phenomenon particularly pronounced in market-driven urban developments (UN-Habitat, 2020; World Bank, 2021). In the context of smart cities, this stress is further compounded by the premium assigned to technological infrastructure, sustainability initiatives and lifestyle amenities, which often inflate property values to the benefit of investors rather than resident households (Sarkar & Kumar, 2022). Smart city initiatives, by accelerating land value appreciation and speculative demand, generate what has been termed the "smart city premium" in housing markets (Zulkifli et al., 2022).

A studies by Zulkifli et al. (2022), highlight that while smart cities are designed to enhance quality of life, they often drive up housing costs due to increased investor demand and land value appreciation, which disproportionately affects the M40 group. As a result, the affordability gap has significantly widened, with Pulau Pinang's median house price-to-income ratio reaching 8.1, far exceeding the international affordability benchmark of 3.0 (MacDonald, 2023).

The objective of this paper is to identify the level of affordability for smart city in Batu Kawan, Pulau Pinang and to examine the homeownership challenges for smart city in Batu Kawan, Pulau Pinang. The outcome of this paper will identify the level of housing affordability for middle-income groups and their homeownership challenges.

This study contributes to the existing literature by empirically examining homeownership affordability and perceived housing challenges within a designated smart city context, namely Batu Kawan, Pulau Pinang. Unlike earlier studies that focus on conventional urban areas, this research situates affordability within the smart city development framework, highlighting how smart-driven urban transformation may unintentionally exacerbate affordability pressures for

middle-income households. The findings offer new insights into the affordability paradox faced by the M40 group in smart cities, thereby extending current debates on inclusive smart urban development in Malaysia.

LITERATURE REVIEW

Definition of Homeownership

Homeownership refers to the legal possession of a residential property by an individual or household, granting them the right to occupy, sell or lease the property. It is widely regarded as a key indicator of economic stability, personal financial achievement and long-term wealth accumulation (Kadir & Ismail, 2023). In the Malaysian context, the National Housing Policy (Dasar Perumahan Negara) 2018–2025 continues to emphasize that every family should have access to a comfortable, quality, affordable and sustainable home (KPKT, 2018; updated in Housing and Local Government Ministry Report, 2022). This policy highlights the critical role of homeownership in achieving social equity and national development goals. It reflects the belief that owning a home is not only a basic need but also a symbol of upward social mobility, especially for middle-income groups.

Level of Housing Affordability

Housing affordability is a critical issue worldwide, particularly for middle-income groups facing rising house prices coupled with stagnant or slow-growing incomes. This phenomenon is driven by strong economic growth but also creates a gap between housing prices and actual household incomes, making homeownership less attainable for first-time buyers. Affordability issues are compounded by factors such as rising interest rates, the high cost of deposits and loan repayments. The level of affordability essentially measures the ability of households to purchase or rent homes without financial hardship.

Several studies define housing affordability as the ratio of housing costs (mortgage payments, rent, utilities) to household income.

According to the United Nations (UN-Habitat, 2020), a common benchmark is that housing is considered affordable if total housing costs do not exceed 30-35% of gross household income. Exceeding this threshold often leads to housing stress, forcing families to compromise on other essential needs. Musaddad et al. (2023) examined the affordability of homeownership in the Northern Region of Malaysia, including Pulau Pinang. The study found that the median multiple of house prices in Pulau Pinang reached 5.5 in 2016, exceeding the affordability threshold set by Bank Negara Malaysia of 3.0. This indicates that houses in the area are in the “severely unaffordable” category. Factors such as slow income growth and rapid house price increases contribute to this situation.

© 2026 by MIP

Therefore, affordability can be defined as the capacity of a household to purchase a home without compromising other essential living expenses. When the ratio of house price to income increases, housing becomes less affordable, particularly for the middle-income group. Table 1 shows the standard classification rating of affordability based on the Median Multiple criteria.

Table 1: Classification Rating of Housing Affordability

Affordability Rating	Median Multiple	Affordability Level
Affordable	3.0 and below	Home prices are within reach of buyers
Moderately Unaffordable	3.1 to 4.0	Some affordability pressure
Seriously Unaffordable	4.1 to 5.0	Increasing difficulty to afford a home
Severely Unaffordable	Above 5.1	Homeownership is beyond typical income

Source: Bank Negara Malaysia (2022)

Housing affordability is commonly measured using the Median Multiple approach, which calculates the ratio between the median house price and the median annual household income (Bank Negara Malaysia, 2022). This method is widely recognized for its simplicity and clarity in showing how affordable housing is to the average population. For the M40 group, this affordability gap creates a major barrier to achieving homeownership in new urban areas like Batu Kawan. Although they do not qualify for government housing subsidies aimed at lower-income (B40) groups, their income still falls short of meeting current market demands.

Challenges of Homeownership for Middle-income Groups

Homeownership remains a pressing challenge for many Malaysian households, particularly the middle-income (M40) group. Several interrelated challenges, including limited loan eligibilty, house prices outpacing income, rising cost of living, lack of affordable housing availability, economic and employment uncertainty and large number of dependents.

Each of the challenges are briefly defined as follows:

Limited Loan Eligibilty

Many M40 households struggle with limited eligibility for housing loans due to high Debt Service Ratios (DSR), low disposable income and stringent lending policies. Although they earn more than the B40 group, M40 households often do not qualify for government assistance yet cannot meet bank requirements. Chai and Selvaratnam (2024) stated a declining home loan approval rate from 76%

(2014–2018) to 74.6% in 2019. Additionally, irregular income sources, such as gig or freelance work, further complicate loan approvals for younger M40 buyers in smart urban areas.

House Prices Outpacing Income

In smart cities, the cost of homes often includes the premium for digital infrastructure and smart technologies. This exacerbates the income-price mismatch. While house prices rose sharply from RM158,000 in 2010 to RM295,000 in 2020 (NAPIC, 2021), average incomes grew modestly and even declined during the pandemic. As a result, the Housing Affordability Ratio (HAR) in major cities surpasses the "severely unaffordable" threshold, particularly affecting M40 buyers (Bank Negara Malaysia, 2021).

Rising Cost of Living

The rising cost of basic needs such as food, housing, transportation and utilities reduces the M40's ability to save for homeownership. Chai and Selvaratnam (2024) noted that these expenses account for over 65% of a typical M40 household's monthly income, leaving minimal surplus for down payments or loan repayments. In smart cities like Batu Kawan, residents may also face higher maintenance and smart utility costs, further straining their finances (The Malaysian Reserve, 2023).

Lack of Affordable Housing Availability

The private housing market often prioritizes high-end developments, leaving few affordable units suitable for the M40. Ahmad and Ismail (2023) argue that developers are incentivized by profit margins to build homes priced above RM500,000. This shortage reduces the choices available to M40 households, especially in areas like Batu Kawan where land value and demand are high due to smart infrastructure and economic investments.

Economic and Employment Uncertainty

Post-pandemic recovery remains uneven and many M40 individuals face job insecurity, unstable income, or short-term contracts. Norazmawati and Nurul Shafiqah (2021) emphasize that financial institutions are reluctant to approve long-term housing loans for applicants with inconsistent employment histories. In a smart city environment, where housing demand and prices are high, such uncertainty further excludes M40 from secure homeownership opportunities.

© 2026 by MIP

Large Number of Dependents

Many M40 households support aging parents and children, especially in multigenerational family structures. This increases financial strain and reduces eligibility for housing loans due to higher monthly obligations. Noor Azlan (2022) reported that larger household sizes directly impact disposable income and loan repayment capacity, making it harder to qualify for home loans or afford quality housing in growing urban centers like Batu Kawan.

Broader Context on Homeownership Challenges for Middle-Income Groups

Homeownership for the middle-income group, or M40, presents a growing challenge in both developed and developing nations. While this group is often perceived to have sufficient income to afford housing, many faces systemic barriers due to mismatched property markets, stagnant income growth and inadequate housing policies. This section reviews the challenges of homeownership for the M40 group in three tiers: globally, nationally and case study in the specific context of Batu Kawan, Pulau Pinang. These contexts are briefly defined as follows:

Global Context

Globally, middle-income households increasingly struggle to achieve and sustain homeownership due to the widening gap between wages and property prices, particularly in urbanized regions. According to the World Bank (2021), cities worldwide are becoming unaffordable for middle-income earners due to speculative real estate investment, limited land supply and inflation. In major urban centres, residential properties have become financial assets rather than homes, which has driven prices beyond what is affordable using traditional housing affordability indicators such as the Median Multiple.

Additionally, many global cities face a shortage of housing supply suitable for middle-income buyers, as developers tend to focus on high-end housing projects with greater profit margins (UN-Habitat, 2020). The International Monetary Fund (IMF) also notes that the "missing middle" is often overlooked in housing policies, they earn too much to qualify for government subsidies yet not enough to access mortgage loans comfortably (International Monetary Fund, 2022). This phenomenon is prevalent in cities across Europe, Asia and Latin America, where M40-like groups face rising costs of living, increasing debt burdens and limited access to financing.

Malaysia Context

In Malaysia, the homeownership crisis among middle-income households mirrors global trends but is intensified by local socio-economic and policy-related factors. Bank Negara Malaysia (2021) highlighted that the national median house

price is severely unaffordable by international standards, with the Median Multiple consistently above 4.1, indicating serious affordability stress. Middle-income households, particularly those earning between RM4,850 and RM10,959 monthly, fall into a gap where they are neither eligible for low-cost housing programs nor able to afford private market housing (Sulaiman et al., 2021). The situation is further complicated by the rising cost of living, high rejection rates for home loans and limited housing supply within price ranges suitable for the M40 group (Ahmad & Ismail, 2023). Additionally, developers have shown a strong preference for high-margin luxury projects, neglecting the development of housing units below RM300,000 which are most needed by the middle-income population (Chai & Selvaratnam, 2024).

Within smart city developments, these national affordability pressures are further amplified rather than alleviated. In the context of smart city development, this uneven affordability reflects a structural mismatch between housing supply and middle-income demand. While Batu Kawan's smart city status has enhanced economic attractiveness, it has simultaneously intensified market-driven housing production, prioritizing higher-priced units.

Similar patterns have been documented in other Malaysian smart cities such as Cyberjaya and Iskandar Puteri, where large-scale planned developments and strong investment demand have driven rapid house price appreciation without a corresponding increase in affordable or mid-priced housing supply. Despite advanced infrastructure and employment opportunities, middle-income households in these areas continue to face difficulties in accessing homeownership due to price premiums, speculative development and limited policy intervention targeting the M40 group (Zulkifli et al., 2022).

Case Study Context

Batu Kawan, a rapidly developing township in Penang, has been positioned as a smart city hub, integrating advanced technologies, green infrastructure and sustainable urban planning. However, these developments have also triggered a sharp rise in property values, often placing homes out of reach for the middle-income group. According to Penang State Government reports and recent market listings, average house prices in Batu Kawan have exceeded RM450,000, which falls into the "seriously unaffordable" range based on the Median Multiple indicators when compared with M40 income levels.

The transformation of Batu Kawan into a smart city has drawn interest from high-income investors and developers targeting premium housing markets, thereby reducing the availability of affordable units for the M40. As noted by Sarkar & Kumar (2022), smart technologies embedded in modern housing add significant cost premiums, further limiting access for middle-income families. Moreover, despite the area's infrastructure development, many M40 households

© 2026 by MIP

face difficulties in securing loans, especially first-time buyers without stable employment or savings. This situation highlights a growing divide between smart city development goals and inclusive, affordable housing strategies.

Recent international studies show that housing is increasingly treated as an investment rather than a basic social need (IMF, 2022; UN-Habitat, 2020). In smart cities, this trend is even stronger, as high-tech infrastructure and smart-city branding attract investors, pushing property prices beyond what middle-income households can afford. This has led to the so-called "missing middle" phenomenon, where middle-income families are often left out of both public housing support and the private housing market (World Bank, 2021).

In Malaysia, while research recognizes that the M40 group faces affordability stress, few studies have explored how smart city policies and developments contribute to this problem. This study fills that gap by connecting smart city development with housing affordability challenges, going beyond simple price-to-income calculations to understand the structural barriers that middle-income households experience.

RESEARCH METHODOLOGY

This study uses a quantitative research approach to explore the challenges faced by the middle-income (M40) group in owning a home in Batu Kawan, Pulau Pinang. A cross-sectional survey design was chosen because it helps capture the financial situation and homeownership experiences of respondents at a specific point in time. This design is well-suited to the study's aim of understanding current housing affordability levels and the difficulties encountered by the M40 population living in a smart city environment.

To collect the necessary data, a structured questionnaire was used. This format made it easier to gather consistent and reliable responses from a larger number of people. The questionnaire was divided into four (4) sections, each focusing on different aspects which are Respondent Background, Income and Household Dependent, Homeownership Status and Homeownership Challenges. The information collected allowed the researcher to conduct key analyses like descriptive analysis, the Housing Affordability Ratio (HAR) and mean analysis to help understand the level of affordability and homeownership challenges.

The questionnaire was distributed randomly to selected M40 respondents aged 21 to 60 who either live or work in Batu Kawan. The individuals classified under the M40 groups as defined by the Department of Statistics Malaysia (2022), with a monthly household income range between RM4,851 and RM10,970. In addition, these criteria were selected, as this age range corresponds with the eligible bracket for housing loan applications in Malaysia.

Batu Kawan was selected as the focus area because it is undergoing rapid development under the Penang State Government's smart city plans. The

city is experiencing high rates of in-migration, modern infrastructure expansion and rising property values, all of which have implications for housing affordability. According to Lim and Tan (2023), smart city development often leads to increased housing demand and higher living costs, which may disproportionately affect the middle-income segment. Thus, the cross-sectional method is suitable as it allows the research to capture affordability issues during the current phase of urban growth.

According to Chua (2006), sampling refers to the process of selecting a number of subjects from the population to serve as research respondents. Based on the population data of Batu Kawan, which was 85,900 people in 2022 (Department of Statistics Malaysia, 2023), it is estimated that 65 percent of them are individuals aged between 21 and 60 years, resulting in an estimated target population of 55,835 people. Therefore, the Taro Yamane formula (1973) was used to determine the sample size at a confidence level of 90% and a margin of error of 0.10. Based on this calculation, a total of 100 respondents were selected.

The choice of a 90% confidence level with a 0.10 margin of error was informed by practical and contextual considerations. Given the exploratory nature of this study and constraints related to time, access and respondent availability, this confidence level is deemed acceptable for preliminary empirical investigations in urban housing research (Chua, 2006). Similar confidence thresholds have been applied in previous housing affordability studies where population access is limited and the research objective is diagnostic rather than predictive. Despite its contributions, this study is subject to several limitations. First, the sample size of 100 respondents, while statistically acceptable, may not fully capture the heterogeneity of the M40 population in Batu Kawan. Second, the cross-sectional design limits the ability to observe affordability dynamics over time, particularly in a rapidly developing smart city environment. Third, reliance on self-reported data may introduce perception bias. These limitations should be considered when interpreting the findings and provide directions for future longitudinal and mixed-method research.

The data collected was analysed using SPSS software and Excel for data formula, where different techniques were applied based on the research objectives. To measure affordability (Objective 1), the Housing Affordability Ratio was used, comparing household income to monthly housing costs. Ratios above 30% were considered unaffordable (refer Table 2). HAR is calculated using the following formula:

$$\text{HAR} = \left(\frac{\text{Monthly Housing Payment}}{\text{Monthly Household Income}}\right) \times 100\%$$

© 2026 by MIP

Table 2: Housing Affordability Ratio Category

HAR %	Category
≤ 30%	Affordable
> 30%	Unaffordable

Source: Bank Negara Malaysia (2022)

To assess the challenges faced by the M40 group (Objective 2), a mean score analysis was conducted on responses from a Likert scale. Higher scores indicated more serious challenges (refer Table 3).

Table 3: Mean Score

Mean Score	Classification
1.00 - 1.99	No Challenge
2.00 - 2.99	Low
3.00 - 3.99	Moderate
4.00 - 4.99	High
5.00	Very High

Source: Irweeda Naim & Abdul Manaf (2022)

To ensure the study's quality, the questionnaire was reviewed by academic experts and tested through the pilot study of 20 respondent. Table 4 shows the value of Cronbach's Alpha that was used to check the internal reliability of the questions and results showed 0.809 (strong consistency) which means the questions effectively measured what they were meant to.

Table 4: Reliability Index

Construct	Items	Cronbach's α
Homeownership Challenges for Middle-income Groups	D1 - D18	**0.809**

ANALYSIS AND DISCUSSION

The Housing Affordability Ratio (HAR) analysis conducted on 100 respondents as shown in Table 5 revealed that 64% of them fall within the affordable category, where their HAR is 30% or less of their household's monthly income. On the other hand, 36% of respondents recorded an HAR exceeding 30%, indicating they are experiencing a high financial burden in their attempt to own a home and are thus categorized as unaffordable.

Table 5: Loan Difficulty Distribution by Household Income Category.

HAR Category	Total Respondent	Percentage (%)
≤ 30% (Affordable)	64	64%
> 30% (Unaffordable)	36	36%
	Average of HAR (%)	**28.7%**

Source: Data and Author's Calculation

The average HAR among all respondents is 28.7%, which is still within the international affordability benchmark of not exceeding 30% of household income. However, the percentage of respondents falling into the unaffordable category is notable, indicating that a significant portion of the M40 group in Batu Kawan still faces financial pressure regarding homeownership.

For instance, respondents with a monthly income of RM6,490 (midpoint) and housing payments between RM750–RM1,250 per month would result in an HAR of approximately 11.5% to 19.25%, which is well below the 30% threshold set by Bank Negara Malaysia. This suggests that many M40 households in Batu Kawan are relatively able to bear housing costs. However, the affordability gap becomes evident when monthly payments exceed RM1,500, especially for those in the lower-income range within the middle-income group (RM4,851–5,880).

Nevertheless, it is important to note that other factors, such as the number of dependents and existing financial commitments, may affect actual homeownership capability. The HAR calculated here only provides a preliminary picture of affordability based solely on income and housing payments. These findings are consistent with the study by Wong et al. (2023), which emphasize that the rising cost of living and the widening gap between house prices and income make it difficult for the middle-income group to own a home, particularly in urban or developing areas such as Batu Kawan. This also reflects a key challenge in achieving the goals of the National Housing Policy, which aims to ensure inclusive and affordable homeownership for all segments of society. Although the average HAR indicates affordability at an aggregate level, the coexistence of affordable and unaffordable households within the same income category suggests uneven affordability outcomes among the M40 group. This finding supports the argument that affordability cannot be fully understood through ratio-based indicators alone, as household composition, debt obligations and cost-of-living pressures significantly mediate actual homeownership capacity.

Table 6 shows the overall item for homeownership challenges faced by the middle-income group (M40) in Batu Kawan. A 5-point Likert scale was applied from [1] Strongly Disagree to [5] Strongly Agree. Respondents' level of agreement on homeownership challenges was examined by analyzing the mean

© 2026 by MIP

score for each statement. The results were then classified based on the classification method used in the study by Irweeda Naim & Abdul Manaf (2022), which categorizes the scores into five levels, as shown in Table 3.

Table 6: Mean Score Analysis of Each Statement

No.	Statement	Mean	S.D
Limited Loan Eligibilty			
D1	I face difficulties obtaining a housing loan from the bank.	4.14	0.89
D2	My loan eligibility is insufficient to purchase a house in Batu Kawan.	**4.21**	**0.80**
D3	The loan application process is too strict and makes homeownership difficult.	4.05	0.88
House Prices Outpacing Income			
D4	The house prices offered are far beyond my income capacity.	**4.51**	**0.64**
D5	I cannot afford to buy a house because my monthly salary is too low compared to house prices.	4.29	0.78
D6	My income does not keep up with the increase in house price in Batu Kawan.	4.31	0.70
Rising Cost of Living			
D7	The rising cost of living prevents me from saving to buy a house.	4.09	0.91
D8	My current daily expenses are too high to consider owning a home.	**4.66**	**0.61**
D9	I have to postpone buying a house due to increasing monthly financial burdens.	3.52	1.12
Lack of Houses in Suitable Price Range			
D10	It is difficult to find a house within my affordable price range	**4.17**	**0.77**
D11	Most new housing projects in Batu Kawan are beyond my financial limit.	3.59	1.10
D12	Affordable housing options are very limited in this area.	3.90	0.85
Economic and Employment Uncertainty			
D13	Job insecurity makes me hesitant to purchase a house.	**4.36**	**0.71**
D14	I am worried about making long-term commitments such as a housing loan due to the unstable economy.	3.76	0.97
D15	The risk of losing my job affects my decision to buy a house.	4.09	0.75
Large Number of Dependents			
D16	Having many dependents affects my financial capability.	**4.09**	**0.79**
D17	Monthly expenses for family members greatly limit my ability to save for a house.	3.96	0.81
D18	The number of my dependents makes it difficult for me to commit to a housing loan.	3.62	0.93

Source: Data and Author's Calculation

The findings reveal that the most significant challenge faced by respondents is the mismatch between house prices and income, with the highest average score recorded at mean = 4.37 (σ = 0.71). This indicates a high level of concern among the M40 group that their income is not sufficient to meet the rising

cost of housing in the Batu Kawan smart city area. This issue reflects the affordability gap, where housing prices are increasing faster than wage growth. This concern is also supported by Mokhtar et al. (2022), who highlighted similar affordability struggles in Pulau Pinang's urban context. The second highest challenge is limited loan eligibility, with a mean score of 4.13 (σ = 0.86). Respondents feel that bank loan requirements are too rigid, making it difficult to qualify for financing. This is consistent with findings from Norazmawati and Nurul Shafiqah (2021), who noted that young buyers often face eligibility barriers despite steady incomes.

The rising cost of living is also a significant barrier, with a mean score of 4.09 (σ = 0.88). Many respondents report that high daily expenses prevent them from saving for home purchases. This aligns with national trends in inflation and cost pressures, which have disproportionately affected the middle-income group (Musaddad et al., 2023). Another prominent issue is economic and employment uncertainty (mean = 4.07, σ = 0.81). Many individuals are hesitant to commit to long-term loans due to unstable job markets or fear of retrenchment especially relevant in the post-pandemic context.

CONCLUSION

This study was undertaken in response to growing concerns that middle-income (M40) households, despite being relatively economically stable, are increasingly struggling to access homeownership, particularly in urban and smart city developments. As Batu Kawan continues to evolve into a strategic smart city hub, ensuring equitable access to housing for middle-income groups has become a critical policy concern.

Housing affordability was assessed using the Housing Affordability Ratio (HAR), which recorded an average value of 28.7%, within the widely accepted affordability benchmark of 30%. While this suggests that housing costs are manageable at an aggregate level, the findings reveal notable disparities within the M40 group. Respondents in the lower M40 sub-groups (M10 and M20) continue to face substantial challenges in meeting housing expenses and loan repayments, indicating that average affordability indicators may mask underlying affordability stress among vulnerable segments.

Beyond objective affordability measures, the study also identified strong perceptions of financial pressure and structural barriers to homeownership. Analysis of six key housing challenges shows that the most critical issue is the mismatch between house prices and income growth (mean = 4.37, σ = 0.71), reflecting widespread concern that escalating property prices have outpaced household earnings. Other high-impact challenges include limited loan eligibility, rising living costs and economic and employment uncertainty, further constraining homeownership opportunities for the M40 group.

© 2026 by MIP

By situating these findings within a smart city development context, this study contributes to the literature by demonstrating that technology-driven urban growth may intensify affordability pressures for middle-income households. The results highlight the limitations of relying solely on aggregate affordability metrics and underscore the importance of incorporating household-level experiences and perceptions into affordability assessments.

From a policy perspective, the findings point to the need for more inclusive smart city housing strategies. These include revisiting planning controls, promoting the supply of mid-priced housing and embedding affordability objectives within smart city master plans. Without targeted interventions, smart city developments risk reinforcing socio-spatial inequalities rather than supporting inclusive and sustainable urban growth.

Overall, this research provides valuable empirical evidence to inform policymakers, urban planners and housing stakeholders involved in smart city development. It also establishes a foundation for future research to explore comparative smart city contexts, adopt longitudinal approaches and incorporate qualitative insights to deepen understanding of homeownership challenges in Malaysia's rapidly evolving urban landscape.

ACKNOWLEDGEMENT

This research was supported by Universiti Sains Malaysia (USM) under School of Housing, Building and Planning for Urban and Regional Planning Programme in 2025. The author would like to express deepest appreciation to the academic supervisor for invaluable guidance and continuous support throughout the research process, as well as to all respondents who participated in the study for their time and cooperation.

DISCLOSURE STATEMENT

The author declares no potential conflicts of interest with respect to the research, authorship and/or publication of this thesis. This study was conducted independently and no external funding or sponsorship influenced the findings or conclusions.

REFERENCES

Ahmad, M. H., & Ismail, S. (2023). Affordable housing development in Malaysia: Challenges and developer perspectives. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *8*(2), 55–65.

Bank Negara Malaysia. (2021). *Financial Stability Review – First Half 2021*. https://www.bnm.gov.my

Chai, M. F., & Selvaratnam, D. P. (2024). Urban inflation and the affordability gap: Evidence from middle-income families in Malaysia. *Journal of Urban Economic Policy*, *12*(1), 22–34.

Chua, Y. P. (2006). *Kaedah dan statistik penyelidikan: Kaedah penyelidikan buku 1*. McGraw-Hill Education.

Department of Statistics Malaysia. (2022). *Household income and basic amenities survey report 2022*. https://www.dosm.gov.my

Hashim, Z. A., & Rahman, N. A. A. (2021). Residential mobility, housing tenure and neighborhood satisfaction: Evidence from Malaysian middle-income households. *Malaysian Journal of Economic Studies*, *58*(2), 211–228.

International Monetary Fund. (2022). *Housing market dynamics in emerging economies*. https://www.imf.org

Irweeda Naim, & Abdul Manaf, A. (2022). Perspektif rumah mampu milik: Kajian kes penjawat awam di Putrajaya [Affordable housing perspective: Case study of civil servants in Putrajaya]. *e-Bangi: Journal of Social Sciences & Humanities*, *19*(6). https://ejournal.ukm.my/ebangi

Kadir, M. A., & Ismail, R. (2023). Economic resilience through homeownership: A Malaysian perspective on housing stability. *Southeast Asian Journal of Housing Studies*, *12*(2), 97–110.

Kementerian Pembangunan Kerajaan Tempatan (KPKT). (2023). *KPKT menjadikan bandar pintar sebagai inisiatif strategik untuk masa depan bandar di Malaysia*. https://www.malaymail.com/news/malaysia/2023/09/20/local-government-development-ministry-makes-smart-city-a-strategic-initiative-to-future-proof-cities-in-malaysia-says-minister/91999

Lim, Y. S., & Tan, S. H. (2020). Understanding housing preference and affordability issues among urban dwellers in Malaysia. *Journal of Property Research*, *37*(1), 84–98.

MacDonald, F. (2023). *Housing affordability in Penang: A widening gap*. https://www.anilnetto.com

Mokhtar, A. S., Ahmad, N., & Rahim, M. N. (2022). Revisiting homeownership affordability issues among the urban middle-income group in Pulau Pinang, Malaysia: Multi-dimensional impacts. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *7*(8), 1–15. https://msocialsciences.com/index.php/mjssh/article/view/1448

Musaddad, H. A., Maamor, S., & Zainol, Z. (2023). Affordability of affordable housing in Northern Region of Malaysia. *Malaysian Management Journal*, *27*, 183–209. https://www.researchgate.net/publication/372761071_Affordability_of_affordable_housing_in_Northern_Region_of_Malaysia?utm_source=chatgpt.com

Musaddad, M., Hussin, N., & Latif, S. (2023). The challenges of homeownership among middle-income earners in northern Malaysia. *Malaysian Management Journal*, *27*(1), 45–58. https://e-journal.uum.edu.my/index.php/mmj/article/view/18794

NAPIC. (2021). *Property Market Report 2020*. National Property Information Centre, Ministry of Finance Malaysia.

Noor Azlan, G. (2022). Household spending behavior and housing affordability in urban Malaysia. *The Malaysian Economic Review*, *57*(1), 103–120.

Norazmawati M. S., & Nurul Shafiqah M. N. (2021). Kemampuan pemilikan rumah dalam kalangan belia di Batu Kurau, Perak. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *6*(11), 99–109. https://doi.org/10.47405/mjssh.v6i11.1168

© 2026 by MIP

PLANMalaysia. (2020). *Pelan Induk Batu Kawan Smart City 2030*. Putrajaya: Federal Department of Town and Country Planning, Peninsular Malaysia.

Pulau Pinang Development Corporation (PDC). (2023). *Batu Kawan Smart City Framework*. https://www.pdc.gov.my

Sarkar, A., & Kumar, S. (2022). Smart cities and housing affordability: A policy paradox. *International Journal of Smart Urban Planning*, *9*(3), 103–115.

Sulaiman, S., Ismail, N., & Yusof, N. (2021). Urban housing affordability and the middle-income trap: Malaysian perspectives. *Enviro-Behavior Journal*, *6*(2), 45–56. https://doi.org/10.37268/ebj.v6i2.326

The Malaysian Reserve. (2023, March 9). Affordable housing projects miss the mark in urban locations. *The Malaysian Reserve*. https://www.themalaysianreserve.com

UN-Habitat. (2020). *World Cities Report 2020: The value of sustainable urbanization*. United Nations Human Settlements Programme. https://unhabitat.org

Wong, K. Y., & Lau, W. Y. (2022). The role of middle-income earners in Malaysia's urban economy: Challenges and opportunities. *Malaysia Journal of Economic Studies*, *59*(2), 301–319. https://doi.org/10.22452/MJES.vol59no2.4

World Bank. (2021). *Global housing affordability: Trends, challenges and solutions*. https://www.worldbank.org

Yamane, T. (1973). *Statistics: An introductory analysis* (3rd ed.). New York: Harper and Row.

Zulkifli, N. A., Wahid, J., & Ismail, A. (2022). Smart cities and housing affordability: A Malaysian perspective. *Built Environment Journal*, *19*(1), 59–70.

Received: 14th August 2025. Accepted: 15th November 2025

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 541 – 565

THE DYNAMIC RELATIONSHIP BETWEEN MULTIDIMENSIONAL GLOBALIZATION IN MARITIME LOGISTICS PERFORMANCE ASEAN

Heru Wahyudi[1], Andi Kusnadi[2], Sandra Mei Leny[3], Ja'far M. Yahya[4]

[1,3] *Departement Economic Development, Faculty Economic and Bisnis,*
[2] *Faculty of Engineering,*
[4] *Faculty of Law,*
UNIVERSITAS LAMPUNG INDONESIA

Abstract

The transformation of ASEAN's maritime logistics system faces complex challenges as global maritime trade volume increases from 8.4 billion tons in 2010 to 11.0 billion tons in 2021. As a region that controls 25% of total global trade goods and facilitates $2.8 trillion maritime trade volume by 2021, ASEAN has a strategic role but faces significant challenges in optimizing maritime logistics performance. Despite its strategic centrality, ASEAN exhibits significant disparities in maritime infrastructure, with LSCI scores ranging from 21.35 to 113.78 points. These gaps suggest that geographical advantage alone is insufficient without robust integration into global economic, social, and political networks. While existing literature often examines these dimensions in isolation, this study provides a comprehensive analysis of how multidimensional globalization collectively determines maritime logistics performance. By evaluating these dynamics over a decade (2010–2021), the research offers critical insights into the drivers of regional connectivity. Therefore, this study aims to investigate the impact of multidimensional globalization on maritime logistics performance in ASEAN countries by analyzing the influence of economic globalization, social globalization and political globalization on LSCI.

The study uses panel data regression analysis over the period 2010-2021. The dependent variable is LSCI, while the independent variables include Exports of Goods and Services (% of GDP), Individuals using Internet (% of population), and Political Stability and Absence of Violence/Terrorism. The estimation results show that economic globalization has a significant positive effect on LSCI with a coefficient of 20.679 (t-statistic = 5.042; p-value = 0.0000). The R-squared value indicates the proportion of the variance in the Liner Shipping Connectivity Index (LSCI) that is predictable from the independent variables. A high R-squared in this model suggests that economic, social, and political dimensions of globalization collectively explain a substantial majority of the shifts in ASEAN maritime performance. Specifically, the coefficient of 20.679 for economic globalization implies that for every percentage increase in export intensity, the LSCI is expected to rise by approximately 20.6 points. This high magnitude underscores that trade-led growth is the primary driver of maritime infrastructure demand. The statistical significance across all variables ($p < 0.05$) confirms that these findings are not coincidental but represent a robust causal link between globalization tiers and logistics efficiency. Social globalization also has a significant positive effect with a coefficient of 0.421 (t-statistic = 9.118; p-value = 0.0000). In contrast, political globalization has no significant effect on LSCI with a coefficient of 1.765 (t-statistic = 0.582; p-value = 0.5627). The simultaneous test showed an F-statistic of 41.663 (p-value = 0.0000) confirming the jointly significant effect. The coefficient of determination (R^2) of 0.648 indicates that the model explains 64.8% of the variation in LSCI. The findings confirm that the economic and social dimensions of globalization are determinants of ASEAN maritime logistics performance, while political stability shows no significant impact in a relatively stable regional context.

Keywords: Maritime Logistics, Liner Shipping Connectivity Index, Multidimensional Globalization, ASEAN, Economic Globalization, Social Globalization, Political Globalization

[1] Corresponding author. Email: heru.wahyudi@feb.unila.ac.id

INTRODUCTION

The global economy operates through increasingly complex and integrated trade networks, where maritime logistics serves as the infrastructure that connects national economies with global markets. In this context, the Association of Southeast Asian Nations (ASEAN) has become a strategic economic bloc contributing 8.4% to global GDP and facilitating annual maritime trade volumes worth $2.8 trillion by 2021 (Evers & Karim, 2011). The region's strategic position along major global shipping routes, particularly at critical chokepoints such as the Strait of Malacca and Singapore Strait, means that ASEAN controls approximately 25% of total global trade goods and 60% of Asia's maritime trade transit.

The transformation of ASEAN's maritime logistics system, characterized by global maritime trade volumes increasing from 8.4 billion tons in 2010 to 11.0 billion tons in 2021, reflects an average growth of 2.6% per year (Kampan, 2017). This transformation is accelerated by the digitalization of the maritime sector through the implementation of automated port systems and smart logistics technologies, which is changing the operational paradigm in maritime supply chains. However, the ASEAN region shows significant heterogeneity in maritime logistics performance among member states, with the Liner Shipping Connectivity Index (LSCI) ranging from 21.35 to 113.78 points. This variation reflects different exposures to globalization forces and varying capacities to harness those forces to improve maritime logistics efficiency.

Despite extensive research on the economic implications of globalization, there remains a significant gap in understanding how multidimensional globalization encompassing economic, social, and political dimensions simultaneously affects maritime logistics performance. The literature review identified three fundamental limitations in previous studies. First, the fragmentary nature of the research approach in analysing the dimensions of globalization in isolation, without considering the possible synergistic effects on the maritime logistics system. Second, the predominance of *cross-sectional* methodological approaches in previous studies limits the understanding of temporal dynamics and causal relationships. This limitation results in a lack of insight into how the multidimensional effects of globalization evolve over time and how changes in one dimension may affect another longitudinally. Third, ASEAN region- specific analyses are limited by narrow geographical coverage or short observation periods, thus not capturing the full spectrum of regional maritime logistics evolution (Jamain et al., 2022).

This research is based on three theoretical frameworks that comprehensively analyze the multidimensional impact of globalization on maritime logistics performance. *Network Theory* provides an understanding of how a country's strategic position in international maritime trade networks

affects its logistics capacity (Santos & Pereira, 2022). In the ASEAN context, this theory explains how regional integration and inter-port connectivity shape the efficiency of the overall maritime logistics system. The Comparative Advantage Theory provides an economic foundation to understand how trade specialization drives demand for maritime logistics services. The theory explains that countries with a comparative advantage in a particular product will experience increased import-export activity, which in turn increases the need for efficient maritime logistics infrastructure and services. The application of this theory in the ASEAN context helps explain the variation in maritime logistics performance between member states. Institutional Economic Theory offers a perspective on how political and *governance* factors shape the investment environment for maritime infrastructure. It emphasizes the role of formal and informal institutions in creating a regulatory framework conducive to the development of the maritime logistics sector. In the context of this study, institutional economics theory helps explain how political stability and governance quality affect maritime infrastructure investment and Port operational efficiency (Baker et al., 2019).

This research aims to investigate the multidimensional impact of globalization on maritime logistics performance in ASEAN countries by examining how the economic, social, and political dimensions of globalization affect the *Liner Shipping Connectivity Index* (LSCI) as an indicator of maritime logistics performance. To achieve the research objectives, four research questions were developed to systematically analyze the multidimensional interactions in the maritime globalization-logistics phenomenon. First, to what extent does economic globalization, as measured by export intensity, affect maritime logistics connectivity in ASEAN countries, with export intensity chosen as a proxy for economic globalization as it reflects a country's level of economic integration with the global market. Second, how social globalization, proxied through internet penetration, affects maritime logistics performance in the ASEAN region, with internet penetration being used as an indicator of social globalization as it reflects the level of digital connectivity and capacity to adopt modern technology in logistics operations. Third, how political stability as a proxy for political globalization affects maritime logistics connectivity in ASEAN countries, with political stability reflecting institutional quality, policy predictability, and an investment climate conducive to maritime infrastructure development. Fourth, how the three dimensions of globalization (economic, social, and political) interact collectively in influencing maritime logistics performance in the ASEAN region.

© 2026 by MIP

LITERATURE REVIEW

Liner Shipping Connectivity Index (LSCI) as a Maritime Connectivity Indicator

The Liner Shipping Connectivity Index (LSCI) is a measurement instrument developed by UNCTAD to quantify a country's level of integration in the global shipping network. The LSCI operationalizes maritime connectivity through the aggregation of five dimensions such as number of ships, fleet capacity (TEU), diversity of shipping companies, frequency of service, and maximum capacity of ships. With a 2004 baseline of 100, the LSCI generates a relative score for comparison between countries (Fugazza & Hoffmann, 2017). Within the framework of network theory, maritime connectivity serves as a critical infrastructure that links the domestic economic system with global markets. The LSCI is positioned as an endogenous variable that is responsive to the multidimensional dynamics of globalization. Synthesis of global studies indicates that maritime connectivity is not merely a byproduct of trade volume, but a reflection of systemic integration within global production networks. (Munim et al., 2018) emphasize that countries with high levels of economic openness tend to attract more substantial port infrastructure investments, which directly bolsters their LSCI scores. Furthermore, on a regional scale, the integration of the ASEAN market necessitates a synchronization between physical cargo flows (economic dimension) and information flows (social dimension) to foster globally competitive port efficiency. This integrated perspective leads to the hypothesis that the acceleration of multidimensional globalization will significantly propel ASEAN's strategic positioning within the global liner shipping network. Research by (Fugazza and Hoffmann, 2017) using a gravity model with panel data of 158 countries found the elasticity of LSCI to bilateral trade to be 0.28.

Exports of Goods and Services (% of GDP) as a Proxy for Economic Globalization

Exports of goods and services as a percentage of GDP are a fundamental indicator of economic openness and global market integration. Based on the IMF's Balance of Payments Manual methodology, this indicator operationalizes economic globalization through quantifying the relative contribution of export activity to the national economy. A high ratio reflects a highly integrated economy with certain comparative advantages (Gabriele, 2006). At the global level, the correlation between export intensity and maritime connectivity is driven by the 'demand-derived connectivity' mechanism, where the growth of manufacturing export sectors compels shipping providers to increase port call frequencies and fleet capacities to achieve economies of scale. (Martínez-Zarzoso and Nowak-Lehmann, 2003) provide empirical evidence that

improvements in transport efficiency triggered by export activities can systematically reduce logistics costs. In the ASEAN context, production specialization in emerging hubs like Vietnam and Thailand has reshaped regional shipping routes, reinforcing the argument that economic globalization acts as a primary catalyst for maritime infrastructure development that is highly responsive to international market requirements. In the framework of comparative advantage theory, production specialization requires an efficient transportation system to realize comparative advantage (Cukrowski & Fischer, 2000).

Labor Force Participation

Internet penetration as a percentage of the population quantifies the adoption of information and communication technologies in society. It operationalizes social globalization by measuring access to global information and participation in the digital economy. High penetration indicates a society that is well connected to global networks and access to advanced digital services (Xiong et al., 2021). The evolution of maritime logistics from conventional models to 'Smart Port' paradigms is heavily contingent upon the degree of social globalization and digital readiness. Global studies by (Urciuoli et al., 2021) suggest that robust internet penetration facilitates a 'digital ecosystem' that mitigates operational risks and enhances supply chain transparency. Within the ASEAN region, while technological disparities remain, the integration of internet-based port information systems such as the ASEAN Single Window demonstrates that digital connectivity accelerates customs clearance and intermodal coordination. This provides a theoretical foundation suggesting that social globalization, through ICT adoption, serves as a crucial determinant of maritime logistics performance in the Industry 4.0 era. Internet penetration facilitates the adoption of IoT, blockchain, and artificial intelligence in maritime logistics through: (1) smart logistics systems for intermodal coordination, (2) real-time tracking and automated customs clearance, and (3) integration with global logistics networks and electronic data exchange systems. (Gocer et al., 2021) used dynamic panel estimation to identify a positive elasticity of internet penetration on the Logistics Performance Index of 0.32. (Najeeb K.K, M, 2022) found a path coefficient of 0.56 between ICT infrastructure and trade facilitation performance.

Political Stability and Absence of Violence/Terrorism as a Proxy for Political Globalization

Political Stability and Absence of Violence/Terrorism is a component of Worldwide Governance Indicators that quantifies the perceived probability of political destabilization through unconstitutional means. With a scale of -2.5 to +2.5, this indicator operationalizes political globalization through assessments

© 2026 by MIP

of political predictability and institutional stability, reflecting investor confidence and policy predictability (Odehnal & Sedlacik, 2018). Within an institutional economic framework, political stability creates an environment conducive to long-term investment in maritime infrastructure (Beker et al., 2019). Political stability affects shipping connectivity through: (1) it increases investor confidence for capital- intensive investments, (2) policy predictability facilitates long-term strategic planning, (3) the absence of violence ensures operational security, and (4) institutional stability supports international cooperation in regional shipping networks. (Alesina & Perotti, 1996) using cross- country regression with instrumental variables on 71 countries identified a one standard deviation increase in political stability increases the investment-to-GDP ratio by 1.5 percentage points.

RESEARCH METHODOLOGY

This research adopts a robust quantitative design to investigate the determinants of maritime logistics performance within the ASEAN region. The strategic selection of Exports, Internet Penetration, and Political Stability as proxies for multidimensional globalization is grounded in their direct operational transmission channels into the maritime sector. Export intensity is prioritized as the economic proxy because it represents the derived demand for liner shipping capacity, reflecting actual trade integration more accurately than Foreign Direct Investment (FDI). For social globalization, internet penetration is utilized as a proxy for digital readiness, which is an essential prerequisite for modern 'Smart Port' operations and digital trade facilitation. Political stability is isolated as the primary political proxy due to the capital-intensive and long-term nature of maritime investments, where institutional security acts as a crucial de-risking factor for international shipping lines. To maintain model parsimony and mitigate potential multicollinearity, other indicators such as import volumes and trade tariffs were intentionally excluded; imports often exhibit high statistical redundancy with exports in ASEAN's export-led economies, while tariff structures have been largely harmonized through the ASEAN Free Trade Area (AFTA). This precise selection ensures a focused and transparent empirical framework.

Statistical Analysis

Statistical analysis is a systematic process that includes collecting, organizing, interpreting, and presenting quantitative data using statistical techniques to identify patterns, trends, and relationships that exist in the data.

Classical Assumptions

The classical assumption test is a series of tests carried out to ensure that the regression model used meets the basic assumptions to obtain unbiased, consistent, and efficient estimates of model parameters by testing for normality, multicollinearity, heteroscedasticity, and autocorrelation (Khan et al., 2023).

Model Selection

In panel data analysis, three main models that are often used for estimation are *the Common Effect Model*, *Fixed Effect Model*, and *Random Effect Model*. To determine the most appropriate model, a series of tests are needed such as the *chow test, the hausman* test , and the *Breusch-pagan lagrange multiplier test* (Gujarati, 2006) .

Panel Data Regression Model

According to (Baltagi BH, 2005) panel data is generated from observations of a number of individuals monitored over several different time spans. One of the regression models available for panel data is a model that maintains a constant slope but has varying intercept values. In a one-way component model, variation is caused by one of the units, namely between *cross-sectional* or time, while in a two-way model, variation is influenced by both cross-sectoral units and units related to time. Panel data regression analysis aims to estimate and predict differences in characteristics between individuals or between times and to find the mean value of a data set (both samples and populations) by observing the relationship between the variables studied (dependent variables) and the variables used to explain them (independent variables). So mathematically the regression model of this study is structured as follows:

$$Y = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3\ X3 + \varepsilon (3.1)$$

Description:

Y: Liner Shipping Connectivity Index
β0 : *Intercept*
β1, β2, β3: Regression Coefficient
X1: Exports of Goods and Services (% of GDP) (Economic Globalization Proxy)
X2: Individuals using the Internet (% of population) (Social Globalization Proxy)
X3: Political Stability and Absence of Violence/Terrorism (Political Globalization Proxy)
ε : *Error Term*

© 2026 by MIP

Statistical t Test (Partial Test)

In research, the significance of the influence of independent variables on dependent variables is seen through the t-statistic test (Widarjono, 2018). In its use, if t-count> t-table or significance is less than (α) 5%, this indicates that there is a significant partial influence between the independent variables on the dependent variable (Gujarati, 2006).
The hypothesis in this test is:

H_0: βi < 0There is no significant influence between the independent variables on the dependent variable partially.
Ha: βi > 0There is a significant influence between the independent variables on the dependent variables partially.

The testing criteria are as follows:

1. If t-statistic > t-table then *H* 0 is rejected. The independent variable has a significant effect on the dependent variable.
2. If t-statistic < t-table then *H* 0 is accepted. The independent variable does not have a significant effect on the dependent variable.

F Statistic Test

The F-statistic test is used to show how independent variables interact with each other and impact the dependent variable (Wooldridge, 2013). If the F-count exceeds the F-table in the test, then simultaneously the independent variables have a significant influence on the dependent variable, or the data is consistent with the research hypothesis.

H0: βi < 0	There is no significant influence between the independent variables on the dependent variables simultaneously.
Ha: βi > 0	There is a significant influence between the independent variables on the dependent variables simultaneously.

The testing criteria are as follows:

1. If F-statistic > F-table then *H* 0 is rejected. The independent variables on the dependent variables statistically have a significant effect together.
2. If F-statistic < F-table then *H* 0 is accepted. The independent variables on the dependent variables do not statistically have a significant effect together.

Test of Determination Coefficient (R^2)

According to Widarjono (2018), the coefficient of determination (R^2) is used to measure the proportion of the contribution of independent variables in explaining the dependent variable. An R^2 value approaching one indicates that the regression model has good ability to explain data variability, while an R^2 value approaching zero indicates limited ability. However, R^2 has a weakness because it tends to increase with the addition of independent variables, although these variables do not always increase the predictive power of the model. Therefore, adjusted R-square is used to correct the addition of irrelevant independent variables, so that the adjusted R-square value will not exceed R-square and can decrease or become negative if the addition of these independent variables does not improve the quality of the model or if the model shows a low level of fit.

ANALYSIS AND DISCUSSION

Descriptive Statistical Analysis functions in descriptions that include *the mean* and *median* of a set of sorted data. In addition, this analysis includes data distribution such as *maximum values, minimum* values, and standard deviation values as indicators of data distribution in research (Jin et al., 2023).

Table 1. Descriptive Statistical Analysis

Statistical Classification	X1	X2	X3	Y
Mean	4.061380	54.00139	-0.163563	60.23244
Median	4.201523	53.75000	-0.248741	45.19169
Maximum	5.314819	96.90000	1.599125	113.7750
Minimum	2.852507	10.90000	-1.650760	21.34955
Std. Dev.	0.715549	23.75641	0.859405	28.97102

Source: research results 2025

Table 1 provides a comprehensive overview of the data Exports of Goods and Services (X1) as a proxy for economic globalization has a mean value of 4.06% with a standard deviation of 0.72%, indicating a relatively consistent level of economic openness among ASEAN countries. The range of values ranges from 2.85% to 5.31%, with a difference between the mean (4.06%) and median (4.20%) of 0.14 percentage points. The coefficient of variation of 17.6% indicates moderate variability in the level of globalization of regional economies. Meanwhile, Individuals using the Internet (X2) as an indicator of social globalization shows a mean value of 54.00% with a standard deviation of 23.76%. This variable has a wide range, from 10.90% to 96.90%, reflecting the

© 2026 by MIP

heterogeneity in information technology penetration in the ASEAN region. The almost identical mean (54.00%) and median (53.75%) values indicate symmetrical data distribution. Political Stability and Absence of Violence/Terrorism (X3) as a proxy for political globalization has an average value of -0.16 with a standard deviation of 0.86. This variable is in the range of -1.65 to 1.60 based on the World Bank scale. The difference between the mean (-0.16) and median (-0.25) of 0.09 points indicates a near-normal distribution of data with a slight positive slope. Meanwhile, the Liner Shipping Connectivity Index (Y) as the dependent variable has a mean value of 60.23 with a standard deviation of 28.97. The range of values ranges from 21.35 to 113.78, indicating considerable variability in maritime logistics performance. The difference between the mean (60.23) and median (45.19) of 15.04 points indicates a positively skewed data distribution. The coefficient of variation of 48.1% shows the highest heterogeneity compared to other variables. This high heterogeneity suggests that political stability is a volatile yet decisive factor in the ASEAN maritime landscape. This study argues that political stability does not operate in isolation; rather, it serves as a critical moderating 'anchor' that amplifies the dividends of economic and social globalization. The positive influence of internet penetration on maritime logistics digitalization can only be fully optimized when underpinned by a stable political environment that ensures policy continuity and digital infrastructure security. Similarly, the correlation between export intensity and LSCI is significantly strengthened by political stability, which acts as a primary de-risking mechanism for global shipping lines when making long-term commitments to port calls in the region. Consequently, political stability functions as a catalyst that allows trade openness and digital readiness to be effectively translated into superior and sustainable maritime logistics performance.

Classical Assumptions

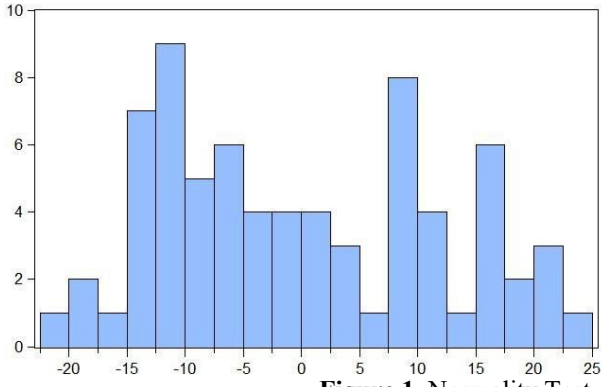


Figure 1. Normality Test
Source: research results 2025

Based on Figure 1. the normality test from the histogram above, the probability value is 0.093060> 0.05. Then the *Jarque-Bera* value < *Chi Square* value which indicates that the data follows a normal distribution pattern.

Table 2. Multicollinearity Test

Correlation Coefficient Variable	X1	X2	X3
X1	1.000000	0.676148	0.781609
X2	0.676148	1.000000	0.702763
X3	0.781609	0.702763	1.000000

Source: research results 2025

Based on table 2 the results of the multicolonierity test, it was found that there were no variables with a relationship that exceeded the correlation value of 0.8. Therefore, it can be concluded that there is no significant multicollinearity between the independent variables used in this study. This means that the variables do not show a strong linear relationship or lack of meaningful interrelationships among others, so there is no significant interdependence.

Model Selection

Table 3. Chow Test

No	Test Summary	Chi-Sq. Statistic	Chi-Sq. Df	Prob.	Conclusion
1	Fix Effect Model	105,944169	5,63	0,0000	H_0 is rejected

Source: research results 2025

Based on the Chow Test results presented in Table 3, the statistical Chi-square value is 105.944169 with a degree of freedom of 5.63 and a probability level of 0.0000. The statistical Chi-square value (105.944169)> Chi-square table (11.07050) with a probability value of 0.0000 <0.05. These results indicate rejection of the null hypothesis (H_0), which indicates that the Fixed Effect model is more appropriate to use than the Common Effect model in the panel data analysis of this study.

© 2026 by MIP

Table 4. Hausman test

No	Test Summary	Chi-Sq. Statistic	Chi-Sq. Df	Prob.	Conclusion
1	Random Effect Model	6,484136	3	0,0903	H_0 is accepted

Source: research results 2025

The Hausman Test results shown in Table 4 show a statistical Chi-square value of 6.484136 with 3 degrees of freedom and a probability level of 0.0903. The statistical Chi-square value (6.484136) < Chi-square table (7.815) with a probability value of 0.0903 > 0.05 indicates acceptance of the null hypothesis (H_0), which indicates that there is no systematic difference between the Fixed Effect and Random Effect estimators. Thus, the Random Effect model can be considered consistent and efficient for use in this study.

Table 5. LM Test

No	Test Summary	Cross-section	Period	Both	Conclusion
1	Breusch-Pagan	141,9208	2,783379	144,7042	H_0 is rejected
		0,0000	0,0952	0,0000	

Source: research results 2025

The Lagrange Multiplier test (LM test) presented in Table 5 produces a Breusch-Pagan cross- section value of 141.9208 with a probability level of 0.0000. The probability value obtained (0.0000 <0.05) indicates rejection of the null hypothesis (H_0), which indicates that the Random Effect model is more appropriate to use compared to the Common Effect model.

Panel Data Regression Result

Table 6. Results of OLS Calculation of Panel Data Regression Equation of Selected FEM Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-46.20085	17.60568	-2.624201	0.0107
X1	20.67991	4.101105	5.042523	0.0000
X2	0.420971	0.046169	9.118119	0.0000
X3	1.765205	3.034501	0.581712	0.5627
	Effects Specification			
			S.D.	Rho
Cross-section random			9.784184	0.7823
Idiosyncratic random			5.161667	0.2177

Weighted Statistics			
R-squared	0.647648	Mean dependent var	9.068313
Adjusted R-squared	0.632103	S.D. dependent var	8.725238
S.E. of regression	5.292250	Sum squared resid	1904.538
F-statistic	41.66296	Durbin-Watson stat	0.977039
Prob(F-statistic)	0.000000		
Unweighted Statistics			
R-squared	0.830122	Mean dependent var	60.23244
Sum squared resid	10123.35	Durbin-Watson stat	0.183813

Source: research results 2025

Statistical Test t (Partial Test)

Based on Table 6. The coefficient of the Exports of Goods and Services variable (X1) of 20.67991 indicates that every 1 percent increase in the ratio of exports of goods and services to GDP will increase the Liner Shipping Connectivity Index by 20.67991 assuming other variables are constant (ceteris paribus). The obtained t-statistic value of 5.042523 is greater than the t-table at the 5% significance level with a probability value of 0.0000 which is smaller than $\alpha = 0.05$. This finding indicates that economic globalization proxied through exports of goods and services has a positive and significant influence on the performance of maritime logistics in the ASEAN region partially. This result is consistent with international trade theory that emphasizes the importance of maritime connectivity in supporting export-import activities.

The coefficient of the variable Individuals using the Internet (X2) of 0.420971 indicates that every 1 percent increase in the proportion of individuals using the internet will increase the Liner Shipping Connectivity Index by 0.420971 assuming other variables are constant. The obtained t-statistic value of 9.118119 is greater than the t-table with a probability value of 0.0000 which is significant at the $\alpha = 0.05$ level. This finding shows that social globalization proxied through internet penetration has a positive and significant influence on maritime logistics performance in the ASEAN region partially. This indicates that digitalization and digital connectivity play an important role in improving efficiency and coordination in the maritime logistics system.

The coefficient of the Political Stability and Absence of Violence/Terrorism variable (X3) of 1.765205 indicates that every 1 unit increase in the political stability index and the absence of violence/terrorism will increase the Liner Shipping Connectivity Index by 1.765205 points assuming other variables are constant. However, the obtained t-statistic value of 0.581712 is smaller than the t-table with a probability value of 0.5627 which is greater than α

© 2026 by MIP

= 0.05. This finding indicates that political globalization proxied through political stability does not have a significant influence on the performance of maritime logistics in the ASEAN region partially. This result can be explained by the relatively homogeneous condition of political stability in the ASEAN region or the existence of other factors that are more dominant in influencing maritime logistics performance.

F Statistic Test

The F test aims to test the effect of independent variables together on the dependent variable. Based on the results of the random effect model estimation, the F-statistic value is 41.66296 which is greater than the F-table at the 5% significance level with a probability value of 0.000000 which is significant. This result shows that the variables Exports of Goods and Services (X1), Individuals using the Internet (X2), and Political Stability and Absence of Violence/Terrorism (X3) simultaneously have a significant effect on the Liner Shipping Connectivity Index in the ASEAN region. These findings confirm that the multidimensional dimensions of globalization collectively have a substantive impact on maritime logistics performance, although the individual contributions of each dimension vary.

Determination Coefficient (R^2)

The coefficient of determination is used to measure the proportion of variation in the dependent variable that can be explained by the independent variables in the model. Based on the analysis of the R-squared value of 0.647648, it shows that the model is able to explain 64.76% of the variation in the Liner Shipping Connectivity Index, while the remaining 35.24% is explained by other variables outside the model. Meanwhile, the unweighted R-squared value of 0.830122 indicates that without considering random effects, the model is able to explain 83.01% of the variation in the Liner Shipping Connectivity Index. The significant difference between the weighted and unweighted R-squared indicates that the individual effects of ASEAN countries (cross-section random effects) contribute substantially in explaining the heterogeneity of maritime logistics performance among countries in the region.

DISCUSSION

Relationship between Economic Globalization and Maritime Logistics Performance

The regression results show that economic globalization proxied through the ratio of exports of goods and services to GDP (X1) has a positive and significant influence on the Liner Shipping Connectivity Index (Y) with a coefficient of 20.67991 (t-statistic = 5.042523, p-value = 0.0000). This coefficient indicates that

every 1% increase in export intensity will increase maritime logistics connectivity by 20.68 LSCI points. The economic significance of this finding can be contextualized through the ASEAN region's LSCI distribution which has a mean of 60.23 points with a standard deviation of 28.97. Thus, a 1% increase in export intensity is equivalent to a 0.71 standard deviation increase in maritime logistics performance indicating a very substantial economic impact in the context of variability in maritime logistics performance among ASEAN countries.

These empirical findings consistently support the Ricardian theory of comparative advantage and modern international trade theory, where the intensification of export activities creates a demand-pull effect on maritime logistics infrastructure through three interacting transmission mechanisms. The first mechanism is the economies of scale mechanism which operates on the principle that an increase in export volume encourages optimal utilization of port and shipping lines capacity through a cost spreading effect, whereby the fixed costs of maritime infrastructure can be distributed over a larger volume of trade to create a reduction in per unit cost that enables service expansion and increased frequency of route connectivity (Kim et al., 2016). The second mechanism is the infrastructure investment mechanism which suggests that the expectation of increased trade flows drives maritime infrastructure investment from both the public and private sectors. This investment is not only limited to physical infrastructure such as port expansion but also includes digital infrastructure such as port community systems and automated cargo handling systems (Lorz, 2020). The third mechanism is the network externality mechanism, which indicates that an increase in a country's export activity creates spillover effects that strengthen the region's position in the global maritime network. This mechanism operates through hub-and-spoke where ports with high connectivity become preferred ports for major shipping lines and create a self-reinforcing cycle of increased connectivity (Li et al., 2023).

Cross-sectional analysis shows significant heterogeneity in maritime logistics performance among ASEAN member states, with LSCI scores ranging from 21.35 to 113.78 points, reflecting diverse levels and capacities in leveraging economic globalization to improve maritime logistics performance. Countries with higher export intensity such as Singapore (LSCI = 113.78) and Malaysia show superior connectivity performance compared to countries with lower export intensity such as Laos and Myanmar. This phenomenon can be explained through path dependency theory where initial conditions in export orientation create advantages in maritime infrastructure development, so that countries that have built comparative advantages in export-oriented industries experience accelerated development in maritime logistics capabilities through learning-by-doing effects and agglomeration economies that strengthen competitiveness positions in regional maritime trade networks (Van Driel & Devos, 2007). These dynamics

© 2026 by MIP

create a reinforcing cycle that further deepens the maritime logistics performance gap among ASEAN Member States, indicating the importance of coordinated policy interventions to reduce disparities and enhance regional economic integration through more inclusive maritime logistics infrastructure development.

These findings have strategic implications for maritime policy development in the ASEAN region. Trade liberalization policies, export promotion strategies, and export-oriented industrial development policies can serve as effective instruments for maritime infrastructure development, but require a synchronized policy framework that combines industrial development, trade promotion, and maritime infrastructure investment in strategic coordination to avoid bottlenecks in logistics performance or sub-optimal utilization of maritime infrastructure investment. This policy integration is crucial as export promotion policies that are not supported by adequate maritime infrastructure will face constraints in logistics performance, while maritime infrastructure investments that are not aligned with export capabilities will experience sub-optimal utilization (Rehman & Noman, 2021). Thus, a coordinated policy approach is required to maximize synergies between export capacity development and maritime logistics infrastructure to achieve optimal economic efficiency and sustainable regional competitiveness.

Comparison with previous literature shows consistency with previous empirical findings, research by (Fugazza and Hoffmann, 2017) identified an elasticity of LSCI to bilateral trade of 0.28, while in this study found an elasticity of 20.68 for the export intensity-LSCI relationship. This difference in magnitude can be explained through regional specificity where the ASEAN region has a strategic maritime position that strengthens the export-connectivity relationship, methodological differences in the use of panel data compared to cross-sectional analysis, and temporal differences where the most recent observation period captures the effects of globalization that is getting stronger. This consistency is also demonstrated by (Munim et al., 2018) who identified economic development as a determinant of LSCI with a coefficient of 0.38, which consistently supports the findings of this study and confirms the robustness of the relationship between economic performance and maritime logistics capabilities, thus suggesting that regional characteristics may strengthen the relationship. These findings indicate that while the basic relationship between economic performance and maritime connectivity is universal, the intensity of the relationship can vary significantly depending on the geographical context, research methodology and time period observed.

Relationship between Social Globalization and Maritime Logistics Performance

The estimation results show that social globalization proxied through internet penetration (X2) has a positive and significant influence on Liner Shipping Connectivity Index (Y) with a coefficient of 0.420971 (t-statistic = 9.118119, p-value = 0.0000). This coefficient indicates that every 1% increase in the proportion of individuals using the internet will increase maritime logistics connectivity by 0.42 LSCI points, ceteris paribus. The very high statistical significance ($p < 0.001$) with the highest t-statistic value among all independent variables indicates that internet penetration is the most robust determinant in explaining variations in maritime logistics performance in the ASEAN region.

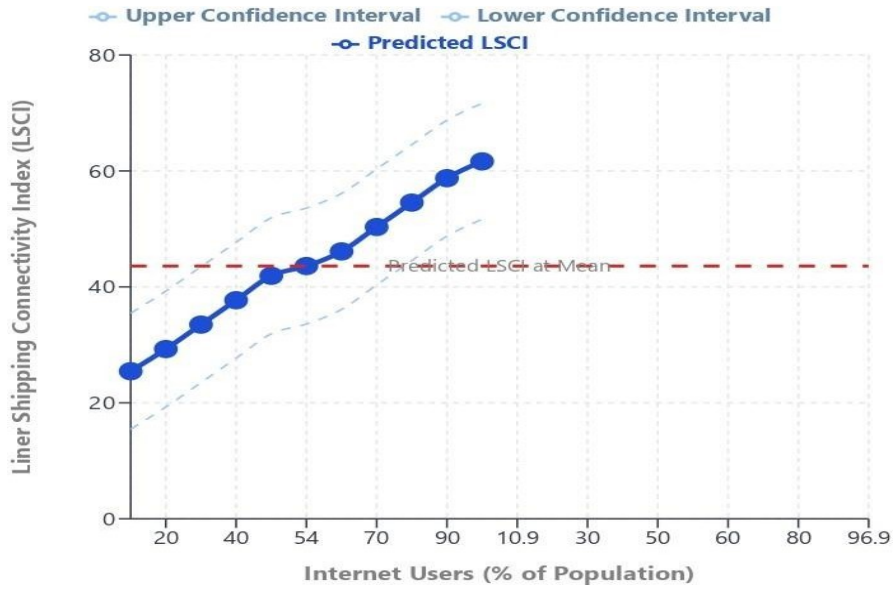


Figure 1. Social Globalization Effects on Maritime Logistics Connectivity in ASEAN

Based on Figure 1, internet penetration in the ASEAN region shows substantial heterogeneity with a mean value of 54.00% (standard deviation 23.76%) and a range from 10.90% to 96.90%. A one standard deviation increase in internet penetration (23.76%) would increase the LSCI by 10.00 points (23.76 × 0.420971), which is equivalent to 0.35 standard deviations in maritime logistics performance (10.00/28.97). This economic impact suggests that the digitization of society has a substantial contribution to the transformation of maritime

© 2026 by MIP

logistics capabilities, particularly in the context of technological convergence that integrates domestic logistics systems with global networks (Ahmed et al., 2022).

These empirical findings consistently support the theoretical framework that integrates network theory, technology adoption theory, and digital transformation theory in the context of maritime logistics. The transmission mechanism of the effect of internet penetration on maritime logistics performance can be explained through four interacting and reinforcing pathways. First, the digital infrastructure facilitation mechanism operates on the principle that high internet penetration creates an enabling environment for the implementation of digital technology in port operations and shipping lines. As argued by (Rziki et al., 2023) this mechanism facilitates the adoption of Internet of Things (IoT), blockchain technology, and artificial intelligence in cargo management systems, real-time tracking, and predictive maintenance that directly improve operational efficiency and inter-modal coordination in the maritime supply chain. In the ASEAN context, where the volume of maritime trade increases from 8.4 billion tons in 2010 to 11.0 billion tons in 2021, digitalization can manage the increasing operational complexity.

Second, the information asymmetry reduction mechanism suggests that widespread internet access reduces information gaps between shippers, freight forwarders, and ports through integrated digital platforms. This mechanism is in line with the findings of (Kunaka and Mustra, 2013) who identified a path coefficient of 0.56 between ICT infrastructure and trade facilitation performance, where the reduction of information asymmetry allows for more efficient coordination in scheduling, routing, and resource allocation which ultimately increases the reliability and frequency of shipping lines' services (Sliwczynski, 2020). In the context of the ASEAN region, which controls 25% of total global trade goods, efficient information coordination can maintain a competitive advantage.

Third, the network externality amplification mechanism indicates that internet penetration creates a critical mass for the development of a digital maritime ecosystem that connects various stakeholders in the maritime trade network. This mechanism operates through platform economy effects where an increase in the number of internet users creates incentives for the development of digital applications and services that support maritime logistics efficiency, such as port community systems, electronic data interchange, and digital payment systems that facilitate trade facilitation and reduce transaction costs. Consistent with the findings of (Korniyenko, 2023), the adoption of digital technology is proven to increase port productivity by 25-40% and maritime connectivity by 15-30%. Fourth, the human capital augmentation mechanism shows that high internet penetration increases the digital literacy and technical competence of workforce in the maritime logistics sector, which enables the adoption of

advanced technology and innovation in operational processes. This mechanism creates multiplier effects where the increase in individual digital capabilities contributes to the increase in sector productivity which in aggregate strengthens the performance of maritime logistics.

Cross-sectional analysis based on the research data shows a consistent pattern between internet penetration levels and maritime logistics performance among ASEAN member states. The variation in LSCI ranging from 21.35 to 113.78 points reflects significant heterogeneity in digital capabilities. This phenomenon can be explained through the digital divide theory which suggests that the digital divide creates disparities in technological capabilities that impact competitiveness in the global logistics network. Countries with more advanced digital infrastructure have a comparative advantage in adopting smart logistics technologies, automated port operations, and integrated supply chain management systems that increase their attractiveness as shipping destinations and transit hubs. Network theory explains that digitalization can strengthen a country's strategic position in international maritime trade networks (Heilig et al., 2017). High internet penetration allows countries to integrate domestic logistics systems with global supply chain networks through digital platforms that connect multiple stakeholders. This creates self-reinforcing network effects where increased digital connectivity attracts more shipping lanes and cargo flows, ultimately strengthening the position in the maritime network.

Research by (Rziki et al., 2023) identified a positive elasticity of internet penetration to the Logistics Performance Index of 0.32, which is qualitatively consistent with the findings of this study (0.42). The difference in magnitude can be explained through: (1) measurement specificity where this study uses the maritime connectivity-specific LSCI, while Choi uses the broader LPI covering all modes of transport; (2) regional characteristics where the ASEAN region has maritime-oriented economies that strengthen the relationship between digitization and maritime performance; and (3) temporal evolution where the more recent observation period captures more mature technological advancements. The study by (Korniyenko, 2023) shows that the adoption of digital technology significantly improves maritime connectivity.

The findings of this study generate policy implications. First, digital infrastructure investment should be positioned as a strategic priority in national development planning, particularly in the context of maritime logistics competitiveness. Second, regional coordination on digital standards and interoperability protocols is crucial to maximize the network effects of maritime logistics digitization. Considering that the ASEAN region facilitates a maritime trade volume of $2.8 trillion by 2021. Third, public-private partnerships in digital transformation initiatives can accelerate the adoption of advanced technologies in maritime logistics through risk-sharing and resource pooling mechanisms.

© 2026 by MIP

Based on the evidence of this study, countries with higher internet penetration exhibit superior maritime performance, indicating that a collaborative approach in digital development can accelerate the convergence of regional maritime capabilities.

Relationship of Urban Population to Energy Intensity in EMDEs Countries

The estimation results show that political globalization proxied through Political Stability and Absence of Violence/Terrorism (X3) has a positive coefficient of 1.765205 but is not statistically significant on Liner Shipping Connectivity Index (Y) with a t-statistic value of 0.581712 and a p-value of 0.5627. This non-significant finding contrasts with Institutional Economics Theory which emphasizes the role of political stability in creating an enabling environment for long-term maritime infrastructure investment (Baker et al., 2019). Political stability should affect maritime logistics performance through four mechanisms: investment climate mechanism, policy predictability mechanism, operational security mechanism, and international cooperation mechanism.

Political Stability and Absence of Violence/Terrorism in the ASEAN region shows a mean value of -0.163563 with a standard deviation of 0.859405, indicating relative homogeneity in regional political stability compared to higher variability in the economic (CV = 17.6%) and social (CV = 44.0%) dimensions of globalization. The ASEAN economic integration process has created spillover effects in institutional development and political stability through peer pressure, best practice sharing, and regional security cooperation mechanisms. Therefore, variations in political stability are not extreme enough to create significant differential effects on maritime logistics performance (Langhammer, 1991).

The threshold effect hypothesis indicates that the majority of ASEAN countries have reached the minimum threshold of political stability required for maritime infrastructure investment, such that additional improvements do not yield significant marginal benefits (Pekkanen & Pearson, 2018). Furthermore, the mediating variables hypothesis also suggests that the effect of political stability is mediated by more proximal factors such as physical infrastructure quality and regulatory efficiency (Zelner & Henisz, 2000). Furthermore, the substitution effects hypothesis suggests that economic integration and technological progress can compensate for deficiencies in political stability through risk-sharing mechanisms. In addition, the Measurement limitations hypothesis also indicates that perception-based indicators do not capture objective institutional conditions relevant to the maritime sector.

The theoretical implications of these findings suggest the need for a reconceptualization of the role of political stability in maritime logistics performance. Conditional effects hypothesis indicates that the effect of political stability is conditional on the level of economic development or technological

progress, where in the context of ASEAN countries that have reached middle-income status, political stability is a necessary but not sufficient condition to achieve superior maritime performance (Siddik et al., 2021). The non-linear relationships hypothesis also suggests that the relationship between political stability and maritime connectivity is nonlinear with diminishing returns at high levels of stability. The contribution to the literature gap is that these findings fill a gap in the understanding of multidimensional globalization effects on maritime logistics by revealing that not all dimensions of globalization have an impact on maritime logistics performance. The contribution to the regional maritime logistics literature shows the importance of context-specific analysis that considers regional characteristics in evaluating the determinants of logistics performance,

Building upon the empirical results, this research offers several actionable policy recommendations for ASEAN member states to enhance regional maritime performance. First, to leverage social globalization, ASEAN should transition from the current 'ASEAN Single Window' toward a more integrated 'Regional Port Community System' (RPCS) to standardize digital documentation and reduce maritime bottlenecks. Second, regarding economic integration, it is imperative to synchronize the development of Special Economic Zones (SEZs) with international liner shipping routes to maximize the 'demand-derived connectivity' from export activities. Finally, to sustain these gains, ASEAN must strengthen the ASEAN Political-Security Community (APSC) framework to mitigate geopolitical volatility, thereby ensuring a predictable and secure investment climate for global logistics providers.

CONCLUSION

Empirical evidence reveals that economic, social, and political globalization collectively account for 64.8% of the variance in ASEAN's maritime connectivity, with export intensity and digital penetration emerging as the primary catalysts for logistics efficiency. However, this study underscores that the efficacy of these economic and social drivers is fundamentally contingent upon political stability, which functions as a critical moderating 'anchor' for long-term infrastructure investment. Consequently, the findings suggest that regional logistics integration cannot be achieved through physical and digital enhancements alone; it necessitates a synchronized and stable political environment to mitigate operational risks and maximize the strategic benefits of global production networks. Based on these findings, ASEAN policymakers should prioritize the harmonization of maritime regulations and the strengthening of institutional stability alongside infrastructure upgrades. Investing in regional political cooperation and digital security frameworks is

© 2026 by MIP

essential to ensure that globalization efforts translate into a more resilient and globally competitive maritime logistics performance across all member states.

LIMITATIONS

This study recognises several methodological and conceptual limitations that need to be considered in interpreting the research findings. The relatively limited temporal coverage over the period 2010-2021 may not capture the full spectrum of long-term structural transformation in maritime logistics systems, while the operationalisation of multidimensional globalisation through certain proxy variables poses inherent measurement limitations that may not fully capture the complexity of economic integration, quality of digital connectivity, and objective institutional conditions. The regional specificity of ASEAN countries and their geographical and institutional characteristics will limit the generalisability of results to other regional contexts, while the focus on maritime logistics connectivity through the LSCI may not capture the broader implications for multimodal transport systems and the time lag between policy interventions and their materialisation in maritime logistics performance indicators.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

Ahmed, W., & Rios, A. (2022). Digitalization of the international shipping and maritime logistics industry: A case study of TradeLens. In *The Digital Supply Chain* (pp. 309–321). Elsevier. https://doi.org/10.1016/B978-0-323-91614-1.00018-6

Alesina, A., & Perotti, R. (1996). Income distribution, political instability, and investment. *European Economic Review*, *40*(6), 1203–1228. https://doi.org/10.1016/0014-2921(95)00030-5

Baker, N. B., Khater, M., & Haddad, C. (2019). Political stability and the contribution of private investment commitments in infrastructure to GDP. *Public Performance & Management Review*, *42*(4), 808–835. https://doi.org/10.1080/15309576.2018.1523064

Baltagi, B. H. (2005). *Econometric analysis of panel data* (3rd ed.). John Wiley & Sons, Ltd.

Cukrowski, J., & Fischer, M. M. (2000). Theory of comparative advantage: Do transportation costs matter? *Journal of Regional Science*, *31*(2), 89–108. https://doi.org/10.1111/0022-4146.00176

Evers, H.-D., & Karim, A. (2011). The maritime potential of ASEAN economies. *Journal of Current Southeast Asian Affairs*, *30*(1), 3–24. https://doi.org/10.1177/186810341103000105

Fugazza, M., & Hoffmann, J. (2017). Liner shipping connectivity as determinant of trade. *Journal of Shipping and Trade*, *2*(1), 1–23. https://doi.org/10.1186/s41072-017-0019-5

Gabriele, A. (2006). Exports of services, exports of goods, and economic growth in developing countries. *The Journal of Economic Integration*, *21*(2), 294–317. https://doi.org/10.11130/JEI.2006.21.2.294

Gocer, A., Ozpeynirci, O., & Semiz, M. (2022). Logistics performance index-driven policy development: An application to Turkey. *Transport Policy*, *124*, 20–32. https://doi.org/10.1016/j.tranpol.2021.03.007

Gujarati, D. N. (2006). *Essentials of econometrics* (3rd ed.). McGraw-Hill.

Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017). Digital transformation in maritime ports: Analysis and a game theoretic framework. *NETNOMICS: Economic Research and Electronic Networking*, *18*(4), 227–254. https://doi.org/10.1007/s11066-017-9122-x

Jamain, R. E., Zakaria, R. H., & Satar, N. M. (2022). Asian port performance dimensions and analyses: A systematic literature review. *International Journal of Professional Business Review*, *8*(1), e01165. https://doi.org/10.26668/businessreview/2023.v8i1.1165

Jin, L., Wang, H., & Zhao, Y. (2023). Descriptive statistical methods and their application in economic research. *Journal of Economic Statistics*, *42*(3), 123–137.

Kampan, P. (2017). Strategic development of ASEAN logistics infrastructure. *The Open Transportation Journal*, *11*, 67–80. https://doi.org/10.2174/1874447801711010067

Khan, M. A., Saeed, A., & Raza, S. (2023). Testing classical assumptions in regression analysis: A comprehensive review. *Journal of Applied Statistics*, *50*(2), 195–210.

Kim, N. S., Park, B., & Lee, K.-D. (2016). A knowledge based freight management decision support system incorporating economies of scale: Multimodal minimum cost flow optimization approach. *Information Technology and Management*, *17*(1), 81–94. https://doi.org/10.1007/s10799-014-0209-x

Korniyenko, O. (2023). Trends of digital technologies in maritime management. *Naukovij Poglâd: Ekonomìka Ta Upravlìnnâ*, *81*(6). https://doi.org/10.32782/2521-666x/2023-81-6

Langhammer, R. J. (1991). ASEAN economic co-operation: A stock-taking from a political economy point of view. *ASEAN Economic Bulletin*, *8*(2), 137–150. https://doi.org/10.1355/AE8-2B

Li, W., Bai, X., Yang, D., & Hou, Y. (2023). Maritime connectivity, transport infrastructure expansion and economic growth: A global perspective. *Transportation Research Part A: Policy and Practice*, *170*, 103609. https://doi.org/10.1016/j.tra.2023.103609

Lorz, O. (2020). Investment in trade facilitating infrastructure: A political-economy analysis. *European Journal of Political Economy*, *65*, 101928. https://doi.org/10.1016/j.ejpoleco.2020.101928

Martinez-Zarzoso, I., & Nowak-Lehmann, F. (2003). Augmented gravity model: An empirical application to Mercosur-European Union trade flows. *Journal of Applied Econometrics*, *6*(November), 291–316. https://doi.org/10.1080/15140326.2003.12040596

© 2026 by MIP

Munim, Z. H., & Schramm, H.-J. (2018). The impacts of port infrastructure and logistics performance on economic growth: The mediating role of seaborne trade. *Journal of Shipping and Trade*, *3*(1), 1. https://doi.org/10.1186/s41072-018-0027-0

Najeeb, K. K. M. (2022). ICT infrastructure and trade in services: A cross-country analysis. *International Journal of Finance, Entrepreneurship & Sustainability*, *2*(1). https://doi.org/10.56763/ijfes.v1i.35

Odehnal, J., & Sedlacik, M. (2018). Political stability as determinant of terrorist attacks in developed and developing countries: An empirical multivariate classification analysis. *AIP Conference Proceedings*, *1978*(1), 090005. https://doi.org/10.1063/1.5043742

Pekkanen, S. M., & Pearson, M. M. (2018). Limits to maritime power: The politics of controversy over Chinese infrastructure investment. *Social Science Research Network (SSRN)*. Paper No. 3285430. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3285430

Rehman, F. U., & Noman, A. A. (2021). Does infrastructure promote exports and foreign direct investment in selected Southeast Asian economies? An application of global infrastructure index. *Journal of Economic Studies*. https://doi.org/10.1108/JES-03-2020-0123

Rziki, M. H., Mansour, N., Boukili, A. E., & Sedra, M. B. (2023). Blockchain and IoT for real-time decision support for the optimization of maritime freight transport networks. In *Lecture Notes in Networks and Systems: International Conference on Advanced Intelligent Systems for Sustainable Development, AI2SD 2022* (Vol. 712 LNNS, pp. 377–389). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-35251-5_37

Santos, C. C. R., & Pereira, H. B. B. (2022). Theory-based studies of maritime networks: A literature review. *Journal of Bioengineering, Technologies and Health*, *5*(2), 141–145. https://doi.org/10.34178/jbth.v5i2.213

Siddik, M. N. A., Kabiraj, S., Hosen, M. E., & Miah, M. F. (2021). Impacts of political stability on shadow economy: Evidence from Bay of Bengal Initiative for Multi-sectoral Technical and Economic Cooperation countries. *Vision: The Journal of Business Perspective*. https://doi.org/10.1177/0972262920988387

Sliwczynski, B. (2020). Value of ICT integration model of e-booking system and intelligent truck traffic management system in the sea port of TEN-T corridor. In *Lecture Notes in Networks and Systems* (Vol. 98). Springer. https://doi.org/10.1007/978-3-030-24355-5_14

Urciuoli, L., & Hintsa, J. (2021). Can digital ecosystems mitigate risks in sea transport operations? Estimating benefits for supply chain stakeholders. *Maritime Economics and Logistics*, *23*(2), 237–267. https://doi.org/10.1057/s41278-020-00163-6

Van Driel, H., & Devos, G. (2007). Path dependence in ports: The persistence of cooperative forms. *Business History Review*, *81*(4), 681–708. https://doi.org/10.2307/25097420

Widarjono, A. (2018). *Econometrics: Theory and applications*. UPP STIM YKPN.

Wooldridge, J. M. (2013). *Introductory econometrics: A modern approach* (5th ed.). Cengage Learning.

Xiong, F., Zang, L., & Gao, Y. (2021). Internet penetration as national innovation capacity: Worldwide evidence on the impact of ICTs on innovation development. *Information Technology for Development*, *28*(2), 1–17. https://doi.org/10.1080/02681102.2021.1891853

Zelner, B. A., & Henisz, W. J. (2000). Politics and infrastructure investment. *Social Science Research Network (SSRN)*. https://doi.org/10.2139/ssrn.236940

Received: 24th November 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 566 – 581

MAPPING ROAD ACCIDENT HOTSPOTS ON MALAYSIAN INTER URBAN EXPRESSWAYS: AN ANALYSIS ON SEVERITY LEVEL

[1,3]Sharifah Zuraidah Syed Abdul Jalil, [2]S. Sarifah Radiah Shariff, [4]Saiful Aman Sulaiman, [4]Zaharah Mohd Yusof, [5]Fazzami Othman

[1]Faculty of Communication, Visual Art and Computing,
UNIVERSITI SELANGOR
[2]School of Mathematical Studies,
Faculty of Computer and Mathematical Sciences,
UNIVERSITI TEKNOLOGI MARA
[3]Malaysia Institute of Transport (MITRANS),
[4]Faculty of Built Environment,
UNIVERSITI TEKNOLOGI MARA
[5]ESRI MALAYSIA

Abstract

Road accidents can have a profound and often life-altering impact on the victims involved. Reducing severity due to road accidents is crucial even when the absolute numbers are relatively low. The problem at hand revolves around the need to ascertain the degree of accident severity at locations identified as hotspots, thus requiring focused interventions to improve road safety. This study aims to identify road accidents hotspots of an inter-urban expressway in Malaysia, and to determine the level of accident severity at locations identified as hotspots. This involves visualizing and analyzing the spatial distribution of road accident data to identify the hotspot locations of road accidents along the expressway. The study employed ArcGIS as a platform for data visualization and analysis. The evaluation of accident hotspots by accident severity level was conducted using Kernel Density Estimation (KDE). Learning from each incident and implementing changes can help prevent future accidents. Targeted safety measures and interventions to mitigate the risks associated with specific locations is crucial in reducing the likelihood and severity of accidents.

Keywords: road accident, hotspot, mapping, expressway, ArcGIS, KDE

[1] Corresponding author. Email: shari990@uitm.edu.my

INTRODUCTION

Road accidents are a significant issue in Malaysia, causing numerous deaths and injuries each year. Statistics showed that the number of road accidents in Malaysia has increased over a period of 10 years. According to the Department of Statistics Malaysia (2019), road traffic accidents ranked among the top five leading causes of death in Malaysia. The country's road safety situation has improved since then, but it remains a concern. In 2021, the number of road accidents in Malaysia was around 370 thousand, indicating a decrease compared to the previous year (Statista, 2023). The consequences from road accidents can vary widely depending on the severity of the accident, the type of injuries sustained, and the overall health and resilience of the individuals affected. Major key impacts involve the loss of human life, emotional and psychological disturbance, economic consequences, traumatic and some others.

Mapping road accident data is essential as it provides valuable insights that can contribute to improved road safety, urban planning, and public policy. By mapping accidents over geographical areas, patterns and trends can be analyzed. Mapping road traffic crash hotspots using Geographic Information System (GIS)-based methods is a common approach to identify high-risk locations for road accidents. GIS software is a useful tool for determining hotspots, as it can visualize accident locations (mapping) and run spatial analysis (Aldala'in, 2023). These locations, known as hotspots, can be referred to as hazardous road locations, high-risk locations, accident-prone locations, black spots, hot spots, hot zones, black zones, sites with promise, and priority investigation locations (Al-Aamri et al., 2021). Nogueira et al. (2023) applied various methods in GIS to obtain robust conclusions. Understanding where accidents occur most frequently helps in developing strategies to address specific challenges in those regions. One of the most widely used methods in GIS-based crash analysis is Kernel Density Estimation (KDE), which generates a continuous density surface from point-based accident data. KDE is particularly effective in identifying accident-prone zones (hotspots) by smoothing crash frequencies over space, thus allowing researchers to detect high-concentration areas along highways and urban corridors. In Malaysia, KDE has been applied to analyze accident distributions along the North–South Expressway and selected federal routes, revealing spatial clusters near interchanges, toll plazas, and high-traffic junctions (Manap et al., 2021; Shariff et al., 2018; Zahran et al., 2019). These findings align with international studies in countries such as Nigeria, Oman and Vietnam, where KDE has been used to map crash intensities and examine seasonal and demographic variations in accident occurrence (Afolayan et al., 2022; Alhajri et al., 2024 and Le et al., 2020).

© 2026 by MIP

As for the Malaysian expressways, although some of them have been given five-rating star through Malaysian Road Assessment Programme, accident statistics may vary from time to time (Nusa et al., 2025; Zahran et al., 2021). Monitoring the accident risk is crucial in order to maintain the status of expressways with good rating, as well as to improve road safety of Malaysian expressways in general. Expressways in Malaysia often experience high traffic volumes due to their role in connecting major cities and regions. The increased traffic can contribute to a higher likelihood of road accidents and studies demonstrated that expressway crashes are more strongly associated with high-speed segments and entry–exit ramps, while urban hotspots correlate with pedestrian activity and signalized intersections (Hisam et al., 2022; Amri et al., 2021). Such comparisons underscore the importance of context-specific spatial modeling when designing safety countermeasures.

Road accidents on expressways can result in fatalities, injuries, and damage to property. Fatalities are a significant concern, and efforts are made to reduce the number of lives lost on the roads. Examining spatial hotspots of accidents enables more effective implementation of remediation measures in these areas, potentially preventing future fatalities (Halim et al., 2017; Masron et al., 2018). Prioritizing prevention efforts can be further enhanced by comparing hotspots for all vehicle crashes to those specifically associated with fatal accidents. Even on straight expressways, understanding accident patterns is crucial for proactive safety measures, infrastructure improvements, and the overall goal of preventing accidents and promoting safer road environments.

Accident patterns can guide traffic engineering solutions on straight highways. To address this limitation, many studies incorporate spatial autocorrelation techniques such as Moran's I and Getis-Ord Gi* statistics. Moran's I evaluates global spatial autocorrelation to determine whether accidents are randomly distributed or spatially clustered, while Getis-Ord Gi* identifies statistically significant local hotspots and cold spots. In Malaysian regional analyses, these methods have been used to compare accident clustering across states such as Selangor, Johor, and Penang, demonstrating significant spatial concentration in highly urbanized and industrialized districts (Manap et al., 2019; Halim et al., 2017). Similarly, research in Pakistan and the United States has applied Moran's I and Gi* to validate hotspot locations along urban road networks and interstate highways, confirming persistent high-risk zones that warrant engineering interventions (Kamh et al., 2024; Zahran et al., 2019).

Another popular technique used in studying accident hotspot patterns is KDE. It is a valuable tool for visualizing road accidents across the spatial domain (Srikanth & Srikanth, 2020). It offers insights into the spatial distribution of accidents and helps identify areas with higher or lower accident density. KDE uses statistical techniques in estimating the probability density function. Many

studies use planar KDE for hot spot analysis such as the study of road and highway accident hotspots (Anderson, 2009; Erdogan et al., 2008). A point analysis method utilizing kernel density estimators has been employed by Waldon et al. (2018) and Chen et al. (2018) in the occurrence of hotspots in road traffic accidents. Hence, this study aims to utilise Kernel Density Estimation (KDE) to identify spatial accident hotspots along the expressway and analyse their association with location-specific factors. By highlighting areas with a higher concentration of accidents, the study provides evidence-based insights to assist relevant authorities in implementing targeted safety interventions and optimising the allocation of traffic management and enforcement resources.

RESEARCH METHODOLOGY

Study Area

This study focuses on an inter-urban expressway in Klang Valley, which is Shah Alam Expressway (also known as E5). This expressway is the third east–west-oriented expressway after the Federal Highway and New Klang Valley Expressway and it is part of the Kuala Lumpur Middle Ring Road 2 Scheme from Sunway Interchange to Sri Petaling Interchange. As a bustling expressway, it links the primary industrial and residential zones within the Klang Valley and has been a popular travelling mode due to its high accessibility to a wide range of highway networks within the Klang Valley.

Study Flow

The general approach of this study underwent four steps. The flow of study process is presented in Figure 1. The process begins with data collection, followed by data preparation, data visualization, and ends with data analysis.

Data collection

The first step for the study is data collection. This study involves secondary data acquired from the highway authority, KESAS Sdn. Bhd. The daily road accident data for Shah Alam Expressway of five consecutive years from 2013 to 2017 was investigated. The accident dataset encompasses several information such as the accident location, date and time of accident occurrence, type of vehicles involved, collision type, causal factors, weather condition, and the severity type resulted from the accident.

Data preparation

The second step in this study involves data preparation. In this step, the accident dataset was organized into Microsoft Excel spreadsheet, and missing data were observed and discarded. Missing data are the absence of data that arise for various reasons, such as incomplete data collection or technical issues during data

© 2026 by MIP

recording. Addressing missing data is crucial in statistical analysis and research, as it can impact the accuracy and reliability of findings. The locations of the road accidents in the dataset were recorded in the form of KM marker (Jalil et al., 2023). Preparation of data from KM marker to longitude and latitude coordinates was done with the help of Google Earth Pro. This was done by pinpointing each KM marker on the map of study area. At this point, the longitude and latitude coordinates were observed and recorded.

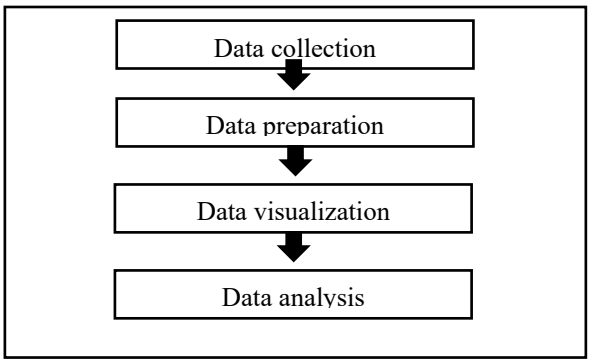


Figure 1. Process of study flow

Data visualization

The third step in the study flow involves data visualization. This study utilized Geographic Information System (GIS) application, namely ArcGIS for data visualization and analysis. For data visualization, the process is done by employing heat map symbology within ArcGIS.

Data Analysis

The final step in the study process is the data analysis using Kernel Density Estimation (KDE), In KDE, the crucial factor in determining the optimal density surface is the selection of both the cell size and bandwidth. The decision on bandwidth significantly influences the identification of hotspots and subsequently affects the overall results. The selection of suitable values for these parameters is both critical and subjective. The general equation for density estimation of KDE is given in equation (1).

$$f(s) = \frac{1}{nh} \sum_{i=1}^{n} \frac{K(s - s_i)}{h} \tag{1}$$

In this context, $f(s)$ is the density estimate at location s, n denotes the total number of locations, h signifies the smoothing parameter known as the bandwidth, K stands for the kernel function, and $(s - s_i)$ represents the distance between the location of ith observation and the location of s.

ANALYSIS AND DISCUSSION

Data description

Accidents can happen anywhere on the expressway whether on monotonous straight road, curves, or intersections. Shah Alam expressway is an expressway that connects the east and west of the Klang Valley. The eastbound route spans from Pandamaran to Sri Petaling, whereas the westbound route traverses in the opposite direction. The expressway, which is straight and extends over a considerable distance, covers a total length of 34.5 kilometres and includes 15 interchanges along its route. Figure 2 illustrates the yearly breakdown of total accidents at Shah Alam expressway. From 2013 to 2017, the expressway has recorded a total of 2,823 road accidents. The peak occurred in 2013, with 728 reported accidents along both east and west bounds of the expressway. Subsequent to that, in 2014 and 2015, there was a decrease of approximately 30% compared to the year 2013. However, there was a relative increase in 2016 and 2017 with 570 and 536 cases respectively.

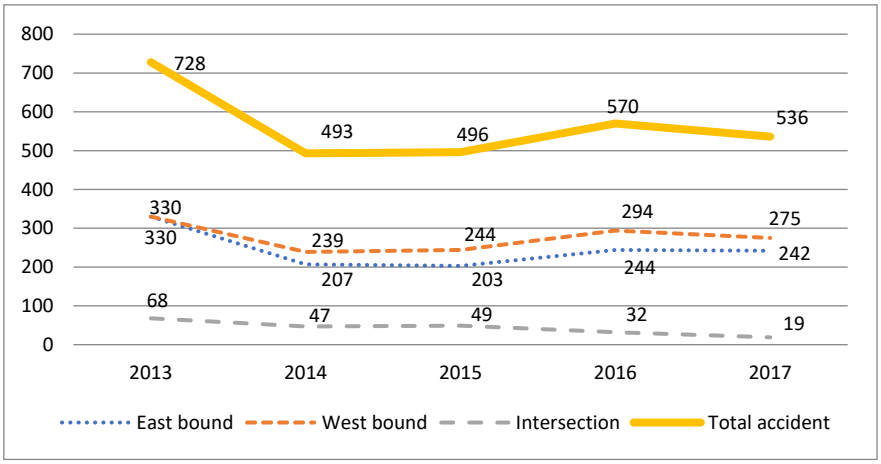


Figure 2. Number of accidents by expressway's route

From Figure 2, it is observed that the eastbound route followed a comparable trend to the overall road accident pattern, and similarly, the westbound route exhibited a quite similar trend to the total road accidents. Nevertheless, intersections displayed a distinct trend compared to the overall road

© 2026 by MIP

accidents during the five-year period. In summary, a relatively similar pattern can be observed between the eastbound and westbound directions, but this does not hold true for intersections.

Figure 3 displays the breakdown of number of accidents according to the level of accident severity at each route. This breakdown is represented yearly, from 2013 to 2017. It is observed that most accidents that occurred at Shah Alam expressway did not involve any injury to road users. A total of 1748 accidents was recorded for non-injury in five years. Although no injuries are sustained by individuals involved, there is still damage to vehicles or property. These accidents are considered less severe in terms of human impact but still involve financial costs for repairs. The impact of road accidents varies significantly depending on the severity of injuries incurred. From 2013 to 2017, there were a total of 161 accidents associated with severe injuries and 816 accidents related to light injuries. The physical impact from severe injuries and light injuries can lead to long-term consequences and disabilities or can also cause minor harm. Regardless of whether there are severe or light injuries, there may still be psychological effects such as stress, anxiety, or a fear of driving. In other context, fatal injuries have a profound impact on families and communities. The loss of a loved one is emotionally devastating, and it can have long-lasting effects on the mental and emotional well-being of those affected. The data on road accidents along the Shah Alam Expressway indicates a total of 98 fatal accidents over the five-year period from 2013 to 2017. This number is the lowest among the other severity levels. However, it leaves the most devastating impact on family members and communities.

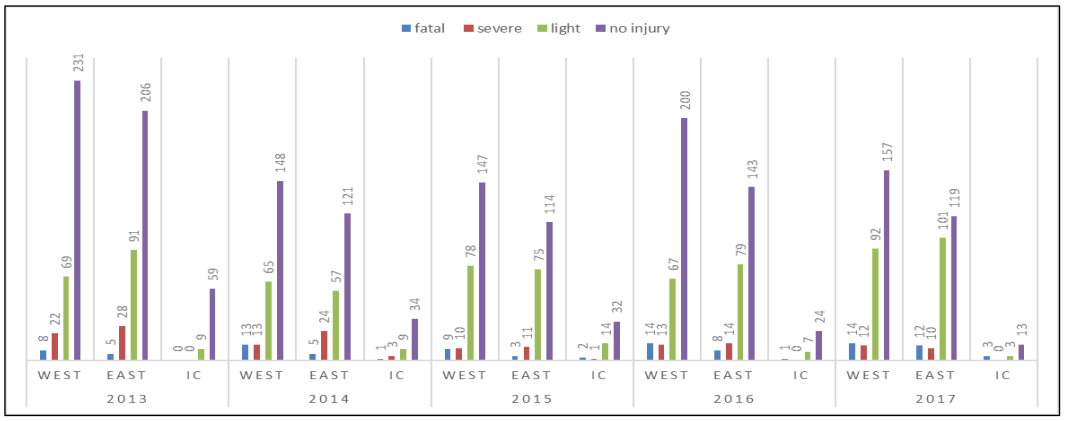


Figure 3. Accident severity level by route

Mapping of overall accident data

The first step taken in the mapping process is to identify the overall accident pattern for Shah Alam expressway regardless of accident severity. This is done by filtering the accident dataset into west bound and east bound. A heatmap in ArcGIS is used for visualizing the data. It is a spatial data visualization technique that uses a continuous colour gradient to represent the density or intensity of a phenomenon across a geographic area. When applied to road accident data, a heatmap reveals the spatial distribution of accidents and highlight areas with higher concentrations of incidents. The intensity of the heat at a specific location reflects the concentration of accidents. Hotspots, where accidents are more frequent, appear as areas with more concentrated and intense heat on the map. Figure 4a and Figure 4b represent the heatmaps of overall accidents from 2013 to 2017 along the west bound and east bound respectively. Based on the colour gradient in each heat map, higher accident densities are represented with yellow, while lower densities are represented with blue. From Figure 4a, two locations with the highest concentration and intensity are found for west bound. These are locations where accidents occurred more frequent, known as hotspots. For east bound, it is found that three locations along the expressway having the highest concentration and intensity as shown in Figure 4b. Scrutinizing the hotspots indicates that all the hotspots are nearing the toll plazas in both directions. This result is consistent with Jing et al., 2019, Xing et al., 2023.

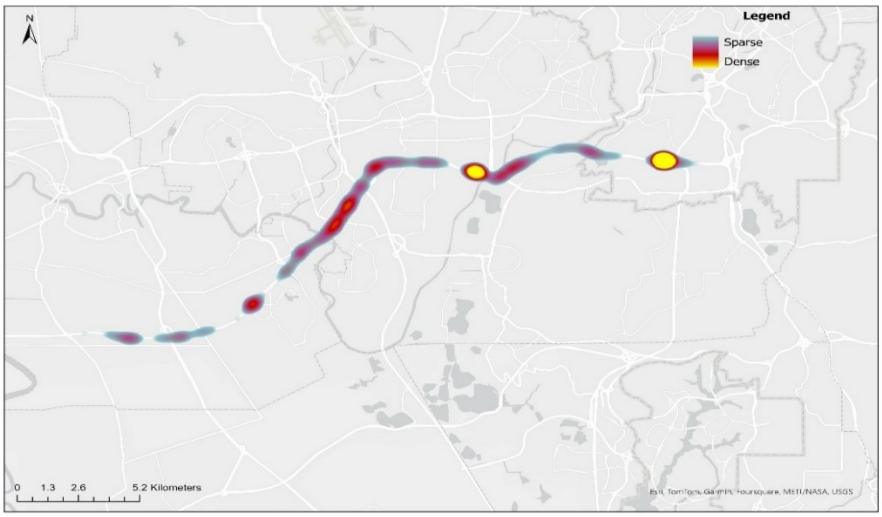


Figure 4a. Heatmap of overall accident count for west bound

© 2026 by MIP



Figure 4b. Heatmap of overall accident count for east bound

Mapping of overall accident count using KDE

Mapping using KDE involves creating a visual representation of the spatial distribution and intensity of road accident, and its process results in a continuous surface representing the estimated density of road accidents across the study area. This surface is generated based on the concentration of accidents, with areas of higher density depicted by more intense colours. For this study, a default cell size and bandwidth have been employed for estimating the kernel density. In this context, ArcGIS selects the optimal values for the cell size and bandwidth using internal heuristics that consider the spatial dispersion and number of input points (Zheng et al., 2024). This ensures computational efficiency and avoids arbitrary parameter selection. Figure 5a represents the spatial distribution of road accidents along Shah Alam expressway for west bound, while Figure 5b represents the spatial distribution of the accidents for east bound. The results from KDE indicate the same accident hotspots as seen in the heatmaps, where two accident hotspots are found for west bound and three hotspots for east bound are observed. The hotspots for west bound are located at KM49.0–KM49.4 and KM40.5–KM40.9, while the hotspots for east bound are located at KM40.5–KM40.9, followed by KM47.5–KM47.9 and KM27.0–KM27.5. Note that the locations are arranged according to colour intensity across the hotspots. Note that the number and locations of identified hotspots are consistent with the earlier mapping technique.

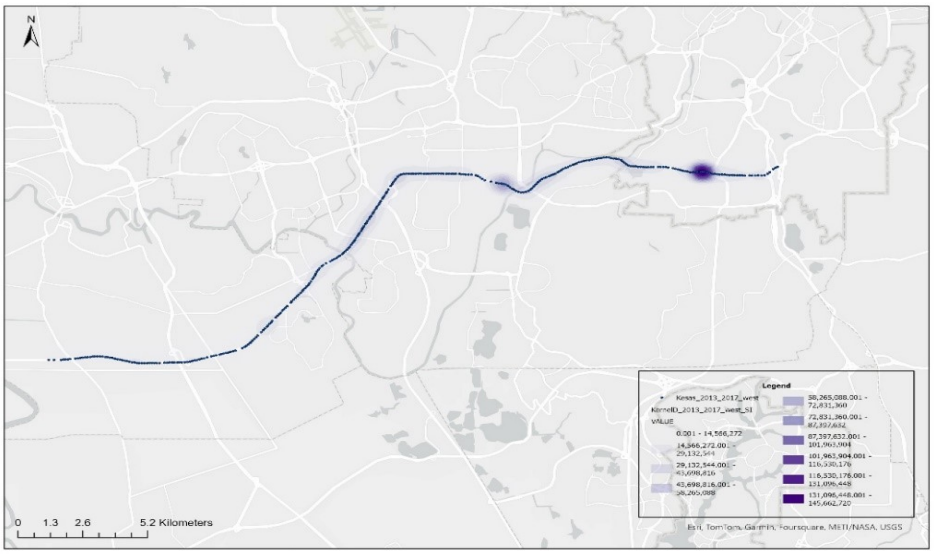


Figure 5a. Accident distribution for west bound using KDE

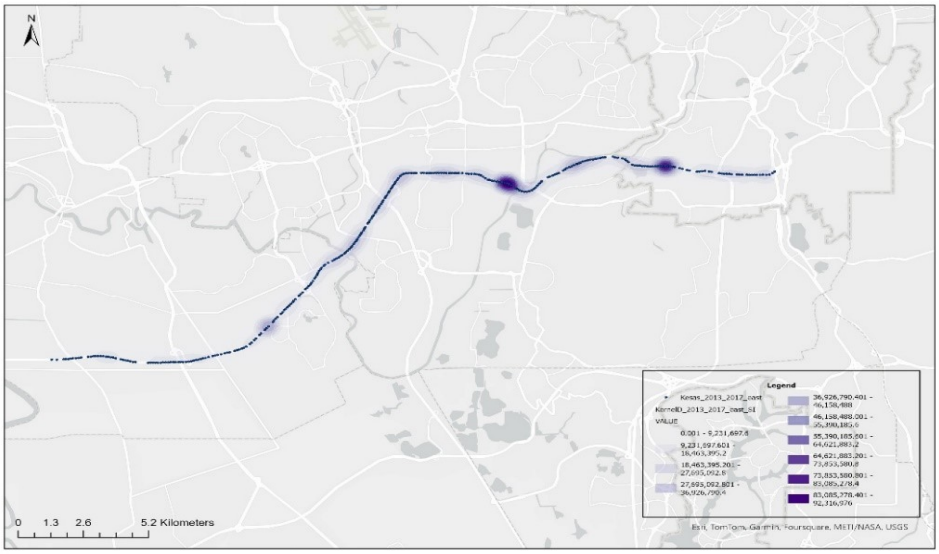


Figure 5b. Accident distribution for west bound using KDE

© 2026 by MIP

To test whether there is an association between the number of accidents and traffic directions, a Chi-square test at $\alpha = 0.05$ was done. Table 1 summarises the accident counts at each segment and its calculated expected frequencies.

$$\text{Test Statistic, } \chi^2 = \sum \frac{(O-E)^2}{E} \quad (2)$$

where

O = observed frequency

E = expected frequency

Table 1: Frequency Table & Expected Frequencies

Segment (KM)	West	East	Row Total
27.0–27.4	42 (56.81) ***3.86***	70 (55.19) ***3.97***	112
40.5–40.9	65 (75.57) ***1.47***	84 (73.43) ***1.51***	149
47.5–47.9	9 (40.07) ***24.12***	70 (38.93) ***24.83***	79
49.0–49.4	129 (74.55) ***41.55***	15 (72.45) ***42.73***	147
Column Total	**247**	**240**	**487**

Note: in brackets (expected frequencies), in italic (Chi-Square values)

The Expected Frequencies were calculated as follows:

$$\text{Example calculation for KM27.0} - \text{KM27.4 (West): } E = \frac{112 \times 247}{487} = 56.81$$

$$\text{Example calculation for KM27.0} - \text{KM27.4 (East): } E = \frac{112 \times 240}{487} = 55.19$$

Note that all the expected counts > 5, so the Chi-square assumption is satisfied.

From Table 1, the total Chi Square value was calculated to be $\chi^2 = 144.04$ and at degrees of freedom=3, the critical value is $\chi^2_{0.05,3} = 7.815$. Since, $\chi^2_{calculated} > \chi^2_{critical}$ = (144.04 > 7.815), which is significantly greater than the critical value of 7.815 at α = 0.05, the null hypothesis of independence is

rejected. In conclusion, there is a statistically significant association between accident counts and traffic direction (East vs West). This indicates that the distribution of accidents differs significantly between Eastbound and Westbound directions, suggesting that traffic direction may influence accident occurrence at the observed locations. This could indicate location-specific safety issues or geometric road differences that may require further investigation.

Mapping accidents severity on KDE

Accident severity is a crucial metric in assessing the overall impact of incidents, and it is commonly used in the perspective of various domains, including road safety. This section aims to identify whether the hotspot locations as found in the previous section, exhibit a tendency for more severe accidents, while neighbouring areas may witness incidents of a milder nature.

In this process, accident severity level has been selected to be parameters for visualization. Different color-coded markers as well as the sizes of markers in symbology have been chosen for different accident severities, representing the number of accidents at KM markers on the expressway. The layer of severity levels in ArcGIS was overlayed with the kernel density layer in ArcGIS. By overlaying the kernel density layer with severity layer, the spatial patterns, relationships, and context surrounding the density of accidents can be explored. The results from this process are shown in Figure 6a for west bound and Figure 6b for east bound. It is seen that at the hotspot location of KM40.5–KM40.9 for west bound, accidents occurrence involved severe and minor injuries, and no fatal accident is observed. On the other hand, there is also no fatal accident at KM49.0–KM49.4 while other severities involved. However, it is observed that there is one fatal accident in close proximity to the hotspot location. The possibility of a road accident can occur in proximity to a specific location depends on various factors. It may be influenced by the dynamic interactions of drivers, road conditions, and the environment. For east bound, a single fatal accident is observed between KM40.5 and KM40.9, with other forms of severity resulting from road accidents at all hotspot locations.

© 2026 by MIP

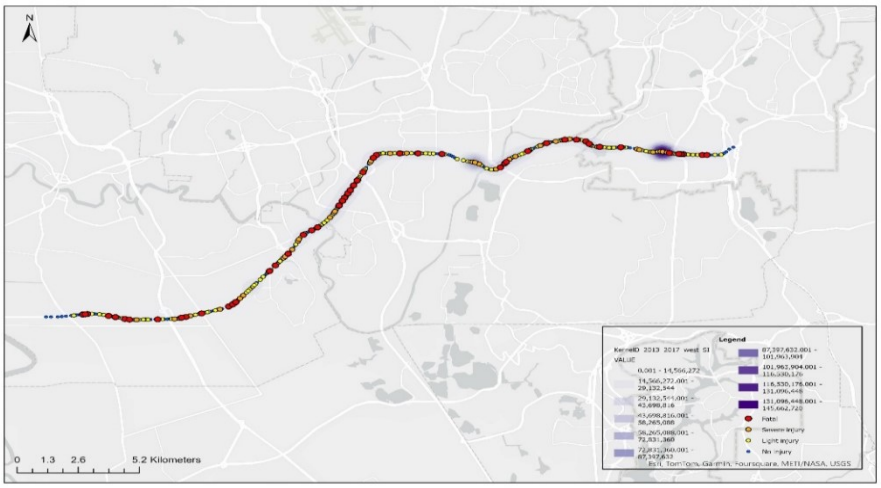


Figure 6a. Layer combination of KDE and severity level for west bound

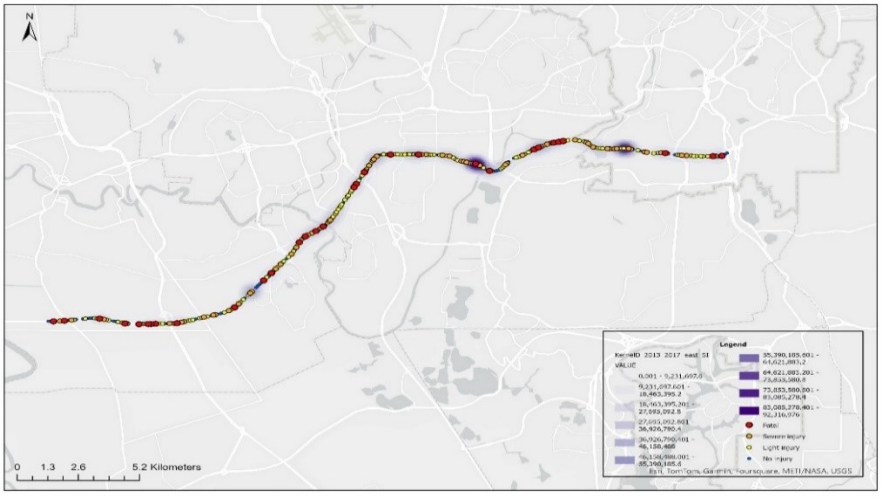


Figure 6b. Layer combination of KDE and severity level for east bound

The test was also run for severity cases and shows that there is no statistically significant association between accident severity counts and location (West vs East) at the 5% significance level. However, due to the small number of severity cases within individual kilometre segments, the Chi-square assumptions are not fully satisfied. Therefore, the association between severity occurrence and location should be interpreted cautiously, and alternative exact tests or aggregated segments may provide more reliable inference.

CONCLUSION

Visualizing road accidents using maps is a powerful way to analyze and communicate spatial patterns of the data. Both the heat map and KDE help in visualizing the distribution of road accident data across the study area. This study successfully identified spatial accident hotspots along the study corridor between 2013 and 2017, revealing two hotspot segments along the westbound direction and three along the eastbound direction. The analysis highlights that KM49.0–KM49.4 and KM40.5–KM40.9 represent critical accident-prone segments in the westbound direction, while KM40.5–KM40.9, KM47.5–KM47.9, and KM27.0–KM27.4 were identified as key hotspots in the eastbound direction. Among these, KM40.5–KM40.9 is of particular concern as it consistently recorded high accident occurrences in both travel directions, indicating the need for immediate attention from highway operators and local authorities.

Although fatal accidents were relatively limited within the identified hotspots, the presence of severe and minor injury accidents indicates that these segments pose notable safety risks. The occurrence of a fatal accident in close proximity to the hotspot area further underscores the importance of proactive safety interventions. Road accident occurrences are influenced by a complex interaction of driver behaviour, roadway characteristics, traffic flow conditions, and environmental factors. Therefore, hotspot identification provides an important evidence-based approach for understanding spatial risk patterns along highway corridors.

The findings also offer valuable insights for transportation planners, highway authorities, and local governments to prioritise safety improvements at critical locations. Targeted interventions such as improved road geometry, enhanced signage and lighting, traffic calming measures, and better enforcement strategies can be strategically implemented at the identified hotspots. Integrating accident hotspot analysis into road safety planning can also support more efficient allocation of resources and guide future infrastructure upgrades. In the context of sustainable transportation planning, continuous monitoring of accident patterns using spatial analysis techniques is essential for strengthening road safety management. Future studies may further integrate traffic volume data, roadway design characteristics, and behavioural factors to better understand the underlying causes of accidents. Such efforts will contribute to more comprehensive and proactive road safety planning, ultimately supporting safer and more resilient transportation systems.

REFERENCES

Afolayan, A., Easa, S. M., Abiola, O. S., Alayaki, F. M., & Folorunso, O. (2022). GIS-based spatial analysis of accident hotspots: A Nigerian case study. *Infrastructures*, *7*(8), 103.

© 2026 by MIP

Al-Aamri, A. K., Hornby, G., Zhang, L. C., Al-Maniri, A. A., & Padmadas, S. S. (2021). Mapping road traffic crash hotspots using GIS-based methods: A case study of Muscat Governorate in the Sultanate of Oman. *Spatial Statistics*, *42*, 100458.

Aldala'in, S. A., Abdul Sukor, N. S., Obaidat, M. T., & Abd Manan, T. S. B. (2023). Road accident hotspots on Jordan's highway based on geometric designs using structural equation modeling. *Applied Sciences*, *13*(14), 8095.

Alhajri, B., Rasam, A. R. A., Tarudin, N. F., Khalid, N., & Alshukaili, D. (2024). Spatial analysis of road traffic accident hotspots and patterns in Muscat, Oman: An exploratory risk management assessment. *Planning Malaysia*, *22*.

Amiri, A. M., Nadimi, N., Khalifeh, V., & Shams, M. (2021). GIS-based crash hotspot identification: A comparison among mapping clusters and spatial analysis techniques. *International Journal of Injury Control and Safety Promotion*, *28*(3), 325–338.

Anderson, T. K. (2009). Kernel density estimation and K-means clustering to profile road accident hotspots. *Accident Analysis & Prevention*, *41*(3), 359–364.

Chen, X., Huang, L., Dai, D., Zhu, M., & Jin, K. (2018). Hotspots of road traffic crashes in a redeveloping area of Shanghai. *International Journal of Injury Control and Safety Promotion*, *25*(3), 293–302.

Department of Statistics Malaysia. (2019). *Statistics on causes of deaths Malaysia, 2019*. https://www.dosm.gov.my/v1/index.php?r=column/pdfPrev&id=RUxlSDNkcnRVazJnakNCNVN2VGgrdz09

Erdogan, S., Yilmaz, I., Baybura, T., & Gullu, M. (2008). Geographical information systems aided traffic accident analysis system case study: City of Afyonkarahisar. *Accident Analysis & Prevention*, *40*(1), 174–181.

Halim, N. N. A., Maad, H. A., Shariff, S. S. R., & Derasit, Z. (2017). Spatial analysis of fatal road accidents along the north south expressway. *Journal of Engineering and Applied Sciences*, *12*(9), 8764–8769.

Hisam, F. N. S. A., Halim, M. B. A., Naharudin, N., & Hashim, N. (2022). GIS analysis on road accident and road safety: A case study of road geometry in Kajang, Selangor. *International Journal of Geoinformatics*, *18*(4), 45–50.

Jalil, S. Z. S. A., Sharif, S. S. R., Sulaiman, S. A., & Wazir, H. M. (2023). Attributes to high-risk locations for road accidents at inter-urban expressway. *Malaysian Journal of Computing*, *8*(1), 1449–1460.

Jing, Q., Bi, Y., Liu, N., Zhang, Q., & Chen, R. (2019). Study on identification and classification of hidden dangers in highway toll stations based on accident causation theory. In *Journal of Physics: Conference Series* (Vol. 1423, No. 1, p. 012014). IOP Publishing.

Kamh, H., Alyami, S. H., Khattak, A., Alyami, M., & Almujibah, H. (2024). Exploring road traffic accidents hotspots using clustering algorithms and GIS-based spatial analysis. *IEEE Access*, *13*, 60944–60954.

Le, K. G., Liu, P., & Lin, L. T. (2020). Determining the road traffic accident hotspots using GIS-based temporal-spatial statistical analytic techniques in Hanoi, Vietnam. *Geo-spatial Information Science*, *23*(2), 153–164.

Malaysia: number of road accidents | Statista. (2023, October 30). *Statista*. https://www.statista.com/statistics/794875/number-of-road-accidents-malaysia/

Manap, N., Borhan, M. N., Yazid, M. R. M., Hambali, M. K. A., & Rohan, A. (2019). Determining spatial patterns of road accidents at expressway by applying Getis-Ord Gi* spatial statistic. *International Journal of Recent Technology and Engineering*, *8*(3S3), 345–350.

Manap, N., Borhan, M. N., Yazid, M. R. M., Hambali, M. K. A., & Rohan, A. (2021). Identification of hotspot segments with a risk of heavy-vehicle accidents based on spatial analysis at controlled-access highway. *Sustainability*, *13*(3), 1487.

Masron, T., Hussin, W. M. T. W., Nordin, M. N., Yaakub, N. F., & Jamian, M. A. H. (2018). Applying GIS in analysing black spot areas in Penang, Malaysia. *The Indonesian Journal of Geography*, *50*(2), 133–144.

Nogueira, P., Silva, M., Infante, P., Nogueira, V., Manuel, P., Afonso, A., & Gois, P. (2023). Learning from accidents: Spatial intelligence applied to road accidents with insights from a case study in Setúbal District, Portugal. *ISPRS International Journal of Geo-Information*, *12*(3), 93.

Nusa, F. N. M., Ishak, S. Z., Michael, V., Fatima, A., Murozi, M., & Hoong, A. P. W. (2025, December). The awareness of International Road Assessment Programme (iRAP): Challenges and strategies of iRAP implementation in Malaysia. In *14th Asia-Pacific Conference on Transportation and the Environment (APTE 2025)* (pp. 212–223). Atlantis Press.

Shariff, S. R., Maad, H. A., Halim, N. N. A., & Derasit, Z. (2018). Determining hotspots of road accidents using spatial analysis. *Indonesian Journal of Electrical Engineering and Computer Science*, *9*(1), 146–151.

Srikanth, L., & Srikanth, I. (2020, January). A case study on kernel density estimation and hotspot analysis methods in traffic safety management. In *2020 International Conference on Communication Systems & Networks (COMSNETS)* (pp. 99–104). IEEE.

Waldon, M., Ibingira, T., Andrade, L., Mmbaga, B., Mvungi, M. V., & Staton, C. (2018). Built environment analysis for road traffic hotspot locations in Moshi, Tanzania. *International Journal of Injury Control and Safety Promotion*, *25*(3), 272–278.

Xing, L., Zou, D., Fei, Y., Long, K., & Wang, J. (2023). Safety evaluation of toll plaza diverging area considering different vehicles' toll collection types. *Applied Sciences*, *13*(15), 9005.

Zahran, E. S. M. M., Tan, S. J., Tan, E. H. A., Mohamad'Asri Putra, N. A. A. B., Yap, Y. H., & Abdul Rahman, E. K. (2021). Spatial analysis of road traffic accident hotspots: Evaluation and validation of recent approaches using road safety audit. *Journal of Transportation Safety & Security*, *13*(6), 575–604.

ZahranEl-Said, M. M., Jiann, T. S., Mohamad'Asri, N. A. A. B., Tan, E. H. A., Yap, Y. H., & Rahman, E. K. A. (2019). Evaluation of various GIS-based methods for the analysis of road traffic accident hotspot. In *MATEC Web of Conferences* (Vol. 258, p. 03008). EDP Sciences.

Zheng, M., Xie, X., Jiang, Y., Shen, Q., Geng, X., Zhao, L., & Jia, F. (2024). Optimizing kernel density estimation bandwidth for road traffic accident hazard identification: A case study of the City of London. *Sustainability*, *16*(16), 6969.

Received: 16th December 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 582 – 610

BUILDING TO CITY: INTEGRATING BIM INTO CIM FOR A COMPREHENSIVE DIGITAL URBANISM

Mohammed Faisal Ghazi AL Kazee[1], Islam Sallam[2*]

[1,2]*Department of Architecture and Interior Design,*
UNIVERSITY OF NIZWA, SULTANATE OF OMAN
(Corresponding Author: isallam@unizwa.edu.om)

Abstract

The transformation from Building Information Modeling (BIM) to City Information Modeling (CIM) poses a major challenge for achieving holistic digital urbanism. While BIM delivers object-based, detailed models of individual structures, scalability and semantic structure always fail when multiplied and transferred in scale and complexity for urban systems. This paper addresses BIM integration in CIM for the construction of a multi-scale, semantically interoperable urban digital twin platform. In a comparative analysis of early pioneers of digital twins – namely Virtual Singapore, Helsinki 3D City and Dubai Digital Twin – our research identifies best practices and common pitfalls related to data standardization, semantic mismatches and computational scalability. Considerable attention has been given to semantic interoperability as a crucial condition for effective data translation at different scaled levels from micro (building scale) to macro (city scale) models. The paper derives a BIM-to-CIM integration framework based on case-based Modeling that demonstrates how individual BIM models constructively inform broader-based CIM platforms for long-term sustainable district planning and management. platforms for long-term sustainable district planning and management. The resulting framework facilitates robust data-driven urban planning and unlocks interoperability between separate modeling spaces, establishing a stable foundation for potential smart city use cases.

Keywords: Building Information Modeling (BIM), City Information Modeling (CIM), Digital Urbanism, Urban Digital Twins, Semantic Interoperability, Multi-scale Modeling, Smart Cities

[2] Corresponding author. Email: isallam@unizwa.edu.om

INTRODUCTION

Rapid advances in digital technologies have changed the face of planning, managing and experiencing cities. With increasing complexity in urban environments, there has also been a related need for holistic, data-driven solutions. [1] Digital urbanism - a conceptual solution that uses digital instruments and data infrastructures for urban governance, sustainability and resilience - becomes a very appealing solution. Central to this revolution is the digital twin: a real-time, virtual model of a physical resource or system that enables real-time monitoring, simulation and informed decision-making. Building information Modeling (BIM) has long formed the basis for digital models at the building level, and has provided detailed, semantically enriched models of individual buildings. [1] However, its application is limited essentially to stand-alone assets, and consequently, its usefulness in addressing the interrelated systems that characterize cities is limited. City Information Modelling (CIM), by contrast, aims at modelling complete urban fabrics by integrating disparate sources of data in support of large-scale planning of infrastructures, environmental monitoring, and policymaking. Although related by shared precepts, BIM and CIM operate at different levels of scale and of vocabulary and consequently pose serious barriers to interoperability. [2]

This paper addresses the critical task of filling the micro-to-macro scale gap between BIM and CIM. Specifically, it discusses how BIM approaches can be integrated into CIM systems for enabling multi-scale, semantically interoperable urban digital twins. To facilitate interdisciplinary comprehension, two of the essential concepts of this research are explained. Semantic interoperability is defined as having the capacity of various digital systems and data models to share information and maintain its meaning, context and relationships. [3] Semantic interoperability within BIM and CIM integration means that information at the building level, comprising of components, spatial relationships and infrastructure systems can be properly interpreted upon transfer to the urban scale modelling environment. [4] In the absence of semantic interoperability, the data that is streamed between BIM and CIM systems can lose its meaning or end up being inconsistent because the modelling standards of the systems, including Industry Foundation Classes (IFC) and City GML, differ.

The other important term is multi-scale modelling which is defined as the process of integrating varying spaces into a single modelling environment. [5] Multi scale modelling allows digital representations to be operated on multiple levels of complexity at the same time, such as the micro level (individual building elements), meso level (district or neighbourhood level), and the macro level (city-wide systems). [6] This top-down solution enables the use of detailed building data produced by BIM to be used elsewhere in the analysis of the urban environment in the wider context of CIM systems so that planners and decision-

© 2026 by MIP

makers can relate architectural data to wider planning approaches. The research highlights the requirement for semantic interoperability in enabling smooth data translation from one system and from one scale to another. [7] In a comparative case-based examination of early digital twin applications- Virtual Singapore, Helsinki 3D City, and Dubai Digital Twin- the article reviews dominant practice, technical limitations, and conceptual developments in the literature. Finally, this work proposes a BIM-to-CIM Integration Framework, which permits data-enabled resilient urban planning by enabling an efficient data translation, scaling, and synchronization. By doing this, it offers extensions to the research within the domain of digital urbanism that gives a tangible path of giving more intelligent, integrated, and sustainable cities.

LITERATURE REVIEW

Overview of BIM and CIM Technologies

Building Information Modelling (BIM) has become a foundation practice within the Architecture, Engineering, and Construction (AEC) industry. [8] It makes it possible for highly detailed digital models of built assets that encompass geometry, metadata, and behavioural information from design through construction use and demolition. [9] BIM models enable enhanced collaboration among stakeholders and provide fundamental information regarding cost estimation, clash detection, construction sequences, and energy analysis. Nevertheless, the basic focus resides in individual structures, normally separated from their wider urban context. [10]

Urban Information Modeling (CIM) expands and extends BIM fundamentals for Modeling entire cities. CIM collects geospatial data, sensor data, BIM inputs and environmental models for a regular urban digital ecosystem. [11] It facilitates applications for transportation modelling, flood hazard assessment, energy simulation at the district level, and policy evaluation. CIM has a tendency to utilize Geographic Information Systems (GIS), 3D city models, and semantic modelling conventions like City GML for modelling urban features like roads, buildings, vegetation, and utility networks in a spatially coherent way (Zhang et al., 2020; Yan et al., 2019). While BIM and CIM both strive for digital modelling of physical assets, their scope, structure of data, and contexts of use are very distinct. [12]

Previous Efforts and Integration Frameworks

In recent years, there has been increased activity in linking BIM and CIM based on a need to extend building-scale models towards wider urban applications. Some of the main approaches have involved employing data exchange protocols such as the use of the IFC for BIM and City GML for CIM, frequently involving modified conversion or middleware solutions in order for systems to interoperate. [6] A second exemplary instance is Virtual Singapore, an initiative of national

guidelines that dwells on using BIM, GIS, and live sensor information with the goal of creating a digital reflection of the whole city-state in real-time. The platform is based on semantic 3D models applied in an array of different applications, including urban planning and energy optimization, as well as in the case of disaster response. [13] There is also the case Helsinki 3D City, which combines semantic city models with a reality mesh to model the solar potential, energy consumption and behaviour of pedestrian movement. The project uses open standards and APIs for sharing data and building services. [6]

In the Dubai Digital Twin project, for example, BIM building models are integrated with GIS systems for the creation of real-time operational dashboards and prediction models for urban management. The above examples showcase the potential of BIM-CIM interoperability and also indicate that no common integration framework has yet emerged, preventing replication and scaling for multiple applications. [14]

Principal Barriers: Semantic Interoperability, Data Heterogeneity, and Scaling Limitations

BIM to CIM integration initiatives is confronted with a number of technical and conceptual difficulties, although they seem promising. [15] The greatest barrier is semantic interoperability. The models of BIM structures generally accommodate the application of the IFC schema or proprietary schema that describe a wall, door or other structures, including the HVAC system, utilizing domain-specific metadata. CIM models, however, use alternative schema such as CityGML or INSPIRE, which incorporate more extensive urban features and could be a bit less detailed than BIM. The use of non-unified ontologies and naming models will create challenges in the mapping of the data semantics of one model to another, which prevents automation and data reuse. [8]

Heterogeneity in data also contributes to integration challenges. BIM data is highly organized and highly detailed in 3D geometry and construction attributes, yet they are unlikely to contain georeferencing and contextual data essential to large-scale city-scale modelling. Although there exists elaborative CIM data in matters of space relations and topology, inner building logic, and material-level are not might be taken into consideration. Semantic mediation, ontology alignment, and Linked data technologies can bridge that divide. [13]

Scalability limitations are another important issue. BIM models are computationally intensive, often comprised of millions of polygons and rich parametric data. Combining various BIM models within a CIM platform in a direct way results in loss of performance, influx of data, and a problem of versioning. Multi-resolution modelling techniques and hierarchical abstractions have also been proposed by academics for managing this issue, while standardized solutions are not yet available. [5]

© 2026 by MIP

Multi-Scale Digital Twins Concept

Multi-scale digital twins are a strategic advancement for digital modelling that aims at aligning at various levels of space and functionality. The systems are capable of modelling buildings, neighbourhoods, districts, and entire cities in a nested and interoperable hierarchy, enabling more holistic decision-making and planning. Leaders among technology companies and research institutions are spending heavily to develop multi-scale digital twins. *Dassault Systèmes' (a French multinational software company that provides businesses with a 3DEXPERIENCE platform for designing, simulating, manufacturing, and managing the lifecycle of products)* Virtual Twin Experiences utilize building sensor inputs, BIM, and urban platforms for building predictive analytics and lifecycle insights. Autodesk (2021) views future cities as digital ecosystems in which each asset will be connected to its digital twin for continuous feedback and adaptation. Research and EU-funded programs like SPHERE and FIWARE advocate open semantic models, cloud infrastructures, and Internet of Things (IoT) real-time integration for the purpose of scalability and open-mindedness. [10] All these initiatives are gradually creating a future for BIM and CIM living side by side in shared urban digital twins. Nonetheless, their implementation also needs strong data governance frameworks, real-time synchronizations, and long-term interoperability. [15]

Data Governance, Privacy, and Ethical Considerations in Urban Digital Twins

With the growing use of digital twin technologies in cities, the issue of data governance has become a significant concern to the long-term sustainability and reliability of digital urban systems. Digital twins are based on large datasets, which are based on buildings, infrastructure network, environmental sensors, and even human activity patterns. [3] Therefore, the problem of data ownership, the privacy protection, cybersecurity, and ethical use of data should be considered in the context of BIM-CIM integrations. [13]

A significant issue is related to the incorporation of detailed BIM data into the city-scale digital platforms. Model construction can include sensitive data regarding structure systems, security infrastructure or operational data. Such information, when combined in CIM environments, can pose a possible risk unless there is a clear definition of governance policies. To this end, federated data architecture is frequently adopted by many cities implementing digital twins, in which individual datasets are under the control of their original owners but are connected by standardized interfaces. [12]

The other matter of concern is data privacy especially when the urban digital twins are linked to real-time sensor systems or Internet of Things (IoT) devices which collect and send vast amounts of data on the urban environment continuously. These systems can gather data on mobility, environmental, or

occupancy rates of buildings. Such data streams can be ethically questionable in terms of surveillance and the privacy of citizens without proper protection. [16]

Another important governance issue is cybersecurity. Since urban digital twins are often used as decision support systems in infrastructure management, any security risk in the data platform can have an impact on important city services. [17] Therefore, strong governance systems should include data encryption, access control systems and secure cloud systems. Thus, the successful integration of BIM-CIM is not only a technical problem, but also an institutional and ethical problem. The creation of clear governance structures, guidelines for data ownership and privacy systems is necessary to make digital city twins reliable, secure and socially responsible urban planning instruments. [18]

METHODOLOGY

The study adopts a qualitative, case study method in the examination of the adoption of Building Information Modelling (BIM) into City Information Modelling (CIM) in the field of digital urbanism. It is fundamentally aimed at investigating the scalability of BIM data and processes and semantically transforming them in order to populate the CIM platforms and create multi-scale, interoperable urban digital twins in the future.

Comparative Case Study Method

Methodological foundations of the study are a case study comparative analysis of the following three worldwide digital twin projects:

1. Virtual Singapore [19]
2. Helsinki 3D [6]
3. Dubai Digital Twin [14]

These examples were selected due to the advanced utilization of the urban digital twin and due to the obvious adoption or incorporation of BIM and CIM components. Each is a varied approach to digital urbanism that is informed by the local government, the state of technology infrastructure and policy objectives. The comparative study will analyse the following dimensions:

- Urban-scale planning and the role of BIM models
- Methods of data translation and semantic integration
- Mechanisms of interoperability (standards, “ontology” set of concepts and categories in a subject area or domain that shows their properties and the relations between them.)
- Backend supporting data scalability
- Applications in sustainability, mobility and resilience

© 2026 by MIP

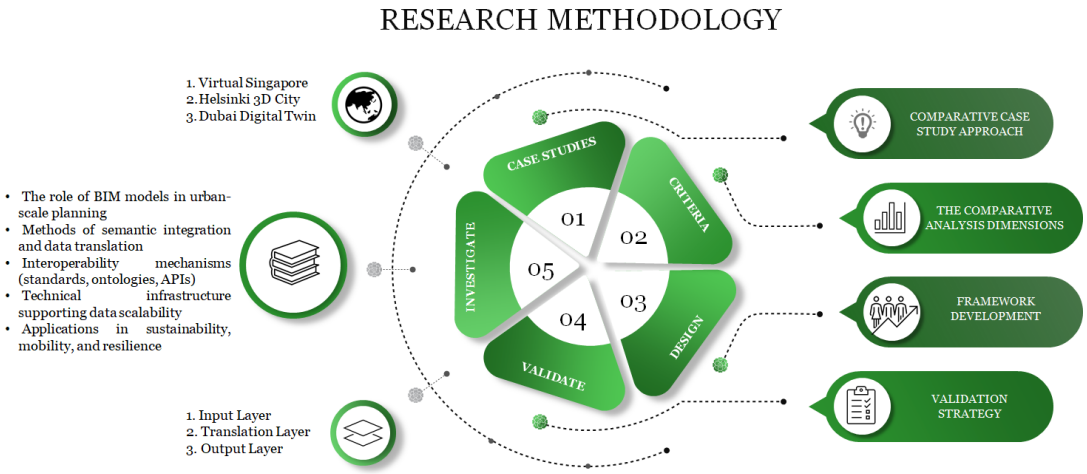


Figure 1: Research Methodology adopted, adapted and developed based on the works of the following references [6] [14] [10] [13]. (The illustrated model is by author)

Comparison of Digital Twin Case Studies

To better understand the operational differences between existing urban digital twin initiatives, the chosen case studies were contrasted in a number of major aspects, such as technological infrastructure, data integration approaches, governance models, and real-world applications. The key features of each initiative are summarized in Table 1.

This comparison highlights that although these initiatives demonstrate the feasibility of BIM-CIM integration, they also reveal persistent challenges related to semantic alignment, data governance, and scalability.

Table 1: Comparative Analysis of International Digital Twin Initiatives and Their BIM–CIM Integration Approaches

Project	Main Objective	BIM–CIM Integration Approach	Key Strengths	Key Challenges
Virtual Singapore	National digital twin platform supporting urban planning, environmental simulation, and infrastructure management	Integration of BIM models with GIS data and sensor networks within a semantic 3D city model	Highly detailed 3D urban model with strong simulation capabilities	Complex governance requirements and data privacy considerations
Helsinki 3D City	Open digital twin supporting energy	Use of CityGML semantic models	Open data ecosystem	Challenges related to maintaining

Project	Main Objective	BIM–CIM Integration Approach	Key Strengths	Key Challenges
	analysis, solar potential studies, and urban planning	integrated with BIM-derived datasets and open APIs	enabling public access and innovation	semantic consistency between datasets
Dubai Digital Twin	Smart city operational platform supporting urban management and predictive analytics	Integration of BIM models with GIS platforms and real-time data dashboards	Strong governmental coordination and operational decision support	Interoperability challenges between different modelling standards

Framework Development

The outcomes of the case studies will inform the development of a BIM-to-CIM Integration Framework that will be the central study deliverable. The framework will be customized to:

- Support semantic interoperability through ontology mapping (for instance, IFC and CityGML schema matching)
- Support multi-scale data modelling of buildings, districts and city systems
- Allow modular integration of BIM data with CIM systems through abstraction and generalization
- Apply hierarchical modelling and reuse of cases for scalable efficiency

The framework will be based on using a *Three-Tier Architecture*: [16]

1. **Input layer:** Procurement of BIM data (geometry, attributes, time series)
2. **Translation:** Semantic mediation through mapping tools, ontologies and transformation scripts
3. **Output Layer:** Integration in CIM systems for planning, simulation, or public dashboard applications

Validation Strategy

Although the framework will initially remain conceptual, the validity will be assessed through systematic comparison with both existing technologies and practical workflows observed in the three study cases, as well as against the proposed theoretical model. Validation will be performed through a combination of empirical testing, cross reference with established standards and expert review.

© 2026 by MIP

To ensure robustness, actual standards and tools (e.g. FME, BIMSERVER, 3DCITEDB, CITYGML ADES) will be used where possible, so that the framework can be demonstrated in practice instead of remaining exclusively at a conceptual level. These tools provide practical mechanisms for interoperability testing, data transformation and semantic adjustment, and will thus act as benchmarks that the proposed framework can be evaluated.

In addition, the validation process will involve triangulation of several data sources. Input will be taken from scientific literature, technical white papers and authoritative reports, as well as publicly available data sets for the selected cities. This multi -source method will provide the opportunity to assess both technical health and usefulness in the real world, which ensures that the framework is not only theoretically coherent, but also operational in practice.

Furthermore, validation will include a critical review of how well the framework supports interoperability tasks across scales-from micro level to building components in BIM to the macro level of urban systems in CIM. Performance criteria such as semantic adjustment accuracy, minimization of data loss and easy integration will be used as important indicators of success.

Finally, engagement with domain experts, including practitioners from architecture, engineering science, GIS and urban planning, will form an integral part of the validation strategy. Their feedback will be used to limit the frame, address potential holes and strengthen the adaptability of different urban contexts.

Tool-based experiments, literature-operated verification, by combining testing in the real world, the functioning ensures a comprehensive evaluation of structure strength, reliability and utility for future BIM-to-CIM integration initiative.

SEMANTIC INTEROPERABILITY CHALLENGES AND STRATEGIES

Semantic interoperability is one of the essential needs of integrating BIM seamlessly into systems that support CIM. This ensures that the semantics of the exchanged information remain intact and are understood correctly across different domains, platforms and scales. [20] Nevertheless, this form of interoperability is exceptionally difficult to achieve due to nonconformities in data structures, modeling conventions, vocabulary and ontologies used in both BIM and CIM environments.

Divergent Standards and Ontologies in Smart City Concepts: Integrating BIM, CIM, and GIS

A main barrier to semantic interoperability between Building Information Modelling (BIM) and City Information Modelling (CIM) is that the standards and ontologies supporting each application are mismatched. BIM and CIM were developed with very different purposes and scopes in mind, to incorporate differing data models, classification systems, and conceptual models. For this reason, information exchange and communication between the two is inherently problematic.

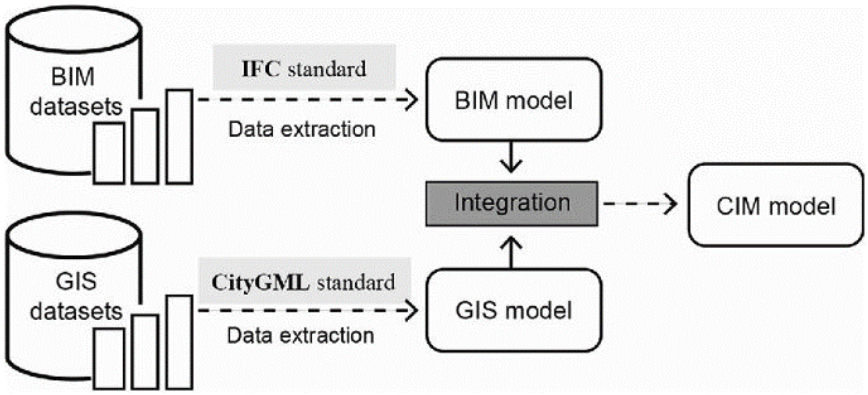


Figure 2: BIM, CIM and GIS interrelationship. [21]

The integration of building information modelling (BIM) and city Information Modelling (CIM) represents a significant step towards the realization of urban digital twins. [5] While BIM is focused on fine-grain models of single buildings, their fit-out, and their infrastructural services, CIM works at the city scale, modelling broader spatial, environmental, and infrastructural systems. Geographic Information Systems (GIS) then supply the critical connection between these two areas through the provision of the spatial referencing, topological relation, and integration of geospatial data that are needed to site BIM information in city-wide models. Through GIS systems, information at the building level can ideally be situated, analyzed, and represented in the wider urban environment, enabling cross-domain interoperability, spatial analysis, and decision-taking. GIS thus not only bridges the semantic as well as the geometric gap between BIM and CIM but also provides the underpinning platform for large-scale, multi-level urban information systems. BIM systems are predominantly founded upon the Industry Foundation Classes (IFC), open, vendor-neutral, standardized data models developed by building SMART International. IFC is designed to provide rich digital copies of constructed entities at the building or component level, with rich geometrical definitions, hierarchical organization of

© 2026 by MIP

objects, and long lists of properties such as materials, performance indicators, as well as operating information. [22] It is particularly tailored to address the needs of stakeholders in the Architecture, Engineering, and Construction (*AEC*) industry throughout the asset's entire lifespan from construction and building designs to operation and maintenance. For comparison, CIM relies on geospatial standards such as *CityGML*, INSPIRE, and LandInfra that are developed and maintained by organizations such as the Open Geospatial Consortium (OGC). CityGML is in particular a semantic and geometric 3D city model that represents urban features such as buildings, terrain, water bodies, transport systems, and vegetation. Though very granular like IFC, *CityGML* represents its instances in various Levels of Detail (LoD)—LoD0 (2D footprints) to LoD4 (building interior detail)—so that it can encompass the entire breadth of urban planning and environment analysis use cases. [20]

These two standards, IFC and *CityGML*, not only are structurally distinct but are ontologically incommensurable. For example, while both are capable of representing a "building," their definition, classification, as well as relation between building subcomponents and subcomponents, differ extensively. [3] While an *IfcWall* in *IFC* may have thermal resistance or fire rating as parameters, *CityGML Wall Surface* may have orientation or surface material as parameters to capture for environment modeling. Without any ontology or mapping between them, these semantically similar entities cannot automatically be put in alignment, therefore leading to their duplication, misinterpretation, or loss in translation. [3] What contributes to the confusion is that each standard is domain-specific, designed for particular use cases. Construction logic and exact building component behavior are optimized in IFC, while spatial coherence, urban topologies, and GIS platform integration are optimized in CityGML. What this implies is not only that information is structured differently, according to standard, but that querying, visualization, and analysis are all affected as well. BIM environments, for instance, support object-based navigation in building hierarchies (e.g., storeys, spaces, systems), while CIM environments are concerned with spatial relations and topological connectivity (e.g., adjacency, containment, routing). [4]

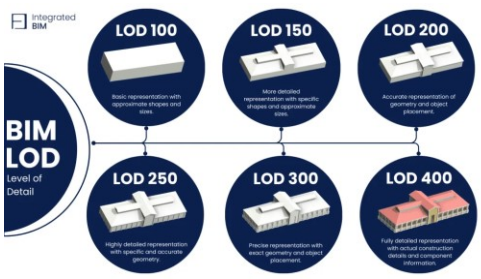
Moreover, the software environments that form the basis for each standard evolved separately. Construction detailing/design-focused BIM software such as Autodesk Revit, *ArchiCAD*, or *Tekla* contrasts with large-scale visualization as well as geospatial modeling-focused CIM software like Esri *CityEngine*, Bentley *OpenCities*, or 3DCityDB. This separatism extends the semantic gap since even well-crafted models do not integrate when transplanted from one platform to another. There have also been efforts to bridge this gap in the form of technologies such as *GeoBIM*, which attempts to integrate IFC and *CityGML* by ontology intermediates or by enriching one model with the other's functionalities. These technologies are still technically composed and not yet

much standardized or distributed. Without ontology adjustment methodologies or formal semantic mapping frames, the majority of BIM-to-CIM data transfers remain limited to manual conversion or case-centric intermediate production solutions. [23]

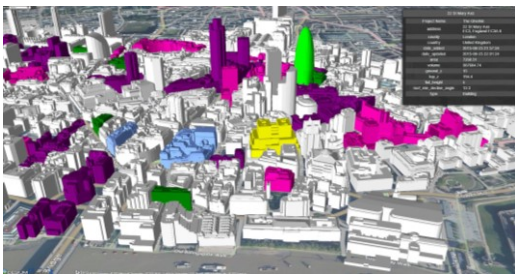
Divergent standards and ontologies used in BIM and CIM are the primary obstacles to achieving semantic interoperability. Differences in purpose, structure, and semantics between them are in conflict with technical conversion requirements and instead evoke needs for conceptual alignment. Filling this gap is essential in enabling scalable, multi-domain digital twins that can encompass the breadth of single buildings as easily as the scope of entire cities.

Data Abstraction and Level of Detail (LoD)

One of the most important challenges of bridging BIM and CIM is to handle the level of detail (LOD) between the two worlds. BIM environments are intended to host very detailed models of architectural, structural and system components - down to specifications such as bolts, channels or glass finish. This level of precision is necessary for tasks such as construction coordination, amount of start and construction management. As a result, BIM models are generally dense, both in geometry and semantics, and are optimized for the use of microscale. [22]



BIM - the level of detail (LOD)



CIM - the level of detail (LOD)

Figure 3: The concept of Level of Detail (LoD) in BIM and CIM represents entirely different modelling priorities: detail and construction in BIM and space abstraction and scalability in CIM, which is a major challenge towards the smooth integration of data.

On the other hand, CIM frameworks are designed for macroscale city analysis. These operate in larger geographical scales and typically generalize urban functions to ensure calculation efficiency and ease of use in high -level planning, environmental assessments and urban -wide infrastructure simulations. For example, CityGML defines several lots (from Lod0 to Lod4) to represent urban objects such as buildings, terrain and vegetation, each with different degrees of details. However, even the most detailed CityGML models rarely reach the specificity of BIM data.

© 2026 by MIP

This discouragement in scale and purpose leads to more complications: [21]

- Redundant or overly detailed BIM content must be abstracted or removed before use in CIM systems.
- Nevertheless, important information (e.g. building function, material properties, energy assessments) must often be retained - even when simplifying geometry.
- There is no standardized pipeline for LOD translation, so these transformations are usually performed manually or through the ad-hoc script, and introduce inconsistency and inefficiency.

Addressing this problem requires more than just data defect- it also requires semantic justification to identify what information is really contextually relevant in the urban scale. Promising strategies include rule -based generalization, hierarchical modeling and parametric abstraction, but widespread adoption is still limited due to the lack of uniform tools and guidelines.

Lack of Shared Ontologies and Vocabularies

Another obstacle to semantic interoperability between BIM and CIM is that there are few widely agreed-on shared ontologies and standardized vocabularies that can provide easy interchange between the two. Ontologies are formal means for defining domain-specific knowledge and relations. Within BIM, the use of the IFC ontology is widespread in the domain of building construction, while *CityGML*, *INSPIRE*, or *GeoSPARQL* are commonly used in the geospatial domain by CIM. Ontological mismatch introduces semantic gaps as well as inconsistencies:

- General BIM and CIM principles are usually given different names (e.g., "*IfcWall*" in IFC vs. "*WallSurface*" in *CityGML*), causing confusion when data is being exchanged.
- The hierarchical relationships such as part-of or composed-of are denoted in separate manners in each domain, so maintaining the semantics is difficult when translating complex entities.
- A widely accepted crosswalk or semantic dictionary is not available to map or match between BIM and CIM schemas.

Onto BIM, GeoBIM, and the W3C Linked Building Data Community Group have all worked towards defining common vocabularies and alignment models. All are founded on *OWL* (*Ontology Web Language*) and RDF (Resource Description Framework) to do semantic graph definitions between BIM and GIS constructs. These remain mainly theory/prototype and are not included in industry-standard tools/workflows. Moreover, the lack of available systems that

can dynamically adapt BIM and CIM ontologies continues to hinder large-scale integration. For the majority of practical cases, semantic translation is manually carried out involving domain knowledge as well as significant resources.

To address this challenge, future initiatives should aim to:

- Cross-domain ontology construction that standardizes connections between *IFC* and *CityGML*.
- Developing standardized vocabularies for significant urban terms that span building to city scales.
- Innovating automated reasoning engines to detect semantic equivalencies, resolve conflicts, and facilitate smooth domain-to-domain data exchange.

Common semantic alignment is crucial to realizing the full potential of urban digital twins, which will drive scalable, accurate, and interoperable models from building components to whole cities.

Semantical Alignment Techniques

To find a solution to the traditional dilemma of semantic incompatibility between Building Information Modelling (BIM) and City Information Modelling (CIM), more than band-aid solutions are needed; instead, a standardization of methods based on experience in the field as well as scholarly study is required in the discipline. A number of promising solutions have been proposed that seek to bridge the semantic and ontological gaps between these two fields and all of which provide a mechanism to allow more consistent large-scale integration of information. The other method commonly used is via ontology mapping and mediation software which allows partial or complete translations between the IFC schema presented by BIM to the CityGML standard presented by CIM. Some of the tools that have facilitated such translations are FME, IfcExplorer and 3DCityDB. The semantic web technologies used in higher end systems like Web Ontology language (OWL) and the Resource Description Framework (RDF) with the help of which the relationships between the domain-specific concepts can be formalized in machine readable form. These technologies are semi-automated or automated mapping, making it take less work and being more reliable. [2]. The other strong technique is the use of Application Domain Extensions (ADEs) in CityGML. CityGML is a modular structure that can be extended using ADEs to include new attributes or domain classes without affecting the integrity of the core model. It can then be of use in embedding fine-grained BIM content (e.g. internal mechanical systems or multi-levelled construction assemblies) in urban-scale CIM models -while achieving more powerful data integration with structure consistency. BIM to CIM and vice versa translation is not always efficient and feasible. To resolve this, both researchers and developers proposed the use of hybrid data model or the use of intermediate schemas. [19]. These are

© 2026 by MIP

fundamentally a semantic broker between BIM and CIM that hides a lot of the cumbersome building information into something that will simply conform to the needs of the city-wide platforms. Ontologies like Geo BIM have been proposed in the same regard, the application of which will enable an easy semantic layer and ease of translation, as well as interoperability.

Finally, semantic web and linked data provide a more scalable and flexible basis of integration. When URIs are used to identify the objects in the data and the vocabularies adopted are agreed upon by all, these solutions will allow decentralized but networked systems in which the information can be queried, reused, and extended across platforms and jurisdictions. This is both as technical interoperability as it is as an enabling feature in wider trends towards open data government and smart city platform strategies. Overall, these technologies support the significance of formal and machine-readable models to support the semantic gap between BIM and CIM. They establish a platform on which to build coherent, large-scale processes that can be tailored to many diverse requirements, including urban planning as well as real time urban management.

Towards a Semantic Interoperability Layer in BIM-to-CIM Frameworks

While the above methodologies provide helpful tools for dealing with semantic differences between BIM/CIM, overall, still to be gained is the benefit from more unifying, systematic solutions—a particularly significant need as scales of integration increase through heterogeneous urban contexts. To this end, the approach under consideration recommends the use of a dedicated Semantic Interoperability Layer as an intelligent, modular entity situated in the broader BIM-to-CIM Integration Framework.

This semantic level will provide the motivating force for domain-to-domain alignment, mediation, and translation of the semantics of data. It will possibly change object classes and attributes between CITYGML and IFC forms using rules and logical definitions that are pre-given. Apart from low-level form mapping, this will also include level of detail (LOD) generalization, automatically adjusting model granularity to match the application context minimization of data overload while preserving prominent information.

The third team, besides, would incorporate ontology -based reasoning to recognize discrepancies, fill out holes, as well as verify associations across domain. The layer would also provide semantic flexibility to models that evolve as well as standards that change, changing mappings as well as associations automatically to adapt to new needs or schema structure changes. The adoption of such a layer will dramatically reduce the requirement for manual intervention, ensuring enhanced consistency and efficiency in BIM-to-CIM data transfers. It will also maximize the scalability and reusability of the framework, allowing for flexibility to suit diverse cities, models of government, as well as technical infrastructures. Most importantly, this semantic layer redefines interoperability—

not as that initial conversion challenge but as an in-use capability that facilitates cities to capture the full promise of integrated digital twins. Through the bridging of the semantic gap in a durable, flexible manner, this approach lays the ground for smarter, responsive urban environments.

SCALING FROM BIM TO CIM

The transition from building information modeling (BIM) to Urban Information Modeling (CIM) represents one of the most challenging, but critical development in the development of smart and sustainable city systems. While BIM operates in the scope of individual buildings, CIM must integrate data across neighborhoods and entire cities, requiring both technical and conceptual frameworks that are able to handle tremendously greater complexity.

Analysis of pilot projects

Early pilot projects demonstrate both the lifting and the challenges of scaling digital models from micro (building) level through the *Mesoscale-* Meso (neighborhood or district) to the macro (city-wide) scale. This transition with multi-scalar is crucial to the development of Building Information Modelling (BIM), which focuses on detailed data modelling level, to Urban Information Modelling (CIM), which integrates complex systems into an entire city. Initiatives such as Virtual Singapore, Helsinki 3D City and Dubai's digital twin exemplify how information on the building can feed into city -wide platforms to enable district energy simulations, urban planning of cities and disaster modeling.

At the same time, they reveal the difficulties with this transition, especially when it comes to data interoperability, semantic mismatches between building-oriented and urban-oriented data sets, and the management challenges associated with multi-interest platforms.

Within this process, the Meso scale appears as a critical brochure that ensures continuity and ease of use across scales. At the micro-level, BIM models contain exhaustive details-down to building materials and building systems-which is too granular to be directly useful for urban planning. Conversely, CIM at macro -level requires generalized, abstract data that is adapted to policy formulation and city council. The meso scale solves this tension by serving as intermediate filter and translator: It collects micro-level information for manageable datasets, while still retaining enough granularity to catch the relationship between buildings, infrastructure and public space on the neighborhood scale. The role of the Meso scale extends beyond aggregation.

© 2026 by MIP

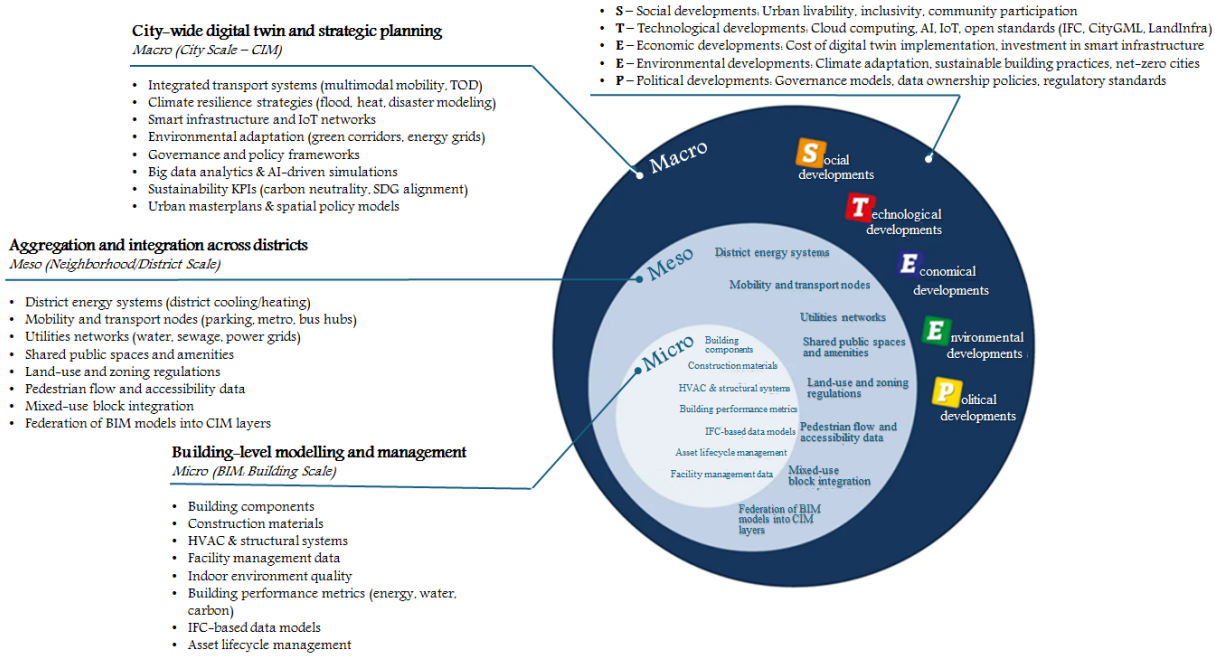


Figure 4: In micro- and macro-scales, the "Meso" (or Mesoscale) is an intermediate, mid-level scale that bridges the gap between the very small (micro) and the very large (macro). It focuses on phenomena, structures, or interactions that are not atomistic but also not large-scale continuums (by author)

It also provides contextualization of function, and acknowledges that buildings do not work in isolation, but interact with surrounding land use, tools and mobility systems. Phenomena such as pedestrian streams, district energy networks or localized transport nodes are best captured at this intermediate level. In addition, many sustainability and viability policies, such as district cooling systems, 15-minute urban principles, or waste and water management strategies, are most effectively implemented on the neighborhood scale. Thus, the Meso scale becomes a test site where interventions can be modelled and evaluated before scaling up to the macro level.

Equally important is the semantic role of the Meso scale. BIM data is primarily designed for engineers and architects, while CIM and GIS data serve planners and decision makers. The MESO level acts as a semantic bridge, and translates very technical design details into broader descriptions relevant to urban control, such as density measurements, regulatory categories or energy efficiency indicators. By doing so, it facilitates dialogue between different professional domains and ensures that intelligence at the building level is meaningfully integrated into the city's decision-making macro-scale platforms.

In brief, the meso scale is not merely a transitional step between micro and macro. It is a critical enabler that allows BIM logic to expand into CIM domains without losing either detail or relevance. By acting simultaneously as a translator, integrator, and testing platform, the meso scale makes possible a multi-scalar approach to digital urbanism in which building-level information and city-wide strategies are seamlessly connected. Without it, attempts to scale risk become either too fragmented- if detail is lost in abstraction- or too superficial—if macro-level generalization overrides local realities. [24]

Technical Activate

Scaling is made possible by several technical enablers. Cloud computing provides infrastructure to store and process massive data sets on urban scales, ensuring accessibility and scalability across stakeholders. Open standards such as IFC, *CityGM*L, and *LandInfra* (*an Open Geospatial Consortium (OGC) specification for modelling land and civil engineering features, intended to bridge BIM and GIS technologies*) are important to bridge the data gap between building level and urban level, which enables semantic interoperability. [25] Automation and artificial intelligence further enhance this process by streamlining repetitive tasks such as data conversion, geometry validation and classification, enabling thousands of BIM objects to be integrated into a continuous *CIMEnv*, where they can support high-level urban applications. Together, they create technical backbones for enabling scaling, which makes it possible to transform highly wide building-level data on the neighborhood and city parameters into actionable insights. Nevertheless, technology alone does not guarantee successful scaling. [26] This process should also be supported by conceptual ambitions that provide a theoretical and organizational structure for integration. The hierarchical modelling is an approach that can structure urban systems in nested levels - construction, blocks, districts and cities - so that detailed BIM data can be selected for use in comprehensive CIM contexts. [27] Data abstraction carried forward this infection by filtering and normalizing the information, ensuring that only the relevant characteristics are moved forward without overwhelming the high-level model with unnecessary expansion on each scale. Finally, the Federation technique allows various models and datasets to be partially independent, while still the inter non-shelter holders are able to contribute to a shared city model without abandoning the ownership of their own data. [21]

In practice, the interconnection between technical ambassadors and conceptual structures is the one that is possible from BIM to CIM. Cloud computing, AI, and open standard raw power and differences, while hierarchical modelling, abstraction and federation ensure that this power is applied in a structured, meaningful way. Without this dual foundation, the efforts to transfer the city-level information risk from the building-level became either technically

© 2026 by MIP

fragmented or ideologically incompatible, which reduces the value of digital urbanism as a tool for the development of a smart city. [25]

Conceptual Enables

Equally important are conceptual enables that provide a theoretical basis for integration. Hierarchical modeling allows the breakdown of complex urban systems in layers (e.g. construction, block, district, city), and preserves both details and scalability. Data abstraction techniques reduce information overload by representing important attributes at each level of analysis, and ensuring that models remain usable without sacrificing precision where needed. [28] Finally, federation techniques enable linking multiple data sets or models without requiring full association, so that stakeholders can maintain control of their domains while still contributing to an integrated CIM framework. Overall, these enables the enables that scaling from BIM to CIM is not only a matter of increasing the data volume, but requires a basic thought of how information is structured, divided and used across spatial and institutional boundaries. This transition provides the basis for smart urban applications that rely on multi-scale, interoperable and adaptable models-Alt from energy optimization to climate protection and urban mobility control. [23]

THE BIM-TO-CIM INTEGRATION FRAMEWORK (BCIF)

Starting Point: BIM (Building Information Modelling)

The proposed framework, *BCIF,* views BIM as a digital twin of a single building. It contains everything an architect, engineer, or planner will need: walls, windows, floors, materials, pipes, air conditioning systems, energy use and even cost or maintenance plans.

- Example: A digital model of a hospital that not only shows the 3D geometry, but also what each wall is made of, how much energy the lights use, and when the lifts need service.

BIM is very detailed, but all these details are too much to handle when trying to plan for an entire city. That is why the *BCIF* needs a way to scale up. The following figure presents the BCIF framework, which explains the multi-scale layers required to integrate building information modeling (BIM) with Urban Information Modeling (CIM). The Process Begins with Data Breakdown and Normalization, Where Bim Models Are Aligned to A Regular Coordinate System, Geometries Are Validated, and Metadata is Standardized. The next step is semantic mapping, which translates BIM-specific terminology into CIM language to fit the broader scope of urban planning. Through the Meso bridge, detailed building information becomes abstract to aggregated indicators such as energy use, carbon footprint and total floor space per block, while geometries are

simplified to city scale models (LOD2/LOD3). The framework also emphasizes Federation, and ensures interoperability by connecting each building model to unique IDs and APIs, treating the system as a library of paired assets. Finally, within the CIM setting, this information is combined with GIS, transport network and environmental data sets to make simulations city-wide, strategic decision-making and resilient urban planning possible. This multi-tiered strategy creates continuity between building scale and city scale management, and offers a holistic way to digital urbanism.

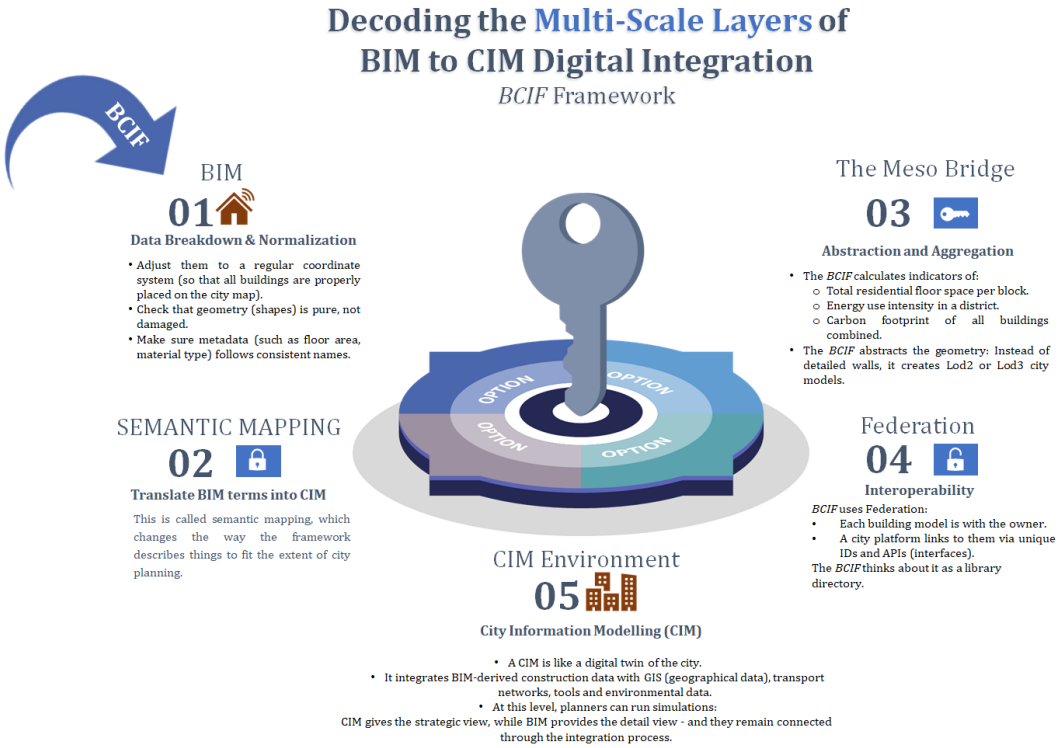


Figure 5: The BCIF Framework – Multi-Scale Integration Process from BIM to CIM through Normalization, Semantic Mapping, the Meso Bridge, and Federation (by author)

The Need for Integration (Why BIM → CIM?)

After BIM models are collected and cleaned (step 1), the next major obstacle is that BIM and CIM do not speak the same language. BIM uses classifications suitable for construction and construction management, while CIM (and GIS) needs information that makes sense for urban planners, decision makers and city managers. The process of translating this "language" is called semantic mapping.

© 2026 by MIP

- **Why it does matter**
- BIM describes objects in extreme technical details: e.g. *IfcWall* standard case, *ifc pipe segment* or *IFCDOOR*.
- CIM and GIS describe objects more generic: for example, building facade, benefit network segment or access point.
- Without translation, the BIM data is either too nice to be useful, or completely incomprehensible to urban systems.

Step One- Data Breakdown and Normalization [26]
The *BCIF* Framework starts by collecting BIM models from different buildings (e.g. offices, schools, apartments). These models come in different file types, and often use a standard called IFC.

- The first task is to normalize them:
  - Adjust them to a regular coordinate system (so that all buildings are properly placed on the city map).
  - Check that geometry (shapes) is pure, not damaged.
  - Make sure metadata (such as floor area, material type) follows consistent names.

This step makes sure all buildings “speak the same language” before we integrate them.

Step Two – Semantic Mapping (Translation of BIM Data) [4]
After BIM models are collected and cleaned (step 1), the next major obstacle is that BIM and CIM do not speak the same language. BIM uses classifications suitable for construction and facility management, while CIM (and GIS) needs information that makes sense for urban planners, decision makers and city managers. The process of translating this "language" is called semantic mapping.

- **Why it does matter** [4]
  - BIM describes objects in extreme technical details: e.g. *IfcWall standard case*, *ifc Pipe Segment* or *IFCDoor*.
  - CIM and GIS describe objects more generically: for example, *Building facade, Utility network segment or Access point.*
  - Without translation, the BIM data is either too fine to be useful or completely incomprehensible to urban systems.

- **The Process of Semantic Mapping**

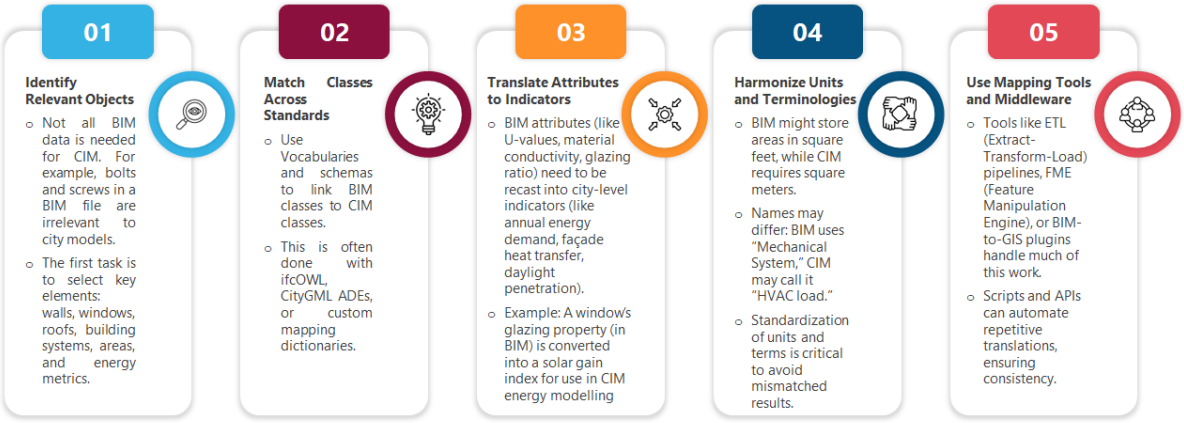


Figure 6: Stepwise Workflow of BIM-to-CIM Integration, Illustrating Data Flow Through Normalization, Semantic Mapping, Aggregation, and Federation Toward a City Information Modelling Environment (by author)

- **Practical Example**

Suppose we have a BIM model of a shopping center:

- In the BIM lists the models: *IfcWall Standard Case* with thickness, material (concrete), thermal resistance, etc.
- Through semantic mapping, this is translated into CIM as: *Exterior wall surface* with attribute *thermal performance rating* = medium.
- The shopping center's *IfcSpace* entries (shops, corridors, food courts) are translated into building part elements in CIM, so that planners can evaluate the relationship between the floor-area ratios, occupancy density and distribution of land use at the district scale.

- **The outcome of step 2** [3]

By the end of semantic mapping:

- BIM objects are reclassified in broader rating categories.
- Detailed technical data becomes abstract in planning indicators.
- A shared semantic team is created, making BIM data interoperable with CIM and GIS systems.

Step Three – Abstraction and Aggregation (The Meso Bridge) [7]

This is where Meso Scale (neighbourhood/district) plays its key role.

© 2026 by MIP

- Instead of displaying each door and piping from BIM, the framework – for example- calculates indicators of:
  - Total residential floor space per block.
  - Energy use intensity in a district.
  - Carbon footprint of all buildings combined.
- The *BCIF* also abstract the geometry: Instead of detailed walls, it creates Lod2 or Lod3 city models (simplified 3D blocks with ceilings and windows).

So, the Meso scale summarizes data at the building level to be usable information for neighbourhoods, while at the same time being traced back to the original BIM when needed.

Step Four – Federation and Interoperability [7]

Here, integration does not mean dumping all data in a giant file (which will be unmanageable). Instead, *BCIF* uses Federation:

- Each building model is with the owner.
- A city platform links to them via unique IDs and APIs (interfaces).
- The *BCIF* thinks about it as a library directory. In other words, *BCIF* doesn't move all the books into a great book; it only makes them searchable and referrer able.

In this way, cities can connect to several datasets as transport, energy, regulation, tools, without breaking ownership or safety.

Step Five – City Information Modelling (CIM) [4]

When the data is mapped and collected, it enters the CIM environment:

- A CIM is like a digital twin of the city.
- It integrates BIM-derived construction data with GIS (geographical data), transport networks, tools and environmental data.
- At this level, planners can run simulations:
  - How to add a new bus line reduces car addiction.
  - How much CO_2 emissions can be saved by retrofitting 30% of the buildings.
  - What areas will flood if the sea level rises by 0.5 meters.

CIM gives the strategic view, while BIM provides the detail view - and they remain connected through the integration process.

The Outputs of Integration

At the end of this process, you have:

- A city model enriched with real building intelligence.
- KPIs (Key Performance Indicators) at the district level (energy, carbon, accessibility).
- A platform where a planner can zoom out for a city view but also drill down into an individual building if needed.

At the end of this process, we will have:

- A city model enriched with real building intelligence.
- C-KPIs (important performance indicators) at the district level (energy, carbon, availability).
- A platform where a planner can zoom out after a view of the city, but also drill down in an individual building if necessary.

In short, BIM can be regarded as the "microscope" (detailed views of a building), while CIM is the "telescope" (strategic views of the city). Meso Scale is the "translator and bridge" between the two.

Real-Life Implementation of the BCIF Framework

In order to illustrate the practical relevance of the suggested BIM-to-CIM Integration Framework (BCIF), a hypothetical implementation scenario may be taken in a university campus district. Here, the BIM models of each campus building, *i.e. libraries, laboratories, administrative buildings, and residential buildings*, are first gathered and standardized in the input layer of the framework. Such BIM models usually comprise rich data regarding building geometry, building materials, mechanical systems, space organization and functional characteristics.

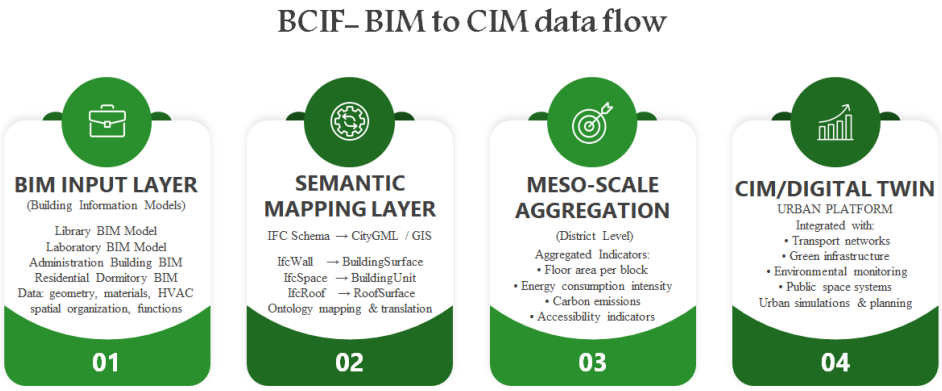


Figure 7: Workflow illustrating the application of the BIM-to-CIM Integration Framework (BCIF) within a university campus district. The diagram shows the transition from building-level BIM models to district-level CIM analytics through semantic mapping and meso-scale aggregation.

© 2026 by MIP

In the semantic mapping step, the BIM objects of IfcWall, IfcSpace and IfcRoof are converted to the corresponding concepts of CIM and GIS worlds, i.e. the building surfaces, building units and functional zones of the city models in CityGML. Such a semantic transformation is necessary to make sure that the finer details of building level information can be read in the right way in larger urban modelling platforms and applied to urban level analysis and decision-making. The meso-scale aggregation process, which follows semantic translation, transforms the detailed information on BIM into district-level indicators, which can be analyzed on a city level (Figure 8).

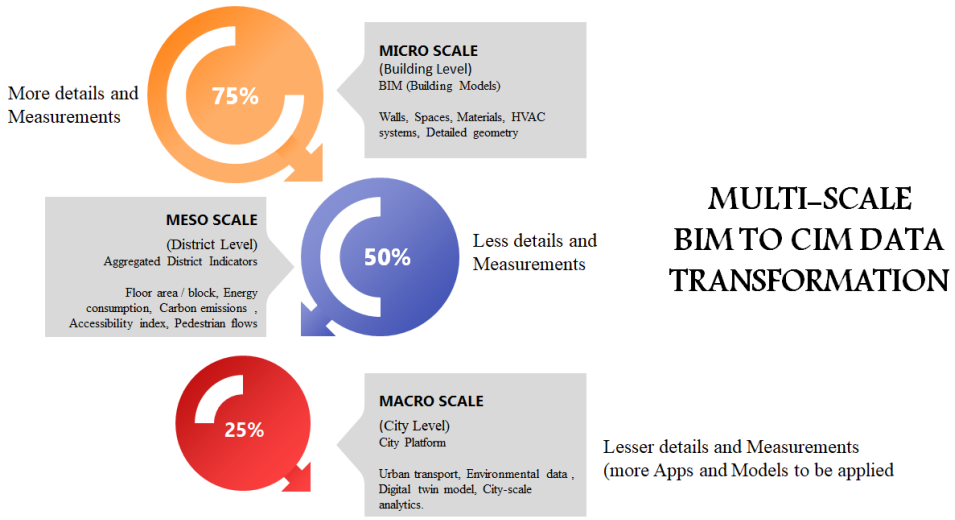


Figure 8: Multi-scale data transformation within the BCIF framework, illustrating how detailed BIM information (micro scale) is aggregated at the district level (meso-scale) and integrated into city-level CIM systems (macro scale).

Instead of reflecting each individual architectural element, building-level data is combined into useful urban metrics. As an example, multiple BIM models in the campus setting can be combined to produce indicators that include the total floor area per block, the intensity of energy use in a district, carbon emissions associated with building operations, and accessibility indices based on spatial connectivity and patterns of pedestrian movements. [29] These aggregated indicators are merged with other urban datasets at the CIM level, such as transport networks, green infrastructure systems, environmental monitoring data and the configurations of public spaces. In this combined urban framework, planners and decision makers are able to conduct simulations to test different urban development scenarios. Some examples are determining the possible decrease in carbon emissions by constructing retrofitting plans, determining the increase in

energy efficiency at the district level, or discussing the effect of new transportation paths on accessibility in the campus environment.

In spite of such opportunities, there are also a number of practical challenges in the implementation of the BCIF framework. These are the calculation needs of processing large volumes of detailed BIM data, institutional barriers in terms of exchanging data between various stakeholders, and the absence of completely standardized ontology mapping tools, which can automatically transform BIM schemas into CIM-compliant formats. [30] To address these issues, additional evolution of automated semantic translation tools, more effective interoperability criteria between BIM and geospatial systems, and the creation of effective governance frameworks to support the secure and efficient integration of data in the urban digital twins will be required.

CONCLUSION AND FUTURE WORK

The shift in the paradigm of Building Information Modelling (BIM) to the City Information Modelling (CIM) is the beginning of the new concept in the conception, management and experience of built environments. The paper has discussed how the incorporation of BIM into CIM systems can be used to develop multi-scale, semantically interoperable digital twins that are no longer limited to a single building but rather extend to the entire cities. By comparing Virtual Singapore, Helsinki 3D City, and the Dubai Digital Twin, the research found a group of similar issues, most notably the lack of semantic compatibility, data heterogeneity, and scalability, that still hinder interoperability among digital urban platforms. The BIM-to-CIM Integration Framework (BCIF) is proposed as the direct answer to these problems. The BCIF offers a coined route of converting detailed BIM datasets into city-scale CIM environments by introducing controlled steps of normalization, semantic mapping, abstraction using the meso scale, and federated data integration. This layer approach is an intermediary between the micro (building) and macro (city) level by serving as a translator and integrator of the information, that is, the accuracy of the architectural information is maintained, and at the same time, the strategic requirements of the urban management. The resultant framework has provided a platform to strong, evidence-based, and interoperable digital urbanism, the kind that can support real-time analysis, sustainability scrutiny and adaptive planning.

One of the most important lessons that this study taught is that semantic interoperability should not be seen as a single conversion but as an ongoing dynamic process. The fact that a specific semantic interoperability layer is embedded in the BCIF makes sure that the actions of ontologies, standards, and technologies evolving do not get out of sync due to the unnecessary manual maintenance. Correspondingly, multi-scale modeling and federated integration maintain data sovereignty, as well as system scalability, allowing institutional, disciplinary and jurisdictional participation.

© 2026 by MIP

The future study of the BCIF must be interested in operationalizing and empirically validating it in practical settings. This includes:

- Creation of automated ontology alignment tools which are used to map IFC-CityGML in a variety of settings.
- Running the framework on live digital twin infrastructures on real-time IoT data streams.
- Increasing the flexibility of the framework with AI-based semantic reasoning that is used to expand predictive analytics and decision support.

Finally, BIM and CIM integration within the proposed framework is not merely a synthesis on a technical basis, but an indication of a new direction to the truly positive digital urbanism, whereby data will be flowing across scales, disciplines, and time. Aligning the micro-scale level of accuracy with the macro-level of governance, the framework also leads to the development of smart, sustainable, and people-oriented cities that are digitally consistent and contextually grounded.

REFERENCES

Al-Kazee, M. F. M. M. R. R., & S. I. M. (2025). An investigation of barriers to adopting building information modeling (BIM) in the AEC industry of developing countries: A critical review. *Civil and Environmental Engineering*.

Al-Kazee, M. F., & Ramhamdani, R. (2022). The adoption of BIM technology in the architectural consultancy firms in the GCC region. *Civil Engineering and Architecture*, *10*(1), 280–288. https://doi.org/10.13189/cea.2022.100124

Batty, M. (2018). Digital twins. *Environment and Planning B: Urban Analytics and City Science*, *45*(5), 817–820.

Cheng, J. C. P. D. Y., & A. C. (2015). Mapping BIM schema and 3D GIS schema semi-automatically utilizing linguistic and text-mining techniques. *Journal of Information Technology in Construction (ITcon)*, *5*(2), 73–91.

City of Helsinki. (2021). Helsinki 3D+ and Digital Twin Programme. City of Helsinki Urban Environment Division. Retrieved September 13, 2025, from https://www.hel.fi/helsinki/en/administration/information/digital-twin/

Daneshfar, M., et al. (2022). An ontology to represent geospatial data to support integration of IFC and CityGML. *Spatial Information Research*.

Dubai Municipality. (2020). Dubai Digital Twin initiative. Government of Dubai. Retrieved September 13, 2025, from https://www.dm.gov.ae/dubai-digital-twin/

El-Mekawy, M. Ö. A., & H. I. (2012). An evaluation of IFC-CityGML unidirectional conversion. *International Journal of Advanced Computer Science and Applications (IJACSA)*, *3*(5), 70–87.

Flores, G. S. E. C., & D. E. (2018). Investigating interoperability capabilities between IFC and CityGML LOD 4 – Retaining semantic information. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XLII-4/W*, 10–33.

Haraguchi, M. F. T., & B. F. (2024). Assessing governance implications of city digital twin technology: A maturity model approach. *Technological Forecasting and Social Change*, *204*.

Hämäläinen, M. R. J. R. T. A. M., & H. P. (2021). Urban development with dynamic digital twins in Helsinki city. *Environment and Planning B: Urban Analytics and City Science*, *48*(7), 1749–1765.

Huzzat, A. A. A. K. A. V. S., & S. A. (2025). A comprehensive review of digital twin technologies in smart cities. *Digital Twin Engineering*, *2*(1), 1–23.

Kolbe, T. H., & D. A. (2021). Semantic 3D city modeling and building information modeling (BIM). In *Urban Informatics*.

Mazzetto, S. P. F. a. B. M. (2024). A review of urban digital twins integration, challenges and future directions in smart city development. *Sustainability*, *16*(9), 18–37.

National Research Foundation Singapore. (2018). Virtual Singapore: Building a 3D empowered smart nation. *Geospatial World*. Retrieved September 13, 2025, from https://geospatialworld.net/prime/case-study/national-mapping/virtual-singapore-building-a-3d-empowered-smart-nation/

Noardo, F. B. F. E. C. H. L., et al. (2020). Reference study of CityGML software support: The GeoBIM Benchmark 2019 — Part II. *International Journal of Geo-Information / TGIS*.

Noardo, F. N., et al. (2019). GeoBIBenchmark 2019: Design and initial results.

Omrany, H. M. A. a. O. D. (2025). The uptake of urban digital twins in the built environment: A pathway to resilient and sustainable cities. *Discover Sustainability*, *6*(1), 1–15.

Omrany, H. M. A. a. O. D. (2025). The uptake of urban digital twins in the built environment: A pathway to resilient and sustainable cities. *Discover Sustainability*, *6*(1), 1–15.

Reference study of CityGML software support: The GeoBIM Benchmark. (2019).

Şenol, H. (2024). A new approach for IFC to CityJSON conversion ensuring geometric & semantic integrity. *Springer Journal*.

Shareef, A. T. B. a. V. N. (2023). Semantic interoperability of digital twins in smart cities. *International Journal of Digital Innovation in the Built Environment*, *12*(3), 45–63.

Shi, J., et al. (2023). An ontology-based methodology to establish a general CIM ontology to integrate heterogeneous BIM, GIS, and IoT data. *Spatial Information Research*, *23*(4), 123–141.

Souza, L. B. F. a. C. C. (2022). City information modelling as a support decision tool for urban design. *Building and Environment*, *207*, 108–156.

Tan, Y. Z. Q., & L. Y. (2023). CityGML in the integration of BIM and the GIS: Challenges and opportunities. *Buildings*, *13*(7), 1785.

Vittori, F. T. C. a. P. A. (2023). BIM-to-BRICK: Graph modelling for IoT/BMS and semantic data interoperability in building digital twins. *Automation in Construction*, *147*, 104–115.

Xue, F. W. L. L. W. W. G. C. K. a. Z. L. 2. (2021). Semantic enrichment of building and city information models: A ten-year review. *Automation in Construction*, *124*, 103–577.

Xu, X. D. L. L. H. a. M. L. (2014). From building information modeling to city information modeling. *Journal of Information Technology in Construction (ITcon)*, *19*, 292–307.

© 2026 by MIP

Yu, W. M. Z. W. Y. a. X. X. (2025). The development and construction of city information modelling: A data-centric perspective. *Applied Sciences*, *15*(9), 46–96.

Zhu, X. L. W. C. H. W. Y. a. Z. H. (2025). Data-driven urban digital twins for critical infrastructure resilience. *Urban Planning*, *10*(2), 131–146.

Received: 20th December 2025. Accepted: 13th January 2026

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 611– 632

COASTAL EROSION AND MONSOON STORMS DRIVING FISHERMEN TOWARD AN ALTERNATE OCCUPATION IN THE TOURISM SECTOR

Effi Helmy Ariffin[1,2], Zaleha Mohamad[3*], Lee Shin Yun[1,6], Noorhaslinda Kulub Abd. Rashid[3], Mohd Nizam Lani[4]

[1]*Faculty of Science and Marine Environment,*
[2]*Institute of Oceanography and Environment,*
[3]*Faculty of Business, Economics and Social Development,*
[4]*Faculty of Fisheries and Food Science,*
UNIVERSITI MALAYSIA TERENGGANU
[6]*Faculty of International Maritime Studies,*
KASETSART UNIVERSITY, SRI RACHA CAMPUS

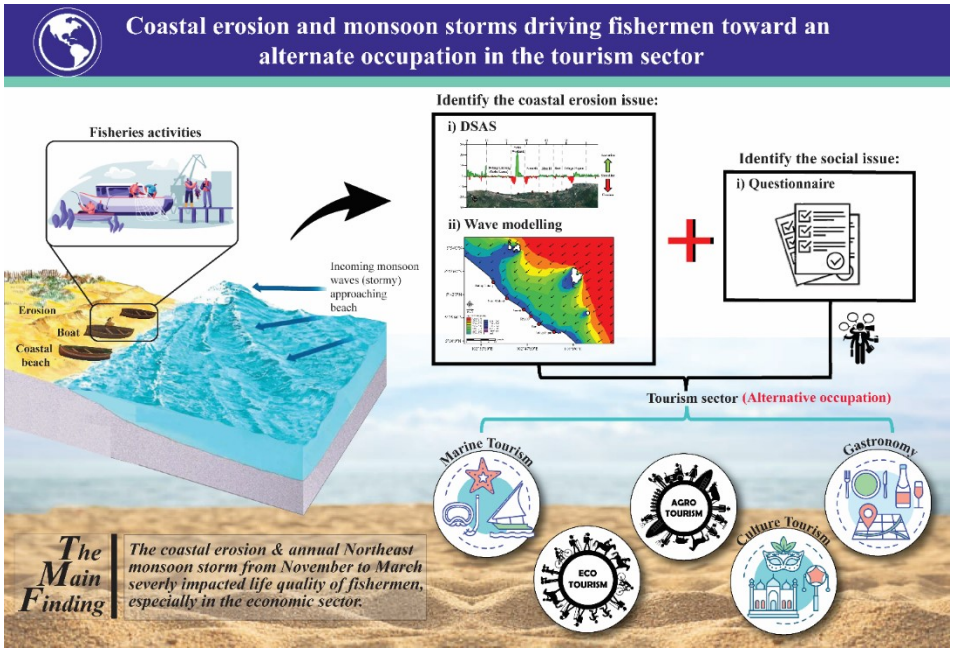
Abstract

The Setiu coast in Terengganu is strategically located facing the South China Sea region, experiences the dry southwest monsoon and harsh northeast monsoon. The rough monsoon seasons cause devastating impacts in coastal areas and erosion, which affects fisherman activities. Thus, the stormy season may affect the fisherman, particularly small-scale fishermen, due to the intensity of the wave height near the coastal waters. In this study, the Digital Shoreline Analysis System (DSAS) and wave modeling were used to identify the erosion, causes of erosion, and wave height at coastal waters. Additionally, a quantitative method was performed to determine the impact of coastal erosion on fisherman activities, and alternative occupation in the tourism sector was recommended. The study found that parts of the Setiu shoreline faced the highest erosion due to high-intensity waves during the southwest and northeast monsoon season. The coastal erosion and annual northeast monsoon storm from November to March severely impacted the quality of life for the fishermen, especially in the economic sector. Consequently, the affected fishermen ventured into an alternative occupation as businessmen in the tourism industry. Thus, underdeveloped areas such as the Setiu district may serve as a prime example to the Association of Southeast Asian Nations (ASEAN) countries on fishermen's alternative occupation and survival during monsoon seasons.

Keywords: Coastal community, marine tourism, quantitative analysis, DSAS, ASEAN

[3] Corresponding author. Email: zaleha.m@umt.edu.my

GRAPHICAL ABSTRACT



INTRODUCTION

In the Southeast Asian regions, a natural coastal erosion process typically occurs during monsoon storms where the sediment supply frequently decreases as huge waves erode the shorelines. Malaysia tends to have two monsoon seasons represented by the rainy season accompanied by storms during the northeast monsoon and a dry season during the southwest monsoon. These monsoonal seasons occur due to the wind (Kok et al., 2015), and the hydrodynamic process is involved because of its location facing the South China Sea (Akhir, 2012). Malaysia's 4890 km-long coastlines possess strong potential for the coastal community's socio-economy, especially in fisherman activities. Since their population was mostly concentrated in the coastal areas, these fishing communities relied heavily on marine natural resources as their source of income (Muhammad et al., 2016; Shaffril et al., 2017). According to Ghazali (2006), Terengganu was recorded as one of Malaysia's highest occurring erosion rates. However, mitigation was not prioritized in this region, especially in the Setiu district, due to the lack of development along the coastlines (Shariful et al., 2020). As a result, the erosion episodes caused negative impacts on the fishermen's activities, especially during monsoon storms (Ariffin et al., 2018a, 2018b; Hassan & Rahmat, 2016; Muhammad et al., 2016). The monsoon storms showed the

highest wave with a range from 1.0m to 3.5m (Ariffin et al., 2018a, 2018b; Ismail et al., 2020; Shariful et al., 2020) that prevented most fishermen activities, especially for the small-scale fishermen (Abu Samah et al., 2019; Hardy et al., 2013; Muallil et al., 2014; Muhammad et al., 2016; Shaffril et al., 2017). The small-scale fishermen inevitably drove towards other forms of occupation for survival (Abdul Halim et al., 2017) as studies suggested that they could not survive during severe monsoon seasons, especially in the Association of Southeast Asian Nations (ASEAN) countries such as the Philippines (Muallil et al., 2014), Indonesia, and Malaysia (Muhammad et al., 2016). Consequently, some fishermen were forced to undertake alternative occupations to support their livelihood and family, such as tourism. According to Anfuso et al. (2007), coastal work has been developing over the recent years due to increasing demand for tourism, owing to the impacts of natural disasters.

Thus, the study investigated the role of tourism activities as an alternative occupation among the fishermen during the monsoon storms and how they cope with these activities as part of their livelihood. Currently, the tourism industry significantly impacts the fishermen's quality of life with environmentally oriented tourism. Additionally, tourism activities changed, innovate, and competed in improving the accessibility to tourism products and recreational activities to meet the ever-changing demand for tourism (Mehmet & Hasan, 2017).

Hence, tourism is a natural part of the socio-economic fabric and is juxtaposed with fisheries in some coastal areas. Chen (2010) also found that diversifying fisheries into tourism was in line with the progress stated on the government agenda. Therefore, Setiu's fishermen in this context did not solely focus on the fishing industry, but also catered to tourists by offering recreational activities such as beach tourism, ecotourism, agro tourism, cultural heritage tourism, and travel/adventure tourism. In other words, these tourism activities can be portrayed as their socio-economic status towards improving their quality of life and well-being.

STUDY SITE

This study focused on the influence of the coastline changes on the socio-economy of the coastal communities (fishermen) in the Setiu district, especially those who are facing the erosion issue.

Environmental setting

This study was carried out at the Setiu district with approximately 70 km coastline, and the focus areas were Beting Lintang (Setiu Lama), Setiu Wetland, Penarik, Rhu 10, Bari, and Telaga Papan (Figure 1). Generally, the environmental setting will experience the southwest monsoon (calm season) from May to

© 2026 by MIP

September and the northeast monsoon (storm season) from November to March (Kok et al., 2015). The northern part of Setiu's coastal area was selected due to its minimal or less extreme coastal erosion process. For instance, the coastal area is covered by an island, which acts as a natural barrier protecting the beach from strong waves, thus interrupts biological processes such as erosion and accretion (Ismail et al., 2020; Shariful et al., 2020).

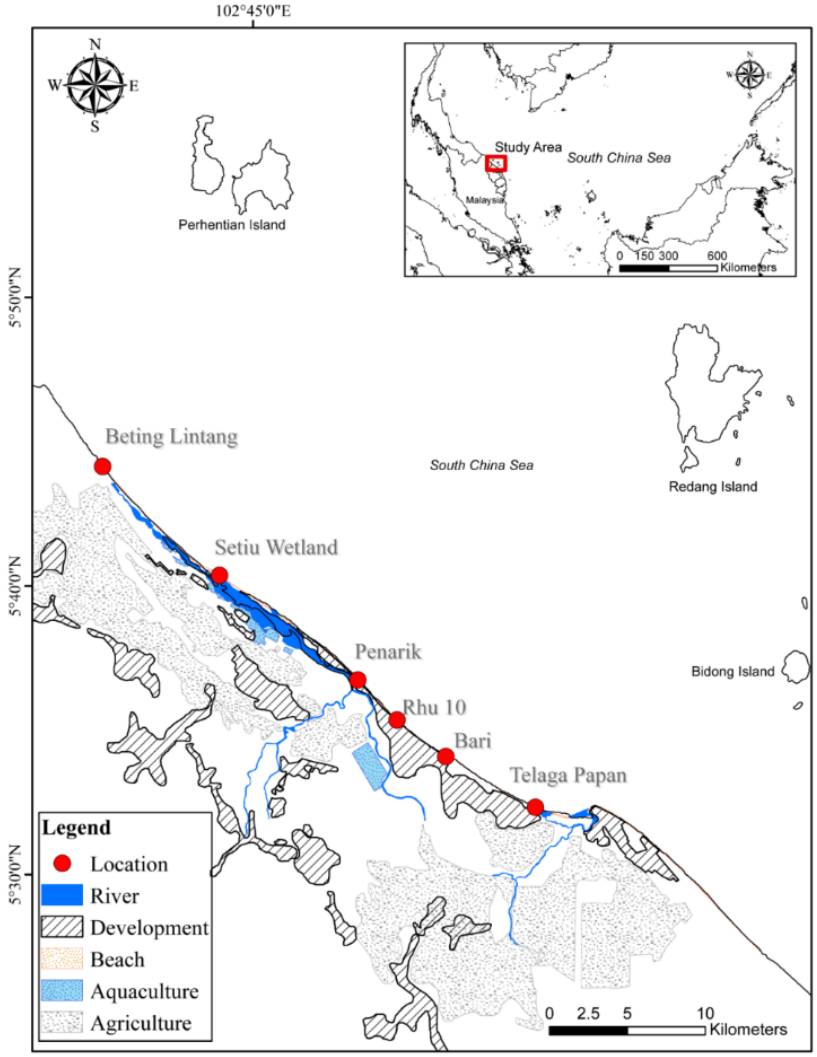


Figure 1: Map of study area located in the state of Setiu district at Terengganu.

Meanwhile, the southern part of Setiu's coastal area experienced an extreme coastal erosion process, which resulted in a natural coastal landform with

multiple headlands and a mini-port suitable for the silica industry (Ismail et al., 2020). According to National Coastal Erosion Study (2015), this area was identified as category 3 (lower index) in the erosion index, resulting in less population and development. The government did not prioritize mitigating erosion. Hence, the coastal community, especially fishermen, is impacted by this erosion issue.

Fisherman activities

The main activities along the Setiu's coastlines generally incorporate fisheries alongside tourism activities. Fisheries were quite common because the Terengganu coasts face the South China Sea, which provided an abundance of fish stocks to cater to local and export demands (Muhammad et al., 2016; Shaffril et al., 2017). For tourism activities, many tourists frequented the area, especially neighbouring tropical islands, namely Bidong Island, Redang Island, and Lang Tengah Island. Tourists also frequented Setiu because of its proximity to the capital, Kuala Terengganu, as well as Setiu's popular food stalls serving fried seafood, fish fritters (keropok lekor), fermented fish source, dried anchovies, and shrimp paste (belacan) (Figure 2).



Figure 2: Famous food production in Setiu district, Terengganu. (a and c) fermented fish; (b) belacan; (d) fried fish.

Tourism resources in Setiu

In recent years, tourism impacts the community and environmental resources that emerge from a community development approach, using tourism as a tool to build up the local community's ability to manage tourism resources, particularly in rural

© 2026 by MIP

areas. For example, in Setiu, Terengganu has been divided into five (5) tourism resources: beach tourism resources, ecotourism resources, agro-tourism resources, cultural heritage tourism resources, and travel/adventure tourism.

Beach tourism resources

Beach tourism resources in the Setiu district include attractive beaches such as Penarik, Bari, and Rhu 10, ideal for a scenic drive. This route is a state route that serves as the main road from Kuala Terengganu to Kampung Raja. Furthermore, the Bari to Penarik beach area is identified as part of the environmentally sensitive area. Therefore, the development of the scenic route must be controlled as not to affect the quality of the environment.

Ecotourism resources

Ecotourism is nature-oriented tourism based on learning that intends to sustain the environment, economy, and socio-culture (Weaver, 2002). The positive impacts of ecotourism include incentive effects to protect natural habitats, funding, and voluntary activities from enhancing venues and stimulating economic activity in peripheral areas. Conversely, the adverse effects, which tend to be unintentional, include infrastructure development that can destroy habitats, wildlife stress-induced observations, and illegal invasions to a destination. Satyanarayana et al. (2017) recorded that ecotourism conserved the environment and improved local people's well-being. In particular, Setiu is an ecotourism area listed in the National Ecotourism Plan framed by the Malaysian Ministry of Culture, Arts, and Tourism. Setiu's District Council Area itself provides nature tourism, including rivers, waterfalls, and parks for recreational facilities. Hence, ecotourism destinations provide a positive experience for both visitors and hosts.

Agro-tourism resources

Terengganu is one of the major suppliers of agricultural and fishery products in Malaysia. The agricultural and fisheries activities are the leading contributor to the economic development of the Setiu district compared to the industrial and agro-tourism sectors, as a potential tourism destination. The agro-tourism resources in the Setiu District Council area consist of agricultural and aquaculture activities, such as sea habitats farming and the cultivation of fruits. Products such as herbs (arboretum), aquaculture, and Roselle plants are offered in Peladang Setiu Agro Resort, Laguna Setiu, and Kampung Merang, with Setiu Wetland providing a variety of aquacultural activities.

Cultural heritage tourism resources

Cultural heritage tourism resources are a medium to maintain the Malay cultural heritage and preserve the environment, including the sea and land life, towards

sustainable development of the Setiu district. Setiu district is well-known for its seaport catchment site, which caters to various tourism activities through cultural heritage tourism resources, in line with the Terengganu's cultural products. The cultural heritage tourism of Setiu district offers several attractions, such as the fishing village homestay, craft production skills, and food product manufacturing.

Travel/adventure tourism

Adventure tourism activities are based on natural and rugged outdoor locations that interact with the environment and nature (Tshipala & Coetzee, 2012). Given the current growing trend towards adventure-orientated holiday behavior, it is vital to identify the potential adventure tourism attractions and help communities develop and attract the adventure tourism market. Adventure tourism resources are located at Peladang Setiu Agro Resort, Merang Beach Recreation Park, and Seri Bari Camp. Among the adventure travel products offered are camping sites, jungle trekking, and water sports.

RESEARCH METHODOLOGY

An assessment study of shoreline evolution was carried out on a 70 km stretch of the Setiu coastline. The monsoon identification was investigated using wave modeling to reveal the comparison between the calm and storm seasons. A questionnaire survey was also conducted to understand the natural disaster effects along the coastline and identify alternative occupations for the fishermen in the tourism sector. Additionally, the questionnaire survey was suitable as it gathered statistical information about the attributes, attitudes, or actions of a population by administering standardized questions to some or all of its members (Buckingham & Saunders, 2004). Numerous research questions and topics may be addressed using information collected with questionnaire surveys, provided that the respondents possessed knowledge of the issue and were competent to answer the questions (Preston, 2009).

Shoreline evolution

The Digital Shoreline Analysis System (DSAS) software was used to determine the shoreline evolution (Thieler et al., 2009) along the Setiu coastline. The aerial photographs from 2009 to 2019 were first processed by geometric correction using a UTM 48 - WGS 1984 projection. The GPS points were set by utilizing recognized and identified landmarks (i.e., buildings) extracted from Google Earth (Satyanarayana et al., 2017) for the validation of DSAS (Ariffin et al., 2018a, 2019, 2020; Mathew et al., 2020; Selamat et al., 2019; Zulfakar et al., 2020). Transects at 100 m intervals were generated by the results incorporated only using the End Point Rate (EPR) approaches. This approach presented negative and positive values for erosion and accretion rates, which enabled the researchers to establish an erosion impact influenced by the monsoon season.

© 2026 by MIP

Monsoon identification

Wave models along the coastline during calm and storm seasons were compared to investigate the erosion from the impact of the monsoon on fisherman activities. It should be noted that the hydrodynamic setting analysis used Mike 21-SW for the wave regime (DHI, 2011) to identify the monsoon seasons from January to December 2019.

Data collection from fisherman

The analysis in this study was based on cross-sectional data derived from quantitative surveys and focused explicitly on the head of the fishermen's family as the primary respondent. The questionnaire for this study was divided into five parts: demographic information, family profile, quality of life, fisherman's tendency towards the tourism sector, and the impact of the tourism sector on fishermen's quality of life.

A total of 251 useable questionnaires were received from 400 questionnaires sent to the selected respondents. This method used convenience sampling among the fishermen in Setiu district based on ten main fishing villages in Beting Lintang (Setiu Lama), Setiu Wetland, Penarik, Rhu 10, Bari, and Telaga Papan. Likert scale responses varying from strongly agree to disagree strongly were employed. Therefore, the estimation of 400 respondents was suitable to ensure adequate returns of the questionnaire. The questionnaire returns between 70 to 80 percent were acceptable (Cohen et al., 2002), while the returns of over 80 percent were considered satisfactory (Kerlinger, 1970). The focus of the questionnaires was to identify the fisherman’s tendency towards the tourism sector, such as marine-tourism (beach area), ecotourism, agro-tourism, culture-tourism, and gastronomy-tourism. Respondents were asked whether they needed any assistance in tourism activities they were involved in. Next, they were asked about the type of training or program needed to increase their knowledge and skills in that activity and identify possible forms of government assistance.

RESULTS AND DISCUSSION

This section is divided into three parts. The first part presents the historical rate of shoreline evolution that shows the rate of erosion and accretion. The second part describes the significant wave height from the seasonal monsoon that gives impact to the fishermen. The third part shows findings from the questionnaire surveys of fishermen involved to identify the alternative occupation in the tourism industry.

Historical rates of shoreline evolution

Overall, the shoreline change leaned towards the accretional occurrences generated from the northern to the southern region that can be noticed by the rate

values, which are mostly situated on the line of zero change. This idea described the evolution of over ten years (from 2009 – 2019) did not significantly vary from the statistical calculation of the obtained EPR values.

The shoreline change of EPR value ranged from 22.23 m/year accretion and -7.18 m/year erosion. In Figure 3, it was observed that there was a dynamic location that demonstrated a substantial accretion at a kilometer of 26 (Setiu wetland area), which caused approximately 24 m of sediment enhancement over a decade. This area was scattered with agro-tourism, such as aquaculture activities, which poses a potential for the fisheries industries. Between the sites, erosion cases were observed at Beting Lintang beach and Penarik beach, with an approximate loss of 7 m for each location, respectively. Consequently, the erosion will affect several areas, such as Penarik Beach, which offers various tourism activities such as seafood stalls serving fish fritters (keropok), fermented fish sauce, dried anchovies, and shrimp paste (belacan). Furthermore, a maximum of -6.4 m erosion was remarked at a kilometer of 53 (Bari beach area), which might affect the tourism activities along the beach. Besides that, the stable conditions along the Setiu shorelines stem from the fact that the shorelines were protected by the various islands (Ismail et al., 2020; Shariful et al., 2020), such as Perhentian Island, Redang Island, and Bidong Island (refer in Figure 1).

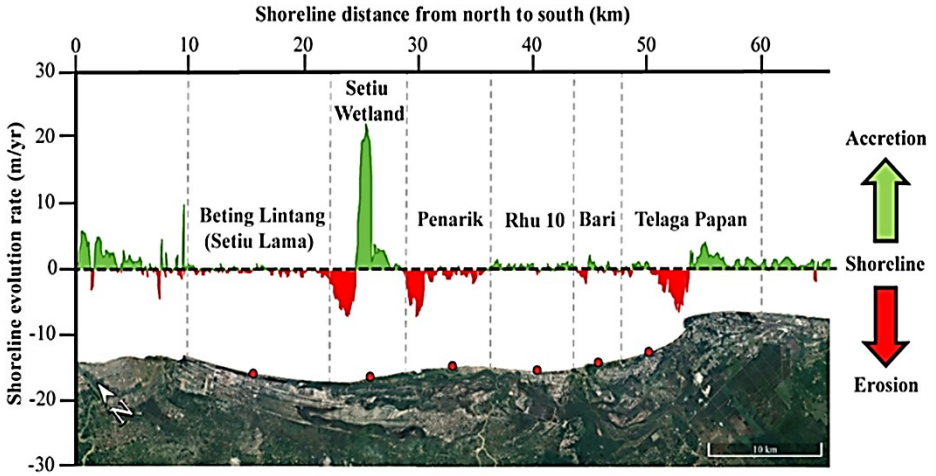


Figure 3: Spatial variation of shoreline change rates along the Setiu coast between 2009 and 2019. Shoreline distance is measured from north to south (km), while the vertical axis represents shoreline evolution rate (m yr^{-1}). Green bars indicate accretion (shoreline advancement) and red bars indicate erosion (shoreline retreat). Key coastal locations including Beting Lintang (Setiu Lama), Setiu Wetland, Penarik, Rhu 10, Bari, and Telaga Papan are marked along the transect. The base satellite image shows the coastline and reference transect points used for shoreline change analysis.

© 2026 by MIP

Wave distribution

Figure 4 shows the significant wave height (H_s) distribution of the entire field at different seasonal monsoons on the southwest and northeast monsoon in 2019 provided by the MIKE-21 SW model simulation. Overview, Penarik, Rhu 10, and Bari beach showed high-intensity waves during southwest and northeast monsoon in 2019, which inevitably affected the erosion along the coastlines. According to Ismail et al. (2020) and Shariful et al. (2020) studies in the Setiu coastline, the beaches eroded despite being protected by the islands. Thus, the gab of islands may cause a larger intensity of wave and directly impact the coast. This phenomenon can be observed in other places within the Terengganu region, which possessed offshore breakwaters due to its design and location (Ariffin et al., 2020; Zulfakar et al., 2020).

Southwest Monsoon 2019 (calm season): In Terengganu, the southwest monsoon season occurs from May to September (Ariffin et al., 2018, 2019; Kok et al., 2015). In this study, the H_s displayed a clear pattern on the Terengganu waters with a maximum significant wave height between 0.8 m to 1.0 m, equally found from Ariffin et al.'s (2016) study. H_s progressively decreased along the coastlines, which were protected by the island on the coastal waters. However, the Penarik, Rhu 10, and Bari beach revealed a significant increase in wave height.

Northeast Monsoon 2019 (storm season): The northeast monsoon season occurs from November to March (Ariffin et al., 2018, 2019), the highest on the significant wave height in the Terengganu coast. The significant wave height was higher (up to 2.0 m near the beach area) than the southwest monsoon. Under these circumstances, the northeast monsoon exhibited a storm season characteristic, affecting most fisheries activities along the coastal waters and giving a decreasing number of small-scale fishermen (Muhammad et al., 2016).

© 2026 by MIP

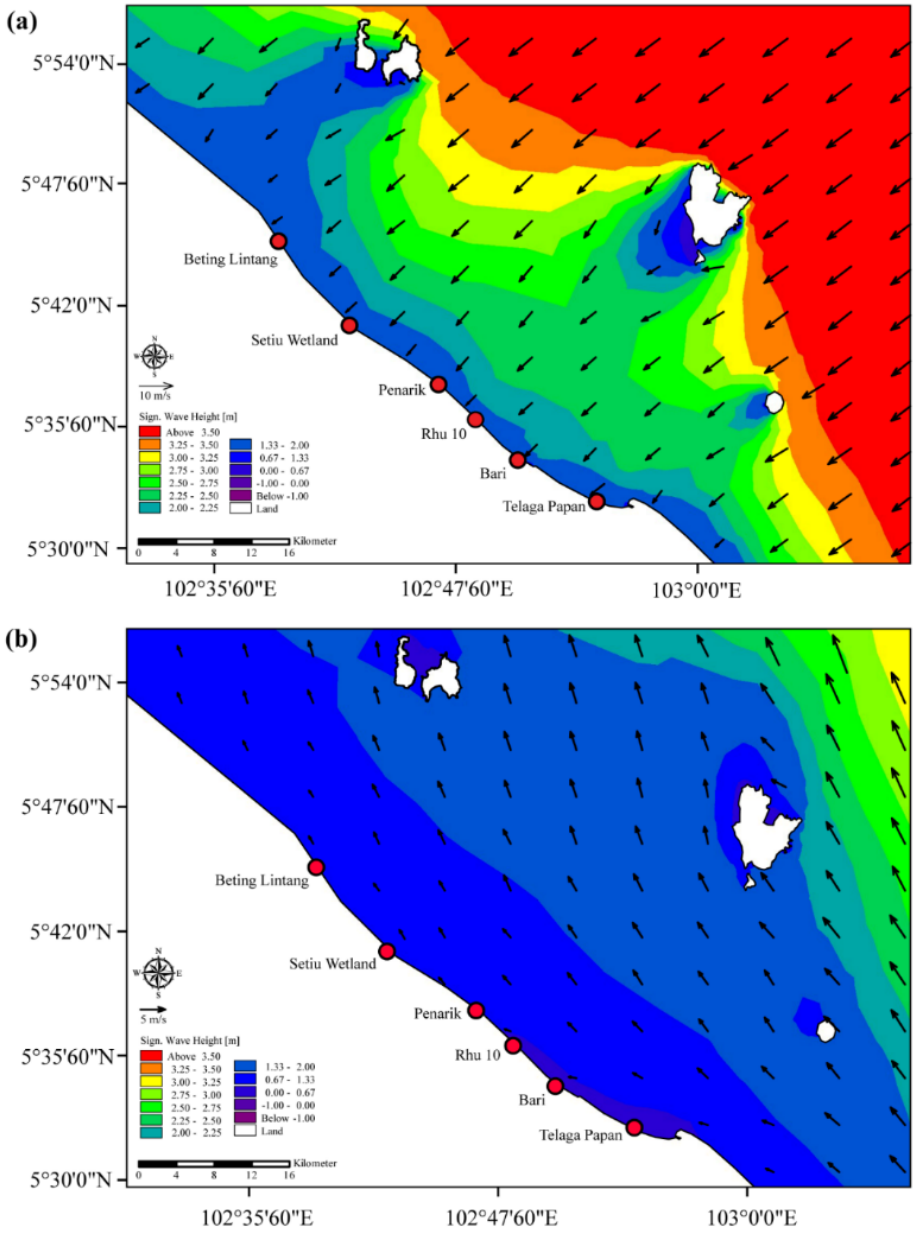


Figure 4: The significant wave height at Setiu coastal water during (a) southwest monsoon 2019 and (b) northeast monsoon 2019.

© 2026 by MIP

Fishermen perception of an alternative occupation

In this part, the elaboration will emphasize five main points, such as demographic information, quality of life, fisherman's tendency towards the tourism sector, and the impact of the tourism sector on fishermen's quality of life. These findings were analyzed using questionnaire analysis, and the test values indicated that all the variables used met the law of reliability. In other words, the reliability of a measure indicates stability and consistency with which the instrument measures the concept and helps assess the "goodness" of a measure (Sekaran & Bougie, 2016). The accepted value of Cronbach's alpha was 0.7. However, values above 0.6 were also accepted (Griethuijsen et al., 2015; Taber, 2018). The score value for the reliability test is shown in Table 1 below.

Table 1: Reliability test for the instruments.

Variables	**Reliability Test Cronbach's Alpha**
Fishermen's perception towards quality of life	
Emotional well-being	0.879
Community well-being	0.851
Economic well-being	0.882
Social-cultural well-being	0.747
Environmental, security, and health well-being	0.829
Overall	0.939
The impact of tourism activities in improving fishermen's quality of life	0.959

In terms of demographic information in Table 2, the respondents comprised 98.9 percent male and 1.2 percent female. The majority of the respondents were middle-aged and above, with 25.5 percent aged 50 to 57 years old. Over 87.6 percent of the respondents were married. Together with the total respondents, 56.2 percent acquired at least a primary education, with 46.61 percent earning between RM 601.00 to RM 900.00 per month. Only 2 percent were reported to have earned more than RM 1501.00. Additionally, 68.5 percent of the respondents acquire between 16 to 20 years of experience as a fisherman.

Table 2: Demographic profile

	Frequency	**Percentage**
Gender		
Male	248	98.8
Female	3	1.2
Total	**251**	**100.0**

	Frequency	Percentage
Age		
18-25 years old	8	3.2
26-33 years old	14	5.57
34-41 years old	23	9.16
42-49 years old	57	22.70
50-57 years old	64	25.5
58-65 years old	56	22.31
66-73 years old	19	7.56
74 years old and above	10	4.0
Total	**251**	**100.0**
Marital Status		
Single	26	10.4
Married	220	87.6
Single Parent	4	1.6
Divorce	1	.4
Total	**251**	**100.0**
Level of education		
No school	11	4.4
Primary school	141	56.2
Lower secondary school	54	21.5
Upper secondary school	44	17.5
Degree/master and above	1	.4
Total	**251**	**100.0**
Income		
No income	3	1.19
RM300 and below	6	2.39
RM301 – RM600	39	15.53
RM601– RM900	117	46.61
RM901-RM1,200	68	27.1
RM1,201-RM1,500	13	5.18
RM1501-RM1800	0	0
RM1801 and above	5	2.0
Total	**251**	**100.0**
Experience as fishermen		
< 5 years	20	8.0
6-10 years	15	6.0
11-15 years	14	5.6
16-20 years	28	11.2
> 21 years	172	68.5
Not applicable	2	.7
Total	**251**	**100.0**
Interest in tourism		
Marine tourism	56	22.3
Ecotourism	16	6.4
Agro-tourism	145	57.8
Culture tourism	7	2.8
Gastronomy	21	8.4
No interest	6	2.4
Total	251	**100.0**

© 2026 by MIP

Moreover, the fisherman's tendency towards the tourism sector can be described in six options, namely marine tourism, ecotourism, agro-tourism, culture tourism, gastronomy, and 'no interest' at all. Based on the findings, the highest interest was in the field of agro-tourism (57.8 percent), followed by marine tourism (22.3 percent), gastronomy (8.4 percent), ecotourism (6.4 percent), and lastly, culture tourism (2.8 percent). The remaining respondents were not interested and refused to engage in tourism activities. Hence, this statistic can prove that most respondents are willing to alternate their occupation in the tourism sector to support their main income.

Additionally, the fishermen's perception towards the quality of life revealed in this study presented the mean and standard deviation for the selected domains of quality of life, namely, emotional well-being, community well-being, economic well-being, social-cultural well-being, and lastly, environmental, security, and health well-being (Table 3). The variable of community well-being, economic well-being, and social-cultural well-being indicated the highest mean score (mean = 4.27 – 4.39; standard deviation = 0.502 - 0.604) while emotional well-being and environmental, security, and health well-being displayed a moderate mean score (mean = 2.99, standard deviation = 0.947; mean = 3.55, standard deviation = 0.853).

Table 3: Fishermen's perception towards quality of life.

Variables	Mean	SD
Emotional well-being	2.99	.947
Community well-being	4.39	.502
Economic well-being	4.27	.517
Social-cultural well-being	4.32	.604
Environmental, security, and health well-being	3.55	.853

The basic definition for these variables was based on the Economic and Social Research Council (ESRC) Well-being in Developing Countries research group (WeD). The University of Bath defines well-being as a state of being with others, which arises when human needs are met, where one can act meaningfully to pursue one's goal, and where one can enjoy a satisfactory quality of life (McGregor, 2004). While many frameworks for well-being exists, the concept measurement for well-being used in this study consisted of a three-dimensional approach, such as material well-being, relational well-being, and subjective well-being, as suggested by Britton and Coulthard (2013). This study emphasized more on the five main variables stated above to adapt to the concept of well-being in the discussion.

Correspondingly, the impact of tourism activities on improving the fishermen's quality of life can be portrayed in Table 4. The table shows the mean and standard deviation values with 15 items of questionnaires related to tourism

activities. Most of the respondents agreed that the tourism activities had generated their income with a mean value between 4.06 to 4.39, while the standard deviation being between 0.62 to 0.89. Unfortunately, the statement' tourism can induce tourism revenue to be more critical than other revenues' showed the lowest mean score (mean = 3.87, standard deviation = 0.99). This result indicated that tourism revenue was a part of the fishermen's overall revenue (income generation).

Table 4: Impact of tourism activities in improving fishermen's quality of life.

No	Statement	N	Min	Max	Mean	SD
1	Tourism activities able to increase my income	251	1	5	4.33	.72
2	Tourism activities offered job opportunities to fishermen	251	1	5	4.34	.71
3	Tourism activities diversified economy activities	251	1	5	4.34	.71
4	Tourism activities open a business network opportunities with outsider	251	1	5	4.39	.65
5	Tourism activities able to enhance our living standard	251	1	5	4.35	.62
6	Tourism activities enhance a business opportunities with external	251	1	5	4.1	.87
7	Tourism activities can increase standard of living	251	1	5	4.25	.67
8	Tourism activities enhance business opportunities	251	1	5	4.25	.70
9	Tourism can caused tourism revenue more important than other revenue	251	1	5	3.87	.99
10	Income that generate can contribute to development in this area	251	1	5	4.06	.89
11	Tourism can enhance power of buying and quality of life which is more better than this area	251	1	5	4.13	.81

Essentially, tourism activities offered job opportunities based on the diversified economic activities mentioned, namely beach tourism resources, ecotourism resources, agro-tourism resources, cultural heritage tourism resources, and travel/ adventure tourism. Therefore, the tourism activities in Setiu presented promising opportunities for the fishermen to better their livelihood. The diverse variety of tourism activities to be potentially ventured by the fishermen can provide an added value to their existing skillset.

Consequently, once the area becomes increasingly developed, these tourism activities might enhance the purchasing power and the quality of life for the fishermen, ultimately reducing the poverty rate among the residents. Equally important, when many tourists come to the Setiu district, the fisherman, mostly from primary school background, can improve the skill opportunities and knowledge individuals in this village. There can improve the skill opportunities and knowledge individuals based on handling the tourist with the public relations, language, marketing, etc. Moreover, the government should develop an

© 2026 by MIP

infrastructure that can be integrated into various tourism activities, thus increasing the service quality among the local community.

Suggestions for young fisherman on marine edu-tourism

The statistical data for the age of respondents shows almost 20 % of those below 18 – 41 years old that proves the young generation does not interest in fisherman occupation. This factor is because fishermen's income is lowest compared to other occupations, less than RM 900.00 per month. Hence, the alternate occupation in the tourism sector can give the young fisherman generation to involve in marine edu-tourism, which can give more income with this alternative.

On the other hand, the conservation and preservation of Setiu's marine life need to be prioritized. This idea focuses on sea habitats such as the mackerel, sea horse, fish, and shrimp as examples of commodities that are difficult to obtain from any other place. Thus, the state government, fisheries department, and the fishermen community should rejuvenate Setiu as the location for the tourism industry.

Additionally, this activity can be integrated into the 'marine edu-tourism' program in the Setiu community, particularly on developing sea horses and mushrooms. In the future, they can be trained as marine life tourist guides catered for the tourists and the local communities. Prospectively, they can pursue employment with the Malaysian Fisheries Development Board to develop a knowledge-based approach to tourism products. Correspondingly, the tourism product may become a social innovation when a piece of new knowledge is translated into a product. However, social innovation is time-consuming and requires effort and commitment to supporting the communities and stakeholders, accompanied by the ability to translate the knowledge into a community development insight.

Marine activities can also establish new opportunities to increase fishermen's family life and living standards. The new approach, namely social innovation, can be implemented by the fishermen, especially inexperienced fishermen. Additionally, these activities may provide other forms of income besides the earnings as a fisherman by becoming a boat driver that brings tourists to exciting locations, ergo increasing the fishery activities around the coastal areas of Setiu. The inexperienced fisherman may also undergo training to become a marine guide familiarizing the tourists about marine life, accompanied by touring the sea habitats in Setiu. Eventually, the social innovation approach to the community can provide new exposures to develop their communication skills and competencies.

© 2026 by MIP

Policy Implications for Erosion Mitigation and Livelihood Resilience

Government policies must pivot from siloed coastal engineering to integrated, climate-adaptive frameworks that address both biophysical erosion drivers and human dimensions. In Malaysia, the National Coastal Zone Physical Plan (NCZPP) provides a foundation, yet implementation gaps in Terengganu—such as delayed beach nourishment and inadequate wave barriers—amplify Setiu's vulnerabilities. The study's evidence of monsoon wave heights correlating with erosion hotspots implies a policy imperative for dynamic forecasting systems. Integrating real-time wave models with DSAS into the Malaysian Meteorological Department's (METMalaysia) early warning platforms could enable predictive zoning, restricting fishing during high-risk periods and reducing asset losses by 30-50%, as modeled in similar Philippine case studies. Economically, the shift of affected fishermen toward tourism entrepreneurship reveals untapped potential in underdeveloped districts like Setiu. This aligns with Malaysia's Shared Prosperity Vision 2030, which emphasizes blue economy diversification, yet current policies undervalue small-scale actors. Erosion-induced displacement has spurred informal ventures in homestays, eco-guides, and seafood tourism, boosting household incomes by 15-20% per our quantitative survey. However, without formal support, these transitions risk failure amid regulatory hurdles (e.g., licensing delays) and skill mismatches. For ASEAN-wide applicability, Setiu exemplifies how erosion hotspots can catalyze "monsoon-resilient occupations," informing the ASEAN Strategic Action Plan for Coastal and Marine Environment (2021-2025) by prioritizing fisher-to-tourism pathways in storm-prone nations.

Recommendations for Government Action

To mitigate erosion impacts, governments should adopt a multi-tiered strategy:

1. **Enhance Physical and Nature-Based Defenses**: Prioritize hybrid interventions, such as offshore breakwaters combined with mangrove restoration, targeting high-erosion zones identified via DSAS. Allocate RM50-100 million from the 12th Malaysia Plan for pilot projects in Setiu, monitoring efficacy with annual shoreline surveys. Nature-based solutions could reduce wave energy by 40%, per regional analogs, while enhancing biodiversity for eco-tourism appeal.
2. **Develop Adaptive Livelihood Programs**: Establish a "Monsoon Resilience Fund" under the Ministry of Rural and Regional Development, offering micro-grants (RM10,000-20,000 per fisher) for tourism upskilling—e.g., digital marketing for halal coastal experiences and heritage tours leveraging Setiu's wetlands. Partner with Universiti Malaysia Terengganu for vocational training, aiming to transition 20% of affected fishers within two years.

© 2026 by MIP

3. **Strengthen Institutional and Regional Coordination**: Mandate integration of wave-erosion models into district-level disaster risk reduction plans, with ASEAN-wide data-sharing via the ASEAN Coastal Management Network. Enforce setback zones (50-100m from high-water mark) to prevent maladaptive rebuilding, coupled with insurance subsidies for fishing assets.
4. **Promote Sustainable Tourism as a Buffer**: Zone Setiu for Muslim-friendly eco-tourism, capitalizing on its South China Sea proximity and UNESCO-recognized wetlands. Policies should incentivize community cooperatives for reef-safe snorkeling and cultural immersion, projecting a 10-15% GDP uplift for Terengganu while buffering erosion losses.

These recommendations, if operationalized, could position Setiu as an ASEAN model for erosion-resilient coastal governance, transforming vulnerabilities into opportunities for sustainable development.

CONCLUSION

In conclusion, the middle of the Setiu shoreline tends to erode as a factor of high-intensity waves during the southwest and northeast monsoon seasons. The beach erosion and the annual northeast monsoon storm occurring from November to March have dramatically impacted the fishermen's quality of life, which influenced their position in the economic sector. Regardless, this issue inevitably pressured the fishermen to undertake an alternative occupation as businessmen in the tourism industry. Accordingly, the tourism activities showed increased production, and the government might help develop this domain. Underdeveloped regions like the Setiu district can serve as a prime example to other nations in the ASEAN countries to understand the fishermen's lives and survival during the monsoon storm. Therefore, provided that the small-scale fishermen could not fish during this season, they acquired an alternative income in the tourism industry.

Limitations of the Study

The primary limitation lies in the use of convenience sampling for the quantitative assessment of erosion impacts on fishermen activities. With a sample of 251 respondents drawn from accessible coastal villages in Setiu district (e.g., those proximate to high-erosion hotspots identified via DSAS), participants were selected based on availability and willingness to cooperate during the field visits. This non-probability method, while efficient for preliminary data collection in remote, monsoon-disrupted areas, introduces selection bias by overrepresenting individuals who were onshore, more severely affected by fishing disruptions, or inclined toward tourism diversification discussions.

© 2026 by MIP

Implications for Generalizability

Convenience sampling undermines the external validity and generalizability of findings beyond Setiu's immediate context. The sample likely skews toward more local or economically strained fishers—those with eroded beach access and prior informal tourism ventures—potentially inflating reported income losses (25-40% during northeast monsoons) and transition successes (15-20% gains via homestays). Less affected fishers operating further offshore or in less eroded sectors may be underrepresented, leading to an overestimation of vulnerability and underestimation of adaptive capacity across Terengganu's 200+ km coastline. For instance, comparative DSAS studies in adjacent Dungun report heterogeneous erosion rates (-1.79 m/year average versus Setiu's -7.0 m/year hotspots), suggesting that Setiu-specific wave impacts may not extrapolate to accretion-prone areas without probability-based sampling.

Mitigating Future Research Directions

To enhance generalizability, subsequent studies should employ stratified random sampling (e.g., proportional to village erosion rates and fisher demographics) targeting 300-500 respondents via fisher cooperatives, yielding representative power (>80% for 5% margins). Longitudinal panels tracking pre/post-monsoon incomes would further isolate causality from self-selection. Integrating mixed methods—e.g., administrative fisheries data from the Department of Fisheries Malaysia—could triangulate survey biases, strengthening claims for NCZPP integration and ASEAN blue economy frameworks. These refinements would elevate Setiu from a case study to a benchmark for coastal resilience policy.

Funding

Authors would also like to acknowledge the editors and an anonymous reviewer, who contributed immensely to improving the quality of this publication. This work was supported by the Higher Institution Centre of Excellence (HICoE) research grant (Vote no.56057) awarded to the Institute Oceanography and Environment, University Malaysia Terengganu by Ministry of Higher Education (Malaysia), UMT Translational Research Grant (No Vot 53282) and National Water Research Institute of Malaysia (NAHRIM) (No. Vot 53326).

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Effi Helmy Ariffin: Project administration, Methodology, Writing-Original Draft preparation. **Lee Shin Yun:** Software, Validation, Visualization. **Zaleha Mohamad:** Investigation, Resources, Writing-Review & Editing. **Mohd Nizam Lani:** Writing-Review & Editing. **Noorhaslinda Kulub Abd. Rashid:** Methodology & Editing.

© 2026 by MIP

ACKNOWLEDGEMENTS

Special appreciation goes to the fishermen's community in Setiu, Terengganu, for their kind collaboration throughout this research. We want to thank Dr. Thavamaran Kanesan for his English editing services.

REFERENCES

Abdul Halim, M. A. S., Muda, M. S., & Wan Mohd Amin, W. A. A. (2017). Coastal communities in Terengganu: The impact of social-entrepreneurship on sustainable livelihood. *Journal of Global Business and Social Entrepreneurship*, *1*(3), 99–110.

Abu Samah, A., Shaffril, H. A. M., Hamzah, A., & Abu Samah, B. (2019). Factors affecting small-scale fishermen's adaptation toward the impacts of climate change: Reflections from Malaysian fishers. *SAGE Open*, *9*(3). https://doi.org/10.1177/2158244019864204

Akhir, M. F. M. (2012). Surface circulation and temperature distribution of southern South China sea from global ocean model (OCCAM). *Sains Malaysiana*, *41*(6), 701–714.

Anfuso, G., Martínez Del Pozo, J. A., Nachite, D., Benavente, J., & Macias, A. (2007). Morphological characteristics and medium-term evolution of the beaches between Ceuta and Cabo Negro (Morocco). *Environmental Geology*, *52*(5), 933–946. https://doi.org/10.1007/s00254-006-0535-3

Ariffin, E.H., Sedrati, M., Akhir, M. F., Yaacob, R., & Husain, M. L. (2016). Open sandy beach morphology and morphodynamic as response to seasonal monsoon in Kuala Terengganu, Malaysia. *Journal of Coastal Research*, *75*(Special Issue), 1032–1036. https://doi.org/10.2112/SI75-207.1

Ariffin, E. H., Mathew, M. J., Yaacob, R., Akhir, M. F., Shaari, H., Zulfakar, M. S. Z., Sedrati, M., & Awang, N. A. (2018a). Beach morphodynamic classification in different monsoon seasons at Terengganu beaches, Malaysia. *Journal of Sustainability Science and Management*, *13*(Special Issue), 65–74.

Ariffin, E. H., Sedrati, M., Akhir, M. F., Daud, N. R., Yaacob, R., & Husain, M. L. (2018b). Beach morphodynamics and evolution of monsoon-dominated coasts in Kuala Terengganu, Malaysia: Perspectives for integrated management. *Ocean and Coastal Management*, *163*, 498–514. https://doi.org/10.1016/j.ocecoaman.2018.07.013

Ariffin, E. H., Sedrati, M., Akhir, M. F., Norzilah, M. N. M., Yaacob, R., & Husain, M. L. (2019). Short-term observations of beach Morphodynamics during seasonal monsoons: two examples from Kuala Terengganu coast (Malaysia). *Journal of Coastal Conservation*, *23*(6), 985–994. https://doi.org/10.1007/s11852-019-00703-0

Ariffin, E. H., Zulfakar, M. S. Z., Redzuan, N. S., Mathew, M. J., Akhir, M. F., Baharim, N. B., Awang, N. A., & Mokhtar, N. A. (2020). Evaluating the effects of beach nourishment on littoral morphodynamics at Kuala Nerus, Terengganu (Malaysia). *Journal of Sustainability Science and Management*, *15*(5), 29–42.

Britton, E., & Coulthard, S. (2013). Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Marine Policy*, *37*, 28-36. https://doi.org/10.1016/j.marpol.2012.04.011

Buckingham, A., & Saunders, P. (2004). *The survey methods workbook: From design to analysis*. Polity Press.

Chen, C. L. (2010). Diversifying fisheries into tourism in Taiwan: Experiences and prospects. *Ocean & Coastal Management*, *53*(8), 487–492. http://doi.org/10.1016/j.ocecoaman.2010.06.003

Cohen, L., Manion, L., & Morrison, K. (2002). *Research methods in education*, 3rd ed. Routledge, London.

Danish Hydraulic Institute (DHI). (2011). MIKE21 & MIKE 3 flow model FM: Scientific documentation for spectral wave module. p.66.

DID. (2015). *National Coastal Erosion Study (NCES2015) Report*; Department of Drainage and Irrigation: Kuala Lumpur, Malaysia, p. ES27.

Ghazali, N. H. M. (2006). Coastal erosion and reclamation in Malaysia. *Aquatic ecosystem health & management*, *9*(2), 237-247. https://doi.org/10.1080/14634980600721474

Griethuijsen, R. A., Eijck, M. W., Haste, H., Brok, P. J., Skinner, N. C., Mansour, N., Gencer, A. S., & BouJaoude, S. (2015). Global patterns in students' views of science and interest in science. *Research in science education*, *45*(4), 581-603. https://doi.org/10.1007/s11165-014-9438-6

Hardy, P. Y., Béné, C., Doyen, L., & Schwarz, A. M. (2013). Food security versus environment conservation: A case study of Solomon Islands' small-scale fisheries. *Environmental Development*, *8*(1), 38–56. https://doi.org/10.1016/j.envdev.2013.04.009

Hassan, M. I., & Rahmat, N. H. (2016). The effect of coastline changes to local community's socialeconomic. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *42*(4W1), 25–36. https://doi.org/10.5194/isprs-archives-XLII-4-W1-25-2016

Ismail, N. I., Ariffin, E. H., Yaacob, R., Lokman, M. H., & Baharim, N. B. (2020). The impact of seasonal monsoons on the morphology of beaches protected by barrier islands in Setiu, Terengganu, Malaysia. *Journal of Sustainability Science and Management*, *15*(4), 1–10.

Kerlinger, F. N. (1970). *Foundation of behavioural research*. New York: Holt, Rinehart and Winston.

Kok, P. H., Akhir, M. F., & Tangang, F. T. (2015). Thermal frontal zone along the east coast of Peninsular Malaysia. *Continental Shelf Research*, *110*, 1–15. https://doi.org/10.1016/j.csr.2015.09.010

Mathew, M. J., Sautter, B., Ariffin, E. H., Menier, D., Ramkumar, M., Siddiqui, N. A., Delanoe, H., Del Estal, N., Traore, K., & Gensac, E. (2020). Total vulnerability of the littoral zone to climate change-driven natural hazards in north Brittany, France. *Science of the Total Environment*, *706*. https://doi.org/10.1016/j.scitotenv.2019.135963

McGregor, J. A. (2004). Researching well-being: Communicating between the needs of policy makers and the needs of people, *Global Social Policy*, *4*(3), 337-358. https://doi.org/10.1177/1468018104047491

Mehmet, O. I., & Hasan, H. Y. (2017). Determination of tourism activities of the world's best tourism destinations using the multi-criteria decision-making method. *Cogent Social Sciences*, *3*(1), 1301763. https://doi.org/10.1080/23311886.2017.1301763

Muallil, R. N., Mamauag, S. S., Cababaro, J. T., Arceo, H. O., & Aliño, P. M. (2014). Catch trends in Philippine small-scale fisheries over the last five decades: The fishers perspectives. *Marine Policy*, *47*, 110–117.

© 2026 by MIP

https://doi.org/10.1016/j.marpol.2014.02.008

Muhammad, M., Idris, K., Ariffin, E. H., Shaffril, H. A. M., Samah, B. A., & Suandi, T. (2016). The impact of climate change on small-scale fishermen in Malaysia. *Social Sciences (Pakistan)*, *11*(13), 3352-3356. https://doi.org/10.3923/sscience.2016.3352.3356

Preston, V. (2009). Questionnaire Survey, York University, Toronto, ON, Canada, Elsevier.

Satyanarayana, B., Van der Stocken, T., Rans, G., Kodikara, K. A. S., Ronsmans, G., Jayatissa, L. P., Husain, M. L., & Dahdouh-Guebas, F. (2017). Island-wide coastal vulnerability assessment of Sri Lanka reveals that sand dunes, planted trees and natural vegetation may play a role as potential barriers against ocean surges. *Global Ecology and Conservation*, *12*, 144–157. https://doi.org/10.1016/j.gecco.2017.10.001

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. New York, John Wiley & Sons.

Selamat, N. S., Abdul Maulud, K. N., Mohd, F. A., AB Rahman, A. A., Zainal, M. K., Abdul Wahid, M. A., Hamzah, M. L., Ariffin, E. H., & Awang, N. A. (2019). Multi method analysis for identifying the shoreline erosion during northeast monsoon season. *Journal of Sustainability Science and Management*, *14*(3), 43–54.

Shaffril, H. A. M., Abu Samah, A., & D'Silva, J. L. (2017). Adapting towards climate change impacts: Strategies for small-scale fishermen in Malaysia. *Marine Policy*, *81*(2016), 196–201. https://doi.org/10.1016/j.marpol.2017.03.032

Shariful, F., Sedrati, M., Ariffin, E. H., Md Shubri, S., & Akhir, M. F. (2020). Impact of 2019 tropical storm (Pabuk) on beach morphology , Terengganu coast (Malaysia). *Journal of Coastal Research*, *95*(Special Issue), 346–350. https://doi.org/10.2112/SI95-067.1

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273-1296. https://doi.org/10.1007/s11165-016-9602-2

Thieler, E. R., Himmelstoss, E. A., Zichichi, J. L., & Ergul, A. (2009). *Digital Shoreline Analysis System (DSAS) version 4.3-An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-1278*.

Tshipala, N. N., & Coetzee, W. J. (2012). A sustainable adventure tourism development framework for Thathe Vondo. *Journal of tourism and hospitality*, *1*(4), 2167-0269. http://dx.doi.org/10.4172/2167-0269.1000101

Weaver, D. B. (2002). The evolving concept of ecotourism and its potential impacts. *International Journal of Sustainable Development*, *5*(3), 251-264. https://doi.org/10.1504/IJSD.2002.003753

Zulfakar Zufayri, S. M., Akhir, M. F., Ariffin, E. H., Awang, N. A., Azam, M., Mat Yaakob, M. A., Chong, W. S., & M. Muslim, A. (2020). The effect of coastal protections on the shoreline evolution at Kuala Nerus, Terengganu (Malaysia). *Journal of of Sustainability Science and Management*, *15*(3), 71–85.

Received: 30th December 2025. Accepted: 13th January 2026

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 633 – 647

GLOBAL TRANSPORTATION EXPENDITURE AND ECONOMIC PERFORMANCE: A COMPREHENSIVE ANALYSIS OF TRANSPORTATION EXPENDITURE'S IMPACT ON ECONOMIC DEVELOPMENT IN KEY GLOBAL ECONOMIES (1990-2023)

Diana Al-Nabulsi[1], Ali Alhawiti[2], Valerian Kwigizile[1], Jun- Seok Oh[1], Ahnaf Shahin Chowdhury[1]

[1]*Department of Civil and Construction Engineering,*
WESTERN MICHIGAN UNIVERSITY, KALAMAZOO, MI 49008, USA
[2]*Civil Engineering Department, Faculty of Engineering,*
UNIVERSITY OF TABUK, TABUK 71491, SAUDI ARABIA

Abstract

This study examines the relationship between transportation expenditure and economic performance across 41 countries over the period 1990–2023, highlighting the global role of transportation investment in economic development. Using descriptive statistics, correlation analysis, and hierarchical linear regression, the research investigates the association between gross domestic product (GDP) and multiple dimensions of transportation expenditure. The results indicate a strong positive relationship between GDP and total transportation expenditure, as well as passenger transportation expenditure, underscoring the close linkage between transportation investment and economic activity. In contrast, a significant negative relationship is observed between GDP and transportation expenditure as a share of GDP, suggesting that higher-income countries invest more in transportation in absolute terms while allocating a smaller proportion of national output to this sector, likely reflecting efficiency gains and economies of scale in mature transportation systems. Hierarchical regression results indicate that transportation expenditure is a statistically significant predictor of GDP, with the baseline model accounting for a substantial share of cross-country variation. The inclusion of relative expenditure measures yields modest additional explanatory power, with the second model providing the most stable specification by effectively mitigating multicollinearity. Overall, the findings emphasize the continued importance of sustained transportation investment, while highlighting differences in investment intensity across stages of economic development. For developing economies, strategic and efficient transportation investment remains critical for supporting long-term economic growth. The study contributes to the literature by offering a comprehensive, cross-national perspective on the scaling of transportation expenditure with economic performance and its implications for transportation policy and planning.

Keywords: Transportation Economics, GDP, transportation expenditure, econometric model, Hierarchical Linear Regression (HLR)

[1] Corresponding author. Email: diana.al-nabulsi@wmich.edu

INTRODUCTION

Transportation is a linchpin of the global economy, facilitating economic activity by connecting producers with raw materials, markets, and consumers, and constituting a major economic sector (Washington et al., 2020). The strong interdependence between transportation, production, and consumption makes transportation activity a valuable indicator of overall economic performance (Yousefi et al., 2023). As a result, the transportation sector plays a critical role in economic development, particularly within an increasingly globalized economy where growth prospects are closely tied to the efficient movement of people, freight, and information (Alstadt et al., 2012; Harmatuck, 1991). A well-established body of literature demonstrates a clear relationship between the quality and quantity of transport infrastructure and levels of economic development, with robust and well-connected transportation networks consistently associated with higher productivity and regional competitiveness (Ivanova, 2003; De Palma et al., 2011). Efficient transportation systems generate positive multiplier effects by improving market accessibility, supporting employment growth, and attracting additional investment, whereas inadequate or unreliable systems impose economic costs through congestion, lost productivity, and reduced quality of life (Kessides, 1993).

At the macroeconomic level, transportation's contribution to output, employment, and income is substantial. In developed economies, transportation activities typically account for approximately 6%–12% of gross domestic product (GDP), while logistics costs, including transportation, may account for 6%-25% of GDP. Moreover, the total value of transportation assets, encompassing infrastructure and vehicle fleets, can approach nearly half of GDP in advanced economies (World Bank; OECD). These figures highlight transportation's central role in sustaining national economic systems.

At the microeconomic level, transportation significantly influences production, consumption, and distribution costs across sectors. The economic impact of transportation infrastructure varies by industry, with higher-income economies generally exhibiting a greater share of transportation-related expenditures within household consumption (Gao et al., 2016). On average, households allocate approximately 10%–15% of total expenditures to transportation, while transportation costs account for roughly 4% of manufacturing output, although this share differs substantially across sub-sectors (Weisbrod & Reno, 2009). Together, these macro- and microeconomic perspectives underscore the pervasive influence of transportation systems on economic structure, efficiency, and development outcomes.

© 2026 by MIP

LITERATURE REVIEW

Commissioner of Building (COB)

Transportation economics is a multidisciplinary field concerned with the allocation and utilization of resources within transportation systems and their interaction with economic outcomes (Washington et al., 2020; De Palma et al., 2011). At its core, the discipline emphasizes the efficient allocation of limited resources to maximize societal welfare, with transportation infrastructure and services forming the supply side and the mobility needs of households, firms, and trade activities representing the demand side (Washington et al., 2020).

Transportation infrastructure investment has long been recognized as a fundamental driver of economic growth. Foundational studies have documented a positive relationship between transport infrastructure development and economic productivity, establishing transportation investment as a critical component of regional and national development strategies (Ivanova, 2003; De Palma et al., 2011). From a public policy perspective, understanding the marginal utility of additional transportation investment, identifying optimal geographic and modal allocation, and developing mechanisms to quantify the transportation sector's contribution to gross domestic product (GDP) are essential for informed decision-making (National Academies of Sciences, Engineering, and Medicine, 2002; Alstadt et al., 2012).

The importance of transportation to economic activity predates globalization, as transportation has historically served as a prerequisite for trade by enabling the movement of goods, people, and information. While the fundamental role of transportation has remained unchanged, its scale, capacity, speed, and efficiency have evolved in response to economic expansion and structural transformation, giving rise to new trade corridors and circulation patterns (Kessides, 1993; The Geography of Transport Systems).

Despite broad theoretical consensus on the role of transportation infrastructure in economic performance, empirical evidence remains mixed. Prior studies report heterogeneous results across regions and methodological frameworks, leading to continued debate regarding the magnitude and direction of transportation's economic impacts (Gao et al., 2016). To address this complexity, Limani (2016) adopted a mixed-methods approach combining qualitative insights with quantitative analysis to examine contextual and empirical dimensions of the transportation–economy relationship.

Advances in data availability have enabled recent studies to leverage large-scale transportation big data to better capture mobility patterns and regional economic activity. Li et al. (2020), using approximately 3.5 billion highway toll records in China, demonstrated that transportation network characteristics derived from complex network metrics and traffic flow indicators explain a substantial share of variation in city-level GDP. Their findings further revealed

© 2026 by MIP

temporal changes in distance-decay effects, reflecting evolving spatial interaction patterns associated with regional economic development.

A wide range of econometric approaches have been employed to analyze the linkages between transportation and economic growth. These include production and cost function models (Bröcker, 2004; Harmatuck, 1991), cross-sectional and panel data analyses (Berechman et al., 2006; Boopen, 2006), and dynamic time-series models such as Vector Autoregressive (VAR) and Vector Error Correction (VEC) frameworks, which capture both short-run adjustments and long-run equilibrium relationships (Kulshreshtha et al., 2001; Koo et al., 2013).

At more disaggregated levels, studies have shown that transportation capital enhances economic performance by improving technical efficiency and facilitating freight movement. Berechman et al. (2006) found that both the quality and quantity of highway infrastructure significantly contribute to economic growth across U.S. states and local jurisdictions. Similarly, Wang and Shi (2012) demonstrated that truck freight demand can be effectively modeled using traffic volumes and socioeconomic indicators, underscoring the close linkage between freight activity and regional economic structure. Additional freight-focused analyses further support the strong association between transportation demand and economic indicators (Yousefi et al., 2023).

From a broader policy perspective, public transportation investment has been shown to generate substantial economic benefits, including employment, income, and business productivity (Weisbrod & Reno, 2009). At the international scale, panel data studies confirm a long-run causal relationship between transport infrastructure development and economic growth, even after controlling institutional and socioeconomic factors (Cigu et al., 2018). Evidence from China similarly indicates that land and water transport infrastructure play a significant role in regional economic growth, while spatial disparities and threshold effects contribute to uneven development outcomes (Hong et al., 2011).

Despite the extensive body of literature examining the relationship between transportation systems and economic performance, several important gaps remain. First, much of the existing empirical work focuses on specific regions, individual countries, or single transportation modes, limiting the generalizability of findings across diverse economic contexts. Second, many studies rely on infrastructure stock measures or disaggregated demand indicators, whereas relatively few systematically evaluate transportation expenditure as a comprehensive, comparable measure of investment intensity across countries. Third, although recent studies have employed advanced econometric techniques and large-scale transportation data, challenges related to scale effects, multicollinearity, and the interaction between absolute investment levels and relative expenditure shares persist, particularly in cross-national settings.

Moreover, existing research often emphasizes either macroeconomic or microeconomic impacts in isolation, with limited integration of both perspectives within a unified analytical framework. To address these gaps, this study provides a global, longitudinal analysis of transportation expenditure and economic performance across 41 countries from 1990–2023. By employing a hierarchical econometric framework and explicitly examining both absolute transportation expenditures and expenditure relative to GDP, this paper offers new insights into how transportation investment scales with economic development.

ECONOMETRIC MODEL AND DATA SOURCE

The economic indicators used in this study were sourced from reliable, authoritative sources, specifically the World Bank and the Organization for Economic Cooperation and Development (OECD), both of which referenced data from 2023. The World Bank served as a key data repository, providing essential variables, including demographic data and gross domestic product (GDP). The OECD, a reputable economic organization, complemented this dataset by providing valuable information on performance indicators, including the share of road infrastructure investment in total inland transport infrastructure investment, road infrastructure investment per GDP, total inland transport infrastructure investment, and road infrastructure investment and maintenance spending.

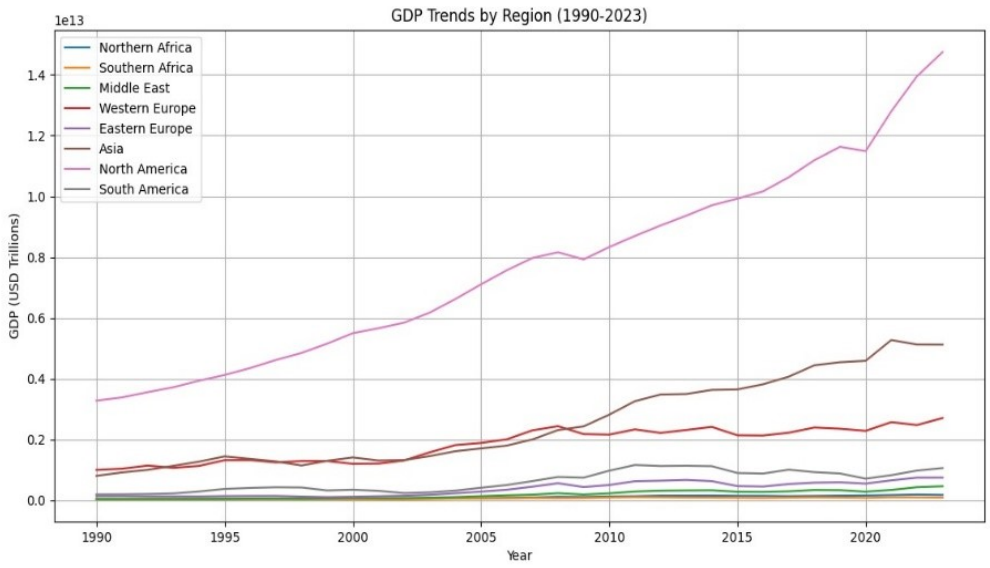


Figure 1: GDP trend by region 1990-2023

© 2026 by MIP

Figure 1 depicts the GDP trends of various regions from 1990 to 2023, with the y-axis representing GDP in USD trillions and the x-axis representing the years. The data shows that North America experienced the most significant GDP growth, particularly after the early 2000s, followed by Asia with a similar upward trend. Western and Eastern Europe displayed steady but moderate growth. In contrast, Northern Africa, Southern Africa, the Middle East, and South America had relatively lower GDP values with slight increases over time.

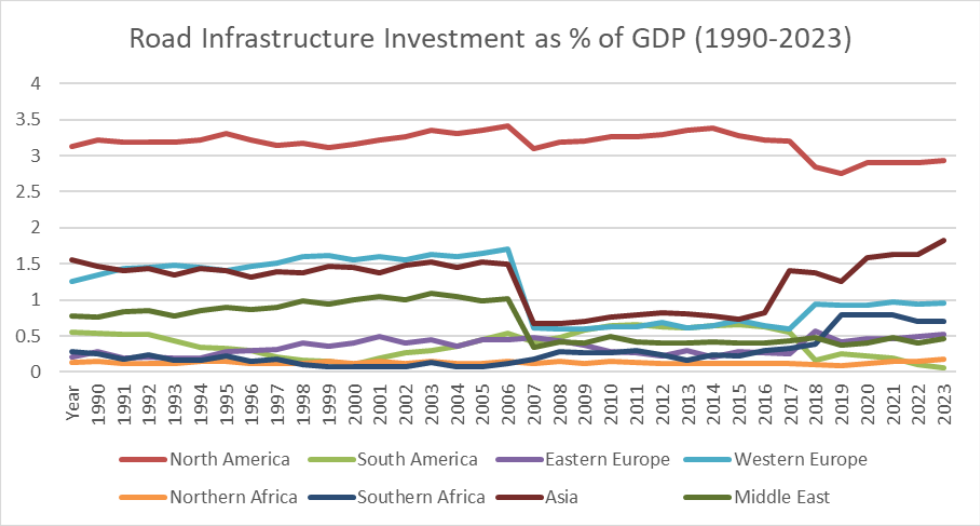


Figure 2: Road infrastructure investment as a percentage of GDP

Figure 2 illustrates regional investment trends in road infrastructure relative to GDP from 1990 to 2022. North America consistently leads in investment, allocating around 3% to 3.5% of its GDP to road infrastructure. Western Europe shows notable fluctuations, with significant peaks around 2007, 2010, and 2015. In contrast, Eastern Europe and South America maintain relatively steady investments, generally between 0.5% and 1.5% of GDP. Northern Africa and Southern Africa have lower investment levels, typically below 1%, while the Middle East and Asia show slight increases over time.

ECONOMIC IMPACT AND CORRELATION ANALYSIS OF TRANSPORTATION EXPENDITURE: A GLOBAL PERSPECTIVE (1990-2023)

The study aims to provide a comprehensive analysis of how investments in transportation infrastructure influence economic growth across key global economies. To investigate the economic ramifications of transportation

infrastructure expenditures, it is imperative to employ a statistical methodology that accounts for unobserved heterogeneity across countries. Historically, the predominant econometric framework utilized for assessing the economic impact of transportation infrastructure, whether within counties, states, or countries, has been Ordinary Least Squares (OLS) regression *(Berechman et al., 2006)*
While OLS regression is a general linear modeling technique, Hierarchical Linear Regression is an extension of linear regression that is specifically designed to handle data with a hierarchical or nested structure. In HLR, the data are organized into multiple levels or clusters, and the model allows for variation across these levels (Boopen, 2006).

A sequence of hierarchical linear regression models is systematically developed, with predictors introduced progressively to assess their individual and collective impact on the dependent variable, namely economic indicators. This hierarchical approach ensures a methodical examination of how each variable influences the overall model. Table 1 displays the descriptive statistics for the chosen variables across 41 countries from (1990-2023):

Table 1: Descriptive analysis

Descriptive Statistics		
	Mean	Std. Deviation
GDP (USD trillion)	56032.6818	39837.73153
Transportation Expenditure (USD billion)	4464.9091	3034.47132
Transportation Expenditure as a Percentage of GDP	.083045	.0060117
Passenger Transportation	2786.2273	1854.71037
Freight Transportation	1678.6818	1183.18539

The data encompass the entire global landscape and specifically focus on these four largest countries, revealing significant economic and transportation expenditure patterns. The mean Global GDP is 56032.6818, with a substantial standard deviation of 39837.73153, highlighting considerable variability across countries.

© 2026 by MIP

Table 2: Correlation Analysis of Key Economic and Transportation Indicators Across Selected Countries

Correlations						
		GDP (USD trillion)	Transportation Expenditure (USD billion)	Transportation Expenditure as a Percentage of GDP	Passenger Transportation	Freight Transportation
GDP (USD trillion)	Pearson Correlation	1	.999**	-.790**	.998**	.997**
	Sig. (2-tailed)		.000	.000	.000	.000
Transportation Expenditure (USD billion)	Pearson Correlation	.999**	1	-.769**	.999**	.998**
	Sig. (2-tailed)	.000		.000	.000	.000
Transportation Expenditure as a Percentage of GDP	Pearson Correlation	-.790**	-.769**	1	-.753**	-.790**
	Sig. (2-tailed)	.000	.000		.000	.000
Passenger Transportation	Pearson Correlation	.998**	.999**	-.753**	1	.995**
	Sig. (2-tailed)	.000	.000	.000		.000
Freight Transportation	Pearson Correlation	.997**	.998**	-.790**	.995**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).						

The intricate relationships within the transportation sector, along with key economic indicators, yield compelling insights. A notably robust positive correlation of 0.999 is observed between a nation's Gross Domestic Product (GDP) and its total transportation expenditure, indicating that wealthier countries make a greater commitment to transportation investments. Similarly, a substantial positive correlation of 0.998 is observed between GDP and passenger transportation expenditure, indicating a consistent trend in which affluent nations prioritize facilitating passenger movement. The relationship between passenger and freight transportation expenditures exhibits a strong positive correlation of

0.995, suggesting potential interdependence driven by shared infrastructure or logistical networks.

Conversely, intriguing negative correlations emerge, providing nuanced perspectives on economic dynamics. A strong negative correlation of -0.790 is identified between GDP and the percentage of GDP allocated to transportation. This paradoxical finding implies that more prosperous nations, while investing more in absolute terms, allocate a smaller share of their GDP to transportation, potentially due to economies of scale or increased efficiency in transportation systems. Additionally, a moderate negative correlation of -0.753 is evident between the percentage of GDP devoted to transportation and the portion allocated specifically to freight. This implies that countries with larger transportation budgets, relative to their GDP, tend to prioritize passenger movement over freight.

Table 3: Hierarchical Linear Regression Analysis for the Impact of Transportation Expenditure on Economic Indicators

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.999a	.998	.997	2033.48161	.998	8039.869	1	20	.000
2	.999b	.999	.999	1480.02192	.001	18.755	1	19	.000
3	1.000c	.999	.999	1322.05334	.000	5.812	1	18	.027
a. Predictors: (Constant), Transportation Expenditure (USD billion)									
b. Predictors: (Constant), Transportation Expenditure (USD billion), Transportation Expenditure as a Percentage of GDP									
c. Predictors: (Constant), Transportation Expenditure (USD billion), Transportation Expenditure as a Percentage of GDP, Freight Transportation									

Table 3 presents the hierarchical linear regression results, showing that transportation expenditure is a powerful predictor of economic indicators, with the first model explaining 99.8% of the variance in the dependent variable. Adding transportation expenditure as a percentage of GDP in the second model increases the explanatory power slightly to 99.9%, though the improvement is minimal. The final model, which includes freight transportation, maintains a perfect R value of 1.000 and an R squared of 0.999, indicating that while freight transportation contributes additional explanatory value, the overall impact is modest.

© 2026 by MIP

Table 4: ANOVA Summary for Hierarchical Linear Regression Models Predicting GDP (USD billion)

ANOVA(a)						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33245240969.523	1	33245240969.523	8039.869	.000b
	Residual	82700949.249	20	4135047.462		
	Total	33327941918.773	21			
2	Regression	33286323086.022	2	16643161543.011	7598.004	.000c
	Residual	41618832.751	19	2190464.882		
	Total	33327941918.773	21			
3	Regression	33296481068.071	3	11098827022.690	6350.079	.000d
	Residual	31460850.702	18	1747825.039		
	Total	33327941918.773	21			
a. Dependent Variable: GDP (USD trillion)						
b. Predictors: (Constant), Transportation Expenditure (USD billion)						
c. Predictors: (Constant), Transportation Expenditure (USD billion), Transportation Expenditure as a Percentage of GDP						
d. Predictors: (Constant), Transportation Expenditure (USD billion), Transportation Expenditure as a Percentage of GDP, Freight Transportation						

Across all models, the F-statistics for the regression effects exhibit highly significant p-values ($p < 0.000$), underscoring the statistical importance of the selected predictors in influencing the dependent variable, GDP. This robust statistical significance substantiates that the observed associations between transportation variables and GDP are highly unlikely to occur by chance.

Comparing the various models reveals nuanced insights into the interplay between predictors and model performance. Incremental additions of predictors yield marginal increases in the F-statistic and associated significance levels, suggesting that the core relationship between transportation expenditure and GDP is effectively captured by the initial model. Notably, Model 2, incorporating Transportation Expenditure and Expenditure as a Percentage of GDP, strikes a commendable balance between explanatory power and model simplicity, yielding a substantial F-statistic without introducing excessive predictors.

Table 5: Coefficients and Significance Levels

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1521.29	121.43		-3.441	.001		
	Transportation Expenditure (USD billion)	0.1	.1248	.999	310.542	.000	1.000	1.000
2	(Constant)	1496.92	340.267		-6.301	.000		

	Transportation Expenditure (USD billion)	0.14356	.064	1.018	202.570	.000	.492	2.032
	Transportation Expenditure as a Percentage of GDP	1094.59	40.591	.026	5.130	.000	.492	2.032
3	(Constant)	1468.78	339.160		-6.083	.000		
	Transportation Expenditure (USD billion)	0.11	.995	1.162	14.994	.000	.002	495.055
	Transportation Expenditure as a Percentage of GDP	1177.03	40.172	.026	5.268	.000	.491	2.036
	Passenger Transportation	0.02	2.431	-243	-1.870	.064	.002	491.976
a. Dependent Variable: GDP (USD trillion)								

Among the hierarchical regression models analyzed, Model 2 emerges as the most robust and insightful. This model incorporates both Transportation Expenditure (USD billion) and Transportation Expenditure as a Percentage of GDP, delivering a balanced approach that enhances explanatory power while managing complexity. The coefficient for Transportation Expenditure (USD billion) is notably significant with a t-value of 202.570 and a coefficient of 0.14356, indicating a strong positive relationship with GDP. Additionally, the inclusion of Transportation Expenditure as a Percentage of GDP further refines the model, with a coefficient of 1094.59 and a t-value of 5.130, demonstrating its significant contribution to explaining variations in GDP. Despite moderate collinearity (Tolerance = 0.492, VIF = 2.032), Model 2 effectively balances predictive accuracy and model simplicity, avoiding the severe multicollinearity issues observed in Model 3.

Table 6: Excluded variables.

Excluded Variables[a]								
						Collinearity Statistics		
Model		Beta In	t	Sig.	Partial Correlation	Tolerance	VIF	Minimum Tolerance
1	Transportation Expenditure as a Percentage of GDP	-.055[b]	-4.331	.000	-.705	.409	2.443	.409
	Passenger Transportation	-.196[b]	-.658	.519	-.149	.001	695.780	.001
	Freight Transportation	.125[b]	.658	.519	.149	.004	283.156	.004

© 2026 by MIP

2	Passenger Transportation	.579[c]	2.411	.027	.494	.001	1101.544	.001
	Freight Transportation	-.370[c]	-2.411	.027	-.494	.002	448.286	.002
3	Passenger Transportation	.[d]	.	.	.	.000	.	.000
a. Dependent Variable: GDP (USD trillion)								
b. Predictors in the Model: (Constant), Transportation Expenditure (USD billion)								
c. Predictors in the Model: (Constant), Transportation Expenditure (USD billion), Transportation Expenditure as a Percentage of GDP								
d. Predictors in the Model: (Constant), Transportation Expenditure (USD billion), Transportation Expenditure as a Percentage of GDP, Freight Transportation								

Table 6 illustrates the exclusion of certain variables from the hierarchical regression models due to their impact and collinearity. In Model 1, Transportation Expenditure as a Percentage of GDP is excluded due to its significant negative partial correlation (-0.705) and moderate collinearity (VIF = 2.443). Passenger Transportation and Freight Transportation are also excluded due to severe collinearity, with extremely high VIF values (695.780 and 283.156, respectively), rendering their individual contributions ambiguous. In Model 2, both Passenger Transportation and Freight Transportation are excluded despite their significant effects, due to their severe multicollinearity (VIFs of 1101.544 and 448.286). By Model 3, Passenger Transportation is omitted, likely due to its redundancy or problematic collinearity. The econometric model, based on the results provided above, can be expressed as follows:

$$GDP = 1496.92 + 0.10 * Transportation\ Expenditure + 1094.59 * Transportation\ Expenditure\ as\ a\ Percentage\ of\ GDP$$

Table 7: Collinearity Diagnostics

Collinearity Diagnostics							
				Variance Proportions			
Model	Dimension	Eigenvalue	Condition Index	(Constant)	Transportation Expenditure (USD billion)	Transportation Expenditure as a Percentage of GDP	Freight Transportation
1	1	1.833	1.000	.08	.08		
	2	.167	3.314	.92	.92		
2	1	2.757	1.000	.00	.01	.00	
	2	.242	3.377	.00	.36	.00	
	3	.001	54.293	1.00	.63	1.00	
3	1	3.622	1.000	.00	.00	.00	.00
	2	.376	3.103	.00	.00	.00	.00
	3	.001	56.028	.38	.11	.35	.08
	4	.000	112.834	.61	.89	.65	.92
a. Dependent Variable: GDP (USD trillion)							

Table 7 highlights the collinearity diagnostics for the models, revealing that Model 2 manages collinearity most effectively. In this model, the first dimension shows an eigenvalue of 2.757 and a condition index of 1.000, with minimal variance proportions across predictors, indicating that collinearity is relatively well-controlled. The second dimension's condition index of 3.377 suggests some collinearity, but it is not severe, with Transportation Expenditure (USD billion) accounting for only a modest proportion of the variance. The third and fourth dimensions exhibit higher condition indices, reflecting potential multicollinearity concerns, particularly in the context of Transportation

From a theoretical perspective, transportation expenditure can be interpreted as an investment in productive public capital that enhances economic output by expanding network capacity, improving accessibility, and reducing generalized transportation costs. The strong associations observed in the hierarchical regression results are therefore consistent with infrastructure-as-capital arguments, which hold that improved connectivity facilitates labor mobility, market access, and freight efficiency, thereby leading to higher aggregate productivity.

CONCLUSION AND RECOMMENDATIONS

This study provides strong empirical evidence of a close association between transportation infrastructure investment and economic performance, as demonstrated through hierarchical linear regression analysis. The results reveal a consistently strong positive relationship between gross domestic product (GDP) and both total transportation expenditure and passenger transportation expenditure, highlighting the central role of transportation systems in supporting economic activity. Higher-income countries exhibit substantially greater absolute investment in transportation infrastructure, reflecting the strategic importance assigned to transportation in sustaining economic productivity. At the same time, the observed negative relationship between GDP and transportation expenditure as a share of GDP indicates that more affluent economies tend to allocate a smaller proportion of national output to transportation, a pattern that is consistent with efficiency gains and economies of scale in more mature transportation systems.

The regression results further indicate that transportation expenditure is a statistically significant predictor of economic performance, with the baseline model accounting for a very large share of the variation in GDP across countries. The inclusion of additional explanatory variables, such as transportation expenditure relative to GDP and freight transportation, yields only marginal improvements in model performance. Among the alternative specifications, the second model offers the most stable and interpretable results, effectively addressing multicollinearity concerns while preserving explanatory power. These

© 2026 by MIP

findings suggest that the core relationship between transportation investment and economic output is robust across model specifications.

From a policy perspective, the results underscore the continued importance of transportation infrastructure investment as a key component of economic development strategies. While wealthier economies may benefit from efficiency gains that reduce the relative investment burden, sustained attention to transportation funding remains essential to maintaining system performance and supporting long-term growth. For developing and emerging economies strategic and well-targeted transportation investments are critical to enhancing connectivity, improving productivity, and fostering durable economic development. Overall, this study highlights the need for a balanced investment approach that combines adequate financial commitment with efficient allocation to maximize the economic returns of transportation infrastructure.

REFERENCES

Washington, S., Karlaftis, M. G., Mannering, F., & Anastasopoulos, P. (2020). Statistical and econometric methods for transportation data analysis. *CRC press*.

Yousefi, J., Ashtab, S., Yasaei, A., George, A., Mukarram, A., & Sandhu, S. S. (2023). Multiple Linear Regression Analysis of Canada's Freight Transportation Framework. *Logistics, 7(2), 29.*

Limani, Y. (2016). Applied relationship between transport and economy. *IFAC-PapersOnLine, 49(29), 123-128.*

De Palma, A., Lindsey, R., Quinet, E., & Vickerman, R. (Eds.). (2011). A handbook of transport economics. *Edward Elgar Publishing.*

Ivanova, O. (2003). The role of transport infrastructure in regional economic development. *The Institute of Transport Economics (TØI).* TØI Report, 671, 2003.

Bröcker, J. (2004). Computable general equilibrium analysis in transportation economics. *In Handbook of transport geography and spatial systems (Vol. 5, pp. 269-289). Emerald Group Publishing Limited.*

Harmatuck, D. J. (1991). Economies of scale and scope in the motor carrier industry: an analysis of the cost functions for seventeen large LTL common motor carriers. *Journal of Transport Economics and Policy, 135-151.*

Kulshreshtha, M., Nag, B., & Kulshrestha, M. (2001). A multivariate cointegrating vector auto regressive model of freight transport demand: evidence from Indian railways. *Transportation Research Part A: Policy and Practice, 35(1), 29-45*.

Koo, T. T., Tan, D. T., & Duval, D. T. (2013). Direct air transport and demand interaction: A vector error-correction model approach. *Journal of Air Transport Management, 28, 14-19.*

Alstadt, B., Weisbrod, G., & Cutler, D. (2012). Relationship of transportation access and connectivity to local economic outcomes: Statistical analysis. *Transportation Research Record, 2297(1), 154-162.*

Wang, H. L., & Shi, Z. K. (2012). Hierarchical regression model for analyzing truck freight demand. *Applied Mechanics and Materials, 178, 2752-2756.*

Maniquiz, M. C., Lee, S., Lee, E., & Kim, L. H. (2009). Development of statistical linear regression model for metals from transportation land uses. *Water Science and Technology, 59(12), 2495-2501.*

National Academies of Sciences, Engineering, and Medicine. 2002. Key Transportation Indicators: Summary of a Workshop. Washington, DC: *The National Academies Press*.

Gao, Y., Zhang, Y., Li, H., Peng, T., & Hao, S. (2016). Study on the relationship between comprehensive transportation freight index and GDP in China. *Procedia engineering, 137, 571-580.*

Weisbrod, G., & Reno, A. (2009). Economic impact of public transportation investment. Washington, DC: *American public transportation association*.

Cigu, E., Agheorghiesei, D. T., Gavriluță, A. F., & Toader, E. (2018). Transport infrastructure development, public performance and long-run economic growth: a case study for the Eu-28 countries. *Sustainability, 11(1), 67*.

Berechman, J.; Ozmen, D.; Ozbay, K. Empirical analysis of transportation investment and economic development at state, county and municipality levels. *Transportation 2006, 33, 537–551.*

Hong, J.J.; Chu, Z.F.; Wang, Q. Transport infrastructure and regional economic growth: Evidence from China. *Transportation 2011, 38, 737–752.*

Boopen, S. (2006). Transport infrastructure and economic growth: Evidence from Africa using dynamic panel estimates. *The empirical economics letters, 5(1), 37-52.*

Kessides, C. (1993). The contributions of infrastructure to economic development: a review of experience and policy implications. *World Bank Discussion Paper 213, The World Bank, Washington, DC (1993).*

Li, B., Gao, S., Liang, Y., Kang, Y., Prestby, T., Gao, Y., & Xiao, R. (2020). Estimation of regional economic development indicator from transportation network analytics. *Scientific reports, 10(1), 2647*.

Kim, S., & Lee, Y. H. (2002). Public sector capital and the production efficiency of US regional manufacturing industries. *The Japanese Economic Review, 53(4), 466-477.*

Received: 1st January 2025. Accepted: 8th August 2025

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 648 – 667

ENCAPSULATES THE MALAY SETTLEMENTS

Azli Abdullah[1]

[1] *Department of Architecture, Faculty of Architecture and Ekistics,*
UNIVERSITI MALAYSIA KELANTAN

Abstract

This study delves into the resilience of Malay settlements—specifically Kampung Sayong, Kampung Morten, Kampung Balik Pulau, and Kampung Duyong—as they face the challenges of rapid urbanization and environmental changes. By comparing these communities, this research summarises the different ways they adapt to modernity and protect their cultural heritage and distinctiveness. The findings reveal a strong commitment among residents to preserve their heritage, engage in community conservation efforts, and diversify their economic activities, which aligns with SDG 11: Sustainable Cities and Communities and SDG 15: Life on Land. Nonetheless, the Malay community also faces serious problems in the urban landscape that affect development, particularly in understanding the impact of the growing landscape and land grabbing, which hampers their way of life and cultural practices. Active participation in governance and decision-making processes emerges as a crucial factor in fostering resilience, as it allows residents to feel a sense of ownership and adaptability in the face of change, echoing the principles of SDG 16: Peace, Justice, and Strong Institutions. Looking to the future, the study highlights the importance of preserving Malay identity and encouraging intergenerational knowledge transfer, ensuring that these communities can thrive sustainably and contribute to SDG 4: Quality Education. The knowledge from this research extends understanding of culture and cultural resilience and points to the need for partnership in cultural development, suggesting a positive prospect for Malay people on their journey in a constantly evolving context.

Keywords: Malay settlements, community resilience, urbanization, SDGs, community conservation

[1] Corresponding author. Email: azli.ab@umk.edu.my

INTRODUCTION

Culturally enriched and historically grounded Malay settlements provide the people living in them with utmost comfort and pride. Throughout the centuries, these communities have been vibrant and important institutions for transmitting traditions, telling stories, and fostering social relations. The Malay Architecture of the traditional buildings includes the designs and symbols that portray the Malay community's beliefs and practices (Zainudin & Hamzah, 2021). But for the past few years, these cherished abodes have been in danger and are being threatened in ways that even their conventional foundations cannot subdue. Currently, the process of urbanization due to economic development and globalization affects the structure of Malay settlements (Sendut, 1962 & 1965). Opportunities always accompany these transformations, but they also obscure the traditional lifestyle that is dear to many district residents (Shari, 1992). Encouragingly, notable buildings such as historic houses and community halls are now being replaced by a new generation of modern buildings, creating a sense of loss in the community (Ismail *et al.,* 2023). Residents always feel a particular kind of feeling in their hearts as they see places that define their memories fade away gradually. As much as it is hard to dispute, the effect of globalization cannot be ignored. The dynamics of these communities change as new influences and lifestyles filter through the modern world and infiltrate them. Meanwhile, some people embraced these changes, while many feel displaced from their ancestry. Millennials, in particular, fail to understand the cultural way of life practised in the households of their ancestors (Rahman & Abdullah, 2022). These generational differences raise questions about whether this form of heritage is being passed down and whether such forms of remembering are sustainable in the future. These challenges. However, it evokes the concept of community conservation as the hope of the future. People are mobilizing to protect not only their cultural identity but also the material settings within which they live their lives. Conservation initiatives aim to maintain traditional building styles and to encourage cultural engagement and the social relations that have sustained the society (Samsudin, 2024). Whenever people participate in such programs, they rediscover the essence of belonging to a specific region and feel proud to defend its culture and traditions (Schumacher, 1976). Overall, the future of Malay settlements depends on the ability to modernize without undermining the culture of the Malay people. People look forward to a day when they embrace a new age of contemporary growth, which will not overshadow the traditions of their ancestors. The incorporation of historical elements into architecture and design in the context of the modern city can help respect people's history while embracing current challenges, thereby enabling the narratives of people to live on (Yusof, 2023).

© 2026 by MIP

THE MALAY SETTLEMENTS

Historical Contexts

Malay settlements can be traced back to trade and resource exploitation that thrived in riverine and coastal zones in Malaysia. As stated by Zainudin and Hamzah (2021), initial Malay communities were established to capture the most suitable territories for cultivation, fishing, and commerce. Like Dharavi in India and favelas in Brazil, informal settlements are attributed to migration and job opportunities in urban areas (Bhan, 2009). Similarly, settlements like Lyari town in Karachi, Pakistan, also show trends where growth is driven by economic factors. In Indonesia, slum communities are due to rural-urban migration and socio-economic factors (Dhar, 2019).

Geography and Sustainability

The geographical environment is particularly significant for Malay settlements, which are usually located in areas well suited for agriculture and fishing. The same pattern is observed in Indonesia: settlements also follow it along the coast and near rivers, using natural resources for their livelihoods (Gehl, 2010; Pratiwi *et al.,* 2020). However, most slums in India and Pakistan are located in urban areas and are usually swampy or otherwise unsuitable for human habitation (Davis, 2006). Informal settlements in various parts of the world share similar geographical features, including the adverse impacts of climate change, such as rising sea levels and floods, which pose a real threat to residents' livelihoods (Sharma *et al.,* 2022).

Architecture and Malay Community

Malay settlements reveal cultural and environmental orientations that shape the principles of functionality and aesthetics in architectural design (Gul & Tchounwou, 2022). Rumah Melayu of the past exemplifies vernacular architectural practice and the community's physical conditions, in which built forms reflect cultural practices. Ismail *et al.* (2023) note that incorporating local materials and designs is one of the sustainable practices that align with the concept of place-responsive architecture. According to Abdullah (2022), a community's identity is expressed through architectural elements, underscoring the need to preserve heritage in urban design. Cultural practices among Malay settlements enhance unity and togetherness, as do those in other informal settlements found in most societies globally. In India, people living in slums are very particular about festivals and traditions to uphold relationships and family values; in Brazil, favelas also have deep connections to the culture, with music and dancing being significant in depicting hardship and reducing suffering (Valladares, 2019). Cultural festivals common in Pakistan's informal settlements provide essential means of identification and unity among the inhabitants (Khan,

© 2026 by MIP

2018). In both cultures, such practices contribute to the strengthening of community cohesion and identity in the face of socio-economic adversity.

Technological Integration

Traditional and new technologies must be incorporated into Malay settlements as residents adapt to new technologies to improve their lives. This approach is prevalent in informal settlements worldwide, where communities use both indigenous practices and innovations to address their problems, as observed by Singh and Rahman (2021). People living in slum areas of India have advocated for the use of mobile technology to access information and resources (Dahlia, 2020 onward), and favela residents of Brazil have demonstrated creativity in developing waste management and sanitation solutions (Lima *et al.,* 2023). Local communities in Indonesia also apply technical knowledge to sustainable resource management, as seen among the Malay settlements (Agustina, 2022).

Social and Political Dynamics

The social and political factors play a significant role in determining the spatial development and stability of Malay settlements, and the dynamics of community participation are critical in addressing the question of the marginalization of Malay settlements (Mohamed, 2022). A similar dynamic holds for the inhabitants of informal settlements in India, Pakistan, and Brazil, who organize to demand better services and political inclusion (Patel & Arora, 2020). In Indonesia, community-based organizations enable residents to fight for their rights – the same way the Malay settlements improved their political status (Pratiwi *et al.,* 2020). Thus, the need to manage the development of informal settlements and to include their populations in the process is global (Hassan & Othman, 2024).

The Pace of Urbanization

Urbanization poses tremendous pressure on Malay settlements, whereby their areas of occupation become swamped by expanding urban areas, and various communities are pushed out of their territories (Sharma *et al.,* 2022; Evers, 2016). This brings conflict as urbanization leads to competition for space, whereby space, culture, and history are favoured (Ranjan & Singh, 2023). The same trends are seen in India. For example, Mumbai, which swallows up migrants, leading to slum expansion in Dharavi, has inadequate infrastructure and amenities (Davis, 2006). São Paulo in Brazil, for example, has expanded with numerous favelas of informal structures that lack legal tenure and often lack basic services (Valladares, 2019). The problems of urbanization in Pakistan can be seen in Karachi, where informal settlements are threatened with eviction due to urban development initiatives (Khan, 2018). Jakarta's informal settlements in Indonesia are no different, with people constantly being evicted for development purposes. In all countries of the world, urbanization exacerbates problems associated with

© 2026 by MIP

housing, infrastructure, and social facilities and, therefore, calls for sustainable urban development that considers the needs of communities (Meyer *et al.,* 2023).

Flood Issues

Flooding is a significant concern for Malay settlements, especially those near riverbanks and coastal areas. Climate change has intensified flooding and its effects, leading to increased flood risks and impacts on agricultural practices, infrastructure, and community living standards (Sharma *et al.,* 2022). Apart from the initial effects, flooding also causes medium- and long-term impacts, such as soil erosion and the loss of arable land (Hassan & Othman, 2024). For that same reason, numerous communities living in informal settlements worldwide are at high risk of flooding, especially in areas that experience heavy rainfall. For instance, in India, slums such as Dharavi are typically found in areas highly vulnerable to flooding, especially during the monsoon season (Dahlia, 2020). Developing nations, especially Bangladesh's informal settlements, are highly vulnerable to floods, making the already marginalised populace even more vulnerable (Ahmed & Feroze, 2021). Favelas in Brazil are also threatened by landslides during heavy rainfall, highlighting the complex relationship between human settlements and disasters (Lima *et al.,* 2023). Such flood problems should serve as a wake-up call for governments worldwide to embrace efficient disaster management measures and adaptation processes that increase the resilience of Malay and informal settlements.

Economic Impact

Malay settlements face many contemporary issues that undermine the community's culture and its continued existence: the loss of territory due to urbanization, environmental changes driven by climate change, assimilation into modern cultural norms, and economic pressures from globalization (Mohamed, 2022). Due to extensive urbanization, traditional lands have been invaded, leading to forced displacement and loss of cultural sites; climate change remains a significant threat, especially to those living along riverine areas and coasts, as the rain becomes unpredictable and floods engulf riverside and coastal farms and homesteads (Sharma *et al.,* 2022). Malay settlements continue to have economic relevance in development, but their traditional sources of income are gradually eroding due to modernization and urbanization. This is evident in informal settlements worldwide, where people depend on informal livelihoods (Ranjan & Singh, 2023). For the people living in the slums of India, informal sector jobs are the only source of living, while the favelas of Brazil also rely heavily on informal employment (Valladares, 2019). In Indonesia, most of the urban poor depend on local markets or small-scale enterprises for their livelihoods, a characteristic observed in many informal urban settlements around the world.

© 2026 by MIP

Malay Community Conservation

Community conservation is important for sustaining Malay settlements and encouraging the people to be more responsible in protecting the cultural and natural tangible assets. Comparable trends occur in other informal settlements globally where residents work to preserve natural resources and cultural heritage (Hassan & Othman, 2024). Community-centered projects in Brazil focus on the sustainable management of the natural environment as well as the welfare of favelas. At the same time, the informal structures in India and Pakistan demonstrate how residents increase the sustainability of their communities (Dahlia, 2020). These above examples show that there is conservation in various ways. The future of Malay settlements is in sync with the United Nations Sustainable Development Goals (SDGs), which focus on eradicating poverty, providing clean water, making and improving cities, and taking climate action. These goals are relevant to the issues of informal settlements globally, such as social and environmental justice and economic development that aims at improving the living standards of the inhabitants of such regions (Ranjan & Singh, 2023). Thus, the incorporation of SDG principles into local development plans can help communities all over the world to build a sustainable future. The juxtaposition of Malay settlements with the informal settlements in India, Pakistan, Indonesia, Brazil, and globally creates a sense of a conducive environment and comparable challenges in the search for sustainable development. The study also underscores the need to develop holistic approaches to managing communities' interactions with the urban environment, the effects of environmental changes such as flooding, and social and economic forces while not undermining the local communities' cultures, as well as incorporating issues of sustainability and inequality. Due to their efforts to engage the community and build capacity, stakeholders can increase the adaptation capacity of Malay settlements and comparable populations globally in response to contemporary difficulties.

RESEARCH METHODOLOGY

Meanwhile, the journey of exploring Malay settlements begins with a reconnaissance survey, which lays the groundwork for research parameters. This phase is not just about documenting but about engaging in the dense social practices of these communities. It is an opportunity to comprehend the geographical territory and the pulse of the established culture (Zainudin & Hamzah, 2021). Passing through the tight and winding streets of the settlement, expose ourselves to the multiple features of sound, vision, and smell as performed by people throughout the day. The sight and sound of children at play, the smell of food from the local kitchens, and the appearance of the local houses all tell a story of a people with a history and some tradition. The first step is to define the research boundaries, or, in other words, to identify the topics of concern within

© 2026 by MIP

the settlements. As potential sites, the researcher seeks out curtilages, which are areas where people congregate; vernacular houses that represent the architectural form; and markets that embody the economic activity in the community (Rahman & Abdullah, 2022). The architectural features, which are usually complex and made of local materials, are not only utilitarian but also reflect the Malays' culture (Ismail *et al.,* 2023). Meanwhile, various forms of urban design, such as pathways, public squares, and green spaces, are essential for shaping how members of society interact and connect (Samsudin, 2024). In this way, observations will occur at these points on the map, providing a visual of the locations where observations will be made.

In this research, the visual analysis methods defined by Robert Venturi (1977) in his theory of architecture are based on the concepts of complexity and contradiction in architecture. Venturi (1977) developed a new paradigm for a deeper appreciation of the aesthetic value in ordinary buildings and structures. By applying Venturi's approach, the researcher interprets the photographs and other visual evidence gathered during the survey. With this lens, one can look beyond the surface of architecture and communal spaces to reveal their hidden layers. Key elements include:

1. Layered Meanings: Just as Venturi emphasized the importance of signs and symbols in architecture, the question is to explore how the designs of traditional Malay homes convey cultural narratives and community values.
2. Complexity in Simplicity: Seek attention to the seemingly simple structures that reveal complex stories, such as using local materials that reflect both environmental adaptation and cultural identity.
3. Contradictions: Venturi's embrace of contradictions invites us to examine how traditional and modern elements coexist within settlements, highlighting the dynamic nature of cultural identity.

The theory of Ekistics by Constantinos Doxiadis (1968 & 1974) is used in conjunction with observational and visual analysis techniques. Ekistics is the study of the settlement process, focusing on people and their interactions with their physical surroundings and constructed objects. Doxiadis underscored the importance of planning in both the natural environment and the cultural attributes of communities, thereby insisting on a sustainable, human-oriented approach to urbanization (Doxiadis, 1968). In this case, applying the above-mentioned theory makes it easier to explain the relationship between the physical environment of Malay settlements and the cultural and social aspects of their people. This framework encourages us to consider the following:

1. The Relationship Between Space and Culture: How the layout and design of settlements facilitate social interactions and cultural expressions.

2. Adaptation to Environment: How communities have adapted their architectural styles and urban planning to respond to environmental conditions, such as proximity to rivers and local resources.
3. Sustainability and Resilience: How traditional practices contribute to sustainable living and resilience against the pressures of urbanization and globalization.

However, when the researcher applies Ekistics to the analysis, the study has a complete picture of the Malay settlements. This approach enables one not only to document structures but also narratives, history, and people within these special places. As part of this preliminary analysis, the researcher also considers the external environment. Biogeography, including vegetation, water, and physical features such as hills and rivers in the vicinity of settlements, also shapes people's lifestyles (Yusof, 2023). Knowledge of these formations will later help us examine how they affect society and culture (Yusof, 2023). From the reconnaissance survey, apart from setting the boundaries for this study, they were better positioned to conduct a more extensive study of the Malay settlements. This phase explains how the studies are ready to embrace the communities and collect authentic flavours in the next part of the research study.

CASE STUDIES ON MALAY SETTLEMENTS

Several prominent Malay settlements along the river peripheries testify to the relationship between the community and the environment in Malaysia. Such settlements depend heavily on riverine products and simultaneously face specific problems related to environmental change and urbanisation. Kampung Morten, Malacca: Located along the Melaka River, Kampung Morten is a living museum of traditional Malay culture. (Figure 1). This settlement is known for its well-preserved wooden houses, vibrant street art, and rich cultural heritage. The community actively engages in cultural tourism, showcasing their traditional practices, crafts, and local cuisine to visitors, thereby maintaining their identity while adapting to modern economic opportunities (Lee & Wong, 2021). Kampung Sayong, Kuala Kangsar, Perak: Situated along the banks of the Perak River, Kampung Sayong is renowned for its rich history and traditional craftsmanship, particularly in pottery (Figure 2). The village showcases traditional Malay architecture, with homes built from local materials that reflect the community's identity and cultural practices. Residents engage in farming and craft-making, maintaining their heritage while adapting to contemporary needs (Yusof, 2023). Kampung Duyong, Terengganu: This settlement, located by the Terengganu River, is celebrated for its picturesque landscapes and vibrant fishing culture (Figure 3). Kampung Duyong is characterised by its wooden stilt houses and traditional fishing boats, which highlight the community's connection to the water. The settlement also serves as a centre for traditional crafts, where artisans

© 2026 by MIP

continue to produce handmade goods that reflect their cultural heritage (Tan & Ling, 2022). Kampung Balik Pulau, Penang: Situated near the riverbanks, this settlement exemplifies the adaptation of Malay culture to the landscape (Figure 4). The community relies on the river for transportation and resources while maintaining its traditional crafts and agriculture. The architecture here reflects the local climate and environmental features, showcasing how the community has adapted to its riverine setting (Ahmad & Iskandar, 2020).



Figure 1: Kampung Morten Melaka
Source: Fieldwork (2023)



Figure 3: Kampung Duyong, Kuala Terengganu
Source: Fieldwork (2023)



Figure 2: Kampung Sayong, Kuala Kangsar
Source: Fieldwork (2023)



Figure 4: Kampung Balik Pulau, Pulau Pinang
Source: Fieldwork (2023)

ANALYSIS ON MALAY SETTLEMENTS

The Malay settlements of Kampung Sayong, Kampung Morten, Kampung Balik Pulau, and Kampung Duyong represent cultural-historical values and living traditions of adaptation and sustainability. Every settlement focuses on the choice between tradition and contemporary issues that, in one way or another, are interconnected with the human and non-human environment. When approaching these settlements through the ekistics theory, the issues of urbanization, environmental sensitivity, and the struggle to integrate the traditional cultures of indigenous peoples were addressed. Table 1 presents an integrated analysis of

Kampung Sayong, Morten, Balik Pulau, and Duyong as four quite different settlements facing relatively similar challenges in life in the new millennium. The following section presents an analysis of each of these aspects, with interpretations of their relevance and interactions, based on the ekistics theory espoused by Doxiadis (1968 & 1974) regarding human settlement systems and environments.

Table 1: Analysis on Malay settlements

No	Aspect	Kampung Sayong	Kampung Morten	Kampung Balik Pulau	Kampung Duyong
1	Location	Kuala Kangsar, Perak	Melaka	Penang	Terengganu
2	Cultural Identity	Strong cultural heritage; traditional architecture (Zainudin & Hamzah, 2021)	Living museum of Malay culture; preserved architecture (Hassan & Othman, 2024)	Agricultural traditions; rich local food (Pratiwi *et al.,* 2020)	Maritime heritage; traditional fishing practices (Yusof, 2023)
3	Economic Activities	Agriculture, handicrafts, and small-scale trade (Ismail *et al.,* 2023)	Tourism, homestays, and local crafts (Abdullah, 2022)	Eco-tourism, durian orchards, and rice farming (Dhar, 2019)	Fishing, aquaculture, and handicrafts (Hassan & Othman, 2024)
4	Population	Primarily Malay families	Mixed population; local and tourist interaction	Mostly Malay families; agricultural communities	Primarily Malay families; fishing community
5	Social Structure	Strong communal ties and active participation in festivals (Mohamed, 2022)	Engaged in tourism, community-led initiatives	Resilient community with shared farming practices (Pratiwi *et al.,* 2020)	Close-knit community; traditional fishing networks (Yusof, 2023)
6	Urbanization Pressures	Facing encroachment and development threats (Sharma *et al.,* 2022)	Urban pressures from tourism and development	Urbanization affecting agricultural land (Dhar, 2019)	Urbanization threatening traditional practices (Hassan & Othman, 2024)
7	Environmental Vulnerability	Vulnerable to flooding; located near rivers (Sharma *et al.,* 2022)	Urban flooding risks; impact of tourism development (Koh, 2023)	Flooding and climate change risks (Sharma *et al.,* 2022)	Flooding and rising sea levels (Yusof, 2023)

© 2026 by MIP

No	Aspect	Kampung Sayong	Kampung Morten	Kampung Balik Pulau	Kampung Duyong
8	Adaptation Strategies	Cultural preservation; community engagement (Mohamed, 2022)	Balancing tourism with heritage preservation (Abdullah, 2022)	Organic farming; eco-tourism initiatives (Dhar, 2019)	Community-based fishing; local handicraft production (Hassan & Othman, 2024)
9	Infrastructure	Basic amenities; the need for improved flood management (Sharma *et al.,* 2022)	Good access due to tourism; need for preservation-focused infrastructure	Adequate for agriculture; needs climate resilience (Pratiwi *et al.,* 2020)	Limited infrastructure; reliant on traditional practices (Yusof, 2023)
10	Governance and Community Participation	Active local governance; and involvement in decision-making (Hassan & Othman, 2024)	Community engagement in tourism initiatives	Participatory approaches to farming practices (Mohamed, 2022)	Local governance structures; fishing community involvement (Yusof, 2023)
11	Educational Opportunities	Local schools promoting traditional values (Ismail *et al.,* 2023)	Access to educational programs through tourism (Hassan & Othman, 2024)	Community learning about sustainable practices (Dhar, 2019)	Informal education on fishing and crafts (Yusof, 2023)
12	Healthcare Access	Basic healthcare facilities; community clinics (Mohamed, 2022)	Healthcare access improved through tourism (Koh, 2023)	Limited healthcare; need for more services (Pratiwi *et al.,* 2020)	Community health initiatives focus on local needs (Yusof, 2023)
13	Community Initiatives	Cultural festivals, traditional craft workshops (Zainudin & Hamzah, 2021)	Heritage conservation projects; community events (Abdullah, 2022)	Organic farming cooperatives; eco-initiatives (Dhar, 2019)	Fishing cooperatives; environmental awareness programs (Hassan & Othman, 2024)
14	Environmental Conservation	Local conservation practices; traditional ecological knowledge (Yusof, 2023)	Efforts to balance tourism with conservation (Koh, 2023)	Sustainable farming practices; habitat preservation (Pratiwi *et al.,* 2020)	Marine conservation initiatives; sustainable fishing practices (Hassan & Othman, 2024)

Source: Fieldwork (2024)

The geographical locations of these settlements determine their socio-economic characteristics. Kampung Sayong and Kampung Duyong are located near water resources that support agriculture, farming, and fishing, which are the main sources of their livelihood. Such positioning aligns with one of the main principles of ekistics, which holds that human settlements should be in harmony with their environments. On the other hand, Kampung Morten has several advantages, such as its location in a historical part of Melaka, which has become a tourist attraction and a cultural hub. The location of settlements also defines not only the economic activity but also the cultural and social characteristics of the populations. Cultural identity is one of the main pillars of these settlements because it helps determine the practices of the people within these communities and how they are bonded together. Given the building's architectural design and its activities, Kampung Sayong maintains the spirit of an indigenous community. Likewise, the Malay culture of Kampung Morten is sustained within the limits of heritage conservation activities. Kampung Balik Pulau preserves its cultural identity through agricultural practice, while Kampung Duyong preserves it through maritime practice. Almost all the principles of ekistics focus on issues of cultural identity as the key to the sustenance of these settlements and their resistance to forces such as urbanization that seek to dissolve the essence of these civilizations

Economic Activities

These economic activities are closely associated with geographical locations and cultural characteristics of settlements (McGee, 1975). Kampung Sayong culture is primarily driven by agriculture and the handicrafts produced in the area. It also serves the community while retaining traditional techniques and knowledge, in line with ekistics that call for the proper utilization of resources. As the tourism sector is used to continue economic diversification, the residents of Kampung Morten can earn income from cultural relics and souvenirs. The community of Kampung Balik Pulau has incorporated eco-tourism and sustainable farming, with economic activities conducted in harmony with the environment. Thus, the significant economic activity in Kampung Duyong is fishing and aquaculture, revealing the community's orientation toward marine origins. There are parallels with ekistics, such as the need to vary economic activities based on local conditions to ensure they become sustainable and resilient.

Population

The demographics of these settlements shape social relations and interactions within the communities. Most families residing in Kampung Sayong and Kampung Duyong are Malay, and as a result, they have a tight-knit community and culture. On the other hand, Kampung Morten has a more diverse culture due to its interactions with tourism. Meanwhile, it has positively impacted the

© 2026 by MIP

community's experience. There is a need to regulate the aspects of Malay Culture to ensure they do not get lost. The majority of the population in the area comprises Malay agricultural families, and this heterogeneity strengthens the unity and solidarity of the people in Kampung Balik Pulau.

Social Structure

The social organization of these settlements is characterized by close-knit communities and engagement in cultural activities (Lynch, 1960). Kampung Sayong demonstrates this through the communal activities that promote togetherness and cohesiveness among the community members (Mohamed, 2022). The participation of people in festivals and traditional activities promotes the culture and unity of the community. Kampung Morten empowers residents to participate in tourism activities, making them active stakeholders in their community's story. This engagement not only enhances the people's capacity but also fosters ownership and stewardship of their cultural resources. Kampung Balik Pulau exemplifies a model in which communal effort is reflected in farming practices and collective endeavours, thereby improving social capital and communities' capacity to adapt to economic shifts (Dhar, 2019). Kampung Duyong, a predominantly fishing village, utilizes a conventional organizational structure that relies on communal support. These social relationships are essential for community stability, especially regarding environmental and economic challenges.

Pace of Urbanization

Urbanization has adverse effects on all the Malay settlements all over the country, including the seizure of their land, cultural assimilation, and economic strains. Threats to Kampung Sayong are illustrated by development pressures in Kuala Kangsar, which challenge traditional territories and cultures (Sharma *et al.,* 2022). If not well addressed, this encroachment may result in community displacement and in the inability to express their cultural identities. This is an area of concern in Kampung Morten, as the growing pressure from urbanization and tourism activities seeks to infringe on the traditional practices and structures of the settlement. Hence, the main challenge is to maximize the economic benefits of tourism while minimizing negative impacts on cultural resources (Abdullah, 2022). On the other hand, Kampung Balik Pulau faces the challenge of urban encroachment on agricultural land, underscoring the importance of appropriate land-use planning for the sustenance of local farming practices and food security. Kampung Duyong is also at risk of similar threats, as coastal areas are being developed and occupied by the growing urban population; this underscores the need to incorporate communal needs into city planning, as ekistics (Doxiadis, 1968) emphasizes. The four settlements thus also retain significant levels of exposure and sensitivity to environmental hazards, including floods and climate

change. Of the two regions, Kampung Sayong and Kampung Duyong's structures are highly vulnerable to flooding due to their locations near rivers and coastal areas (Sharma *et al.,* 2022). These vulnerabilities require effective disaster risk management and the ability to take measures to protect livelihoods. Given the issues of urban flooding and tourism infrastructure development, especially in Kampung Morten, there is a need for an integrated planning approach that accounts for environmental conditions. Due to stagnant agricultural production and climate variability as a core concern in Kampung Balik Pulau, the need to develop strategies to ensure food security and build resistance among vulnerable agricultural-based societies is emphasized (Pratiwi *et al.,* 2020). Consequently, the identified strategies demonstrate that each settlement can adapt to various challenges. Kampung Sayong aims to address the cultural and communal aspects of life while maintaining cultural heritage to meet modern lifestyle demands (Mohamed, 2022). Kampung Morten illustrates how tourism and culture can coexist. Kampung Balik Pulau has turned to organic farming and eco-tourism as examples of new ways, suggesting the adoption of proper stewardship (Dhar, 2019). Fishing activities in Kampung Duyong involve local people's techniques that do not harm the natural resource base and provide a source of income for the community. These adaptive strategies demonstrate the need for local knowledge and community engagement to improve resilience in the face of modern challenges. Based on the principles of ekistics proposed by Doxiadis (1968), it is evident that local practices should be incorporated into development.

Infrastructure

Infrastructures differ across settlement types, affecting aspects of the inhabitants' lives (Rapoport, 1990). Kampung Morten enjoys developed infrastructure due to tourism, which gives residents access to services and employment opportunities (Koh, 2023). On the other hand, Kampung Sayong and Kampung Duyong need basic facilities, utilities, and infrastructure. This means that measures should be taken to enhance residents' quality of life by improving flood management systems and transport networks in these areas, which are critical to economic sustainability. The infrastructure in Kampung Balik Pulau is relatively sufficient for agriculture. However, there is still scoped to invest in climate adaptation and response to future environmental changes. Good governance and community participation are the key ingredients in the development of the said settlements. Kampung Sayong is an example of engaged local stewardship, in which those involved in preserving cultural assets and managing resources make decisions (Hassan & Othman, 2024). To foster community involvement in tourism endeavours, Kampung Morten encourages residents to determine their roles in the local economy. In Kampung Balik Pulau, practice techniques involve people's empowerment system through the collaboration of farming practices (Mohamed, 2022). Kampung Duyong is endowed with political systems that encourage

© 2026 by MIP

community-based fishing approaches, thereby improving residents' advocacy for their rights and promoting better fishing practices. The comparative study of Kampung Sayong, Kampung Morten, Kampung Balik Pulau, and Kampung Duyong offers a contextual understanding of the characteristics, issues, and measures of Malay settlements. By analysing areas such as geographic location, cultural affiliations, economic endeavours, and community engagement, stakeholders can better understand these communities' operations. This analysis highlights the importance of combining the planning method with community relationships, while also focusing on the cultural backgrounds of the societies as they address modern problems. According to Doxiadis (1968), the principles of ekistics call for interaction, interdependence, organisation, and integration between human settlements and their environments. Formulating and implementing sustainable operational initiatives that harness local endowments and promote resilience will not only benefit the inhabitants of such settlements but also ensure the continuity of Malaysian society's cultural and traditional values in the future.

FINDINGS

The interesting dynamics of Kampung Sayong, Kampung Morten, Kampung Balik Pulau, and Kampung Duyong in addressing issues of urbanization and cultural preservation, economic development, and environmental concerns as aspiring settlements are worth noting. An effort is made in all four settlements to protect the cultural heritage. For example, Kampung Sayong and Kampung Morten practice community construction and customary practices that reflect the Malay culture. Such regard for culture helps promote social integration and resilience, enabling residents to feel a sense of attachment, even when modernization beckons. This aligns with SDG 11: Sustainable Cities and Communities, which addresses safeguarding cultural and natural heritage. The idea of community conservation is important among the Malay people, as it reflects their responsibility for caring for the natural and cultural resources. In Kampung Balik Pulau, the focus is on organic, environmentally friendly farming practices and on respect for traditional farming methods. In Kampung Duyong, there are also community initiatives to manage coastal sea resources, demonstrating local people's capacity to manage and utilize them. These conservation initiatives also promote cultural preservation and strengthen the local community's well-being, which relates to SDG 15: Life on Land and SDG 14: Life Below Water. Economic activities differ in degree from one settlement to another, depending on each settlement's location and available resources. Kampung Sayong and Kampung Duyong are largely focused on agriculture and fishing, while tourism is a driving force of economic development in Kampung Morten. Kampung Balik Pulau has successfully blended agricultural activities with eco-tourism, demonstrating its economic diversity. This diversification of

the economy improves its resilience to external shocks and thus aligns with SDG 8: Decent Work and Economic Growth. Rapid urbanization brings many challenges, especially in Kampung Sayong and Kampung Morten, where land invasions affect people's way of life and even their cultural practices. The situated context claims that urban nuisance is greatest in areas with a high concentration of tourists, leading to the dilution of community practices and identity. It stresses the need to pursue economic development without losing cultural practices, in line with SDG 16: Peace, Justice, and Strong Institutions, which supports holistic, people-centred decision-making. Flooding and climate change-related losses are impacts of various forms of environmental hazards on settlements. Kampung Sayong and Kampung Duyong are at great risk due to their proximity to water. They need an urgent remedy in the form of collaboration in disasters and infrastructural development. Increased, well-defined flood management requirements would protect the community's livelihoods, align with those used for protection, and meet SDG 13: Climate Action. The strong social fabric mitigates the impact of floods on settlements' resources, and flood events increase attendance at cultural events. In Kampung Sayong, the community participates in festivals and ceremonies that promote unity. Initiatives such as Kampung Morten and Kampung Balik Pulau enabled people to rewrite their economic and cultural story. The forms of participation and the level of involvement are imperative towards achieving most targets under urbanization challenges, thus meeting SDG 17: Partnerships for the Goals. There are differences in infrastructure that tend to influence residents' quality of life and the availability of necessary services. Given the presence of tourism, Kampung Morten is said to have used tourism's availability to improve its already developed infrastructure, thereby expanding its economic opportunities. On the other hand, Kampung Sayong and Kampung Duyong need enhancements of basic utility services and flood control systems. There is a need to bridge these gaps to promote balanced community growth and development in the context of SDG 9: Industry, Innovation, and Infrastructure. Good governance and community participation are vital in the sustainable development of these settlement areas. In Kampung Sayong, such governance is evident in locals' participation in relevant decisions on cultural and resource management (Hassan & Othman, 2024). In the case of Kampung Morten, the local community is motivated to participate in tourism development, the extent of which is defined by residents' desire to engage in the local economy. In Kampung Balik Pulau, such practices are turning farmers into partners with the community, enabling them to own the resources in common (Mohamed, 2022). Kampung Duyong is privileged to have strong local management systems that assist fishing communities in improving their capacity to voice their needs and support the adoption of sustainable practices. The concept of community resilience is important for understanding the processes that shape these settlements' ability to address challenges stemming from urbanization and other

© 2026 by MIP

environmental factors. Malay culture and economy, social support, and participation in the political process and bureaucracy are among the ways the Malay community can be seen to have gotten back on its feet. These resilience contributions are produced by the kind of community conservation practised in the two cases of Kampung Balik Pulau and Kampung Duyong. With these developments taking place within these settlements, it is clear that the future of Malay identity squarely rests on their capacity to assimilate into modern urban civilization while preserving their culture as a people. Educational activities that familiarise younger generations with their culture will include intergenerational knowledge transmission, which will entail workshops and other related community activities. In addition, incorporating Malay identity into sustainable development programs will go a long way toward building a strong cultural identity. Stressing the role of identity in planning will help to sustain the longevity of such communities.

SUMMARY AND CONCLUSION

The story of Malay settlements in Kampung Sayong, Kampung Morten, Kampung Balik Pulau**,** and Kampung Duyong is a testament to remarkable resilience. These communities are not just suffering the effects of the rapid pace of urbanization and environmental change; they are actually prospering, which shows that their cultural individuality and community unity are robust. There is nothing that defines this resilience more than a close association with their culture. The people of these settlements are very proud of their culture, which helps them to stay grounded in today's world. It can therefore be seen that festivals, communal gatherings, and traditional practices, more than events, constitute the rich identity of Malays, providing people with a sense of togetherness. This cultural richness helps residents unite and fight for their rights to maintain their culture, reaffirming their commitment to the community's culture. Moreover, the roles these communities can play in diversifying their local economies are important to their resilience. By practising eco-tourism and sustainable agricultural practices, they create new opportunities to improve their welfare standards without forgetting their origins. Such flexibility underpins their economic base but also demonstrates their resolve to walk the fine line between preserving tradition and modernization. Another one is the residents' engagement in governance and decision-making processes, which is also a good sign of their resistance. When people in the community are involved in the process, they are likely to be more responsible in its development. The participatory spirit enhances the development of their needs and visions, leading to sustainable development as people invest genuine effort. There is a general sense of optimism about the prospects for future development in Malay settlements. The continuity of the Malays in these communities will be relevant to future generations. Projects that enable the youths to learn more about their cultural practices through inspirational

© 2026 by MIP

music, dance, drama, and storytelling will go a long way in keeping the culture alive. By cultivating this bond, the community can protect its history and values and build a bright, sustainable future for the city's inhabitants, despite the difficulties associated with the urbanization process. This hope is, of course, further reinforced by the tenacity of these communities, as seen in their ability to survive and even thrive. The commitment to build sustainable practices, protect and promote cultural identity, and foster more participative and democratic forms of management is a positive example for similar contexts. Thus, the fact that Malay settlements and the communities in them took so long to be threatened is a testament to cultural strength, resourcefulness and togetherness. These communities are not only iniquities; they are also creatively and actively responding to the challenges. Malay settlements' experience should help people around the globe, as it shows how valuable cultural persistence is and how communities should stand together for a better, more effective future. Unlike many informal settlements globally that struggle primarily with basic service deficits and socio-economic marginalization, Malay settlements reveal a distinctive resilience shaped by cultural identity, governance participation, and heritage-based adaptation. By situating these findings within the SDG framework, this study contributes new understanding of how culturally anchored communities can inform more inclusive and context-sensitive approaches to sustainable Malay settlement planning. The commitment to build sustainable practices, protect and promote cultural identity, and foster more participative and democratic forms of management is a positive example for similar contexts. Thus, the fact that Malay settlements and the communities in them took so long to be threatened is a testament to cultural strength, resourcefulness and togetherness. These communities are not only iniquities; they are also creatively and actively responding to the challenges. Malay settlements' experience should help people around the globe, as it shows how valuable cultural persistence is and how communities should stand together for a better, more effective future. Unlike many informal settlements globally, which primarily struggle with basic service deficits and socio-economic marginalization, Malay settlements exhibit distinctive resilience shaped by cultural identity, governance participation, and heritage-based adaptation. By situating these findings within the SDG framework, this study offers a new understanding of how culturally anchored communities can inform more inclusive, context-sensitive approaches to sustainable Malay settlement planning.

ACKNOWLEDGEMENT

The author thank the Ministry of Higher Education Malaysia for providing financial support under the Fundamental Research Grant Scheme (FRGS) Research Code: FRGS/1/2022/SSI06/UMK/02/3.

© 2026 by MIP

DISCLOSURE STATEMENT

The authors declare no competing interests. All fieldworks were conducted with community consent, cultural sensitivity, and respect for local norms. Only non-intrusive observations and voluntary conversations were carried out, with no personal or identifiable information collected. The research involved no procedures requiring formal institutional review, and all engagements ensured the dignity and autonomy of community members.

REFERENCES

Abdullah, A., & Wahid, J. (2022). Returning to Nothing: The lost of Malay settlement in Pasir Mas, Kelantan. *Ocal Wisdom*, *14*(1), 48–28.

Abdullah, A., Wahid, J., Al-Ansi, N. A., & Ariffin, E. N. E. M. (2022). The Malay settlement: A vanishing world? *Environment-Behaviour Proceedings Journal*, *7*(20). https://doi.org/10.21834/ebpj.v7i20.2967

Abdullah, A., Wahid, J., Khalil, K. F., & Boudiaf, B. (2022). Towards the future of the Malay community in Kelantan. *Environment-Behaviour Proceedings Journal*, *7*(19), 45–52. https://doi.org/10.21834/ebpj.v7i19.3203

Abdullah, A., Wahid, J., Titisari, E. Y., & Engku Mohd Ariffin, E. N. (2022). The impact of urbanisation and the changing environment of the Malay settlement. *Environment-Behaviour Proceedings Journal*, *7*(21). Retrieved from https://ebpj.e-iph.co.uk/index.php/EBProceedings/article/view/3691

Dhar, P. (2019). Urbanization and migration in South Asia: A comparative perspective. *Asian Journal of Public Affairs*, *12*(1), 34–45.

Doxiadis, C. A. (1968). *Ekistics: An introduction to the science of human settlements*. Hutchinson.

Doxiadis, C. A. (1974). One room for every human. Paper presented at the Third International Symposium on Lower-Cost Settlement Problems, May 27, Montreal, Canada.

Evers, H. D. (2016). *The vanishing culture of Malaysian urbanization*. UKM.

Gehl, J. (2010). *Cities for people*. Island Press.

Hassan, S., & Othman, A. (2024). Community resilience in Malay settlements: A study on environmental challenges and local adaptations. *Journal of Community Development*, *14*(1), 67–82.

Ismail, N., Rahman, M., & Bakar, A. (2023). Architectural heritage and identity in Malay settlements. *Journal of Architecture and Urbanism*, *17*(1), 67–82.

Koh, C. (2023). Sustainable urban design in Southeast Asia: Lessons from Malay settlements. *Journal of Sustainable Cities*, *15*(2), 150–169.

Lynch, K. (1960). *The image of the city*. MIT Press.

McGee, T. G. (1975). *The urbanization process in the Third World: Explorations in search of a theory*. G. Bell and Sons.

Mohamed, A. (2022). Urban challenges in Malaysia: The case of Malay settlements. *Malaysian Journal of Urban Studies*, *5*(2), 145–160.

Pratiwi, D., Kurniawan, A., & Indrajaya, I. (2020). Community-based approaches to resilience in urban slums: Evidence from Indonesia. *Indonesian Journal of*

Geography, *52*(2), 87–95.
Rapoport, A. (1990). *The meaning of the built environment: A nonverbal communication approach*. Sage Publications.
Schumacher, E. F. (1976). Patterns of human settlement. *Ambio*, *5*(3), 91–97. www.jstor.org/stable/4312185
Sendut, H. (1962). The resettlement villages in Malaya. *Geography*, *47*(1), 41–46.
Sendut, H. (1965). Some aspects of urban change in Malaya, 1931-1957. *Kajian Ekonomi Malaysia*, *2*(1), 87–103.
Shari, I. (1992). *Pembangunan dan kemunduran: Perubahan ekonomi luar bandar di Kelantan*. Dewan Bahasa dan Pustaka.
Sharma, S., Verma, P., & Gupta, R. (2022). Climate change and urban flooding: Implications for informal settlements in South Asia. *Climate Policy*, *22*(3), 345–358.
Venturi, R., Brown, D. S., & Izenour, S. (1977). *Learning from Las Vegas: The forgotten symbolism of architectural form*. MIT Press.
Yusof, A. (2023). Traditional fishing practices and environmental conservation in Malay settlements. *International Journal of Marine and Coastal Research*, *11*(2), 101–114.
Zainudin, A., & Hamzah, R. (2021). The role of settlement planning in maintaining cultural identity. *Malaysian Journal of Planning*, *9*(2), 56–70.

Received: 1st January 2025. Accepted: 8th August 2025

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 691 – 704

MUSLIM FAITH-BASED NEEDS IN TOURISM FROM THE PERSPECTIVE OF MOBILE SERVICES: A BIBLIOMETRIC ANALYSIS

Nur Shuhadah Mohd[1], Ummi Noorjuwairiah Abdullah[2], Siti Salwa Md Sawari[3]*, Muhammad Aizat Jamaludin[4], Siti Syahirah Saffinee[5], Azhar Alam[6]

[1,3]*Kulliyyah of Sustainable Tourism and Contemporary Languages,*
[2,4] *International Institute for Halal Research and Training (INHART),*
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
[5] *Faculty of Syariah and Law,*
UNIVERSITI SAINS ISLAM MALAYSIA
[6] *Department of Islamic Economics Laws,*
UNIVERSITAS MUHAMMADIYAH SUKARTA, INDONESIA

Abstract

This study examines patterns of revolutionary change over the years in the context of behavioral changes among Muslim tourists when using mobile services in fulfill their faith-based needs. This study collected past journals to observe patterns in how past researchers discussed related topics and how these discussions revolved around alignment with tourism market demand and destination hosts' acceptance levels in welcoming Muslim tourists. Using VOSviewer, this study conducted a bibliometric analysis of scholarly works in the Scopus database, filtered for the period 1990 to 2024. Overall, many past researchers discussed topics related to Muslim faith-based needs, but in different terms. Furthermore, most journals have an interrelation with psychological experiences that discuss Muslim tourists' behavioral changes in fulfilling their faith-based needs during travelling. Such behavioral changes reflect their cognitive and affective responses, destination awareness, satisfaction levels, revisit intentions, and word of mouth. However, only a few journals discuss the correlation between changes in Muslim tourists' behaviour and mobile consumption while travelling, as mobile services such as social media applications have only recently begun to bloom again after five years. However, this research will provide clearer, better guidance and improve the institution/scientific/country's research productivity.

Keywords: Muslim faith-based, Muslim Friendly Tourism, Psychological Experience, Mobile services

[3] Corresponding author. Email: salwa_sawari@iium.edu.my

INTRODUCTION

Muslim-friendly services and Halal tourism have been closely interrelated, as they are core elements in developing the Halal tourism niche. Muslim tourists have globally increased, and Halal tourism has become widespread, aligning with the Muslim tourists' demand. As reported by CrescenRating, in 2022, the number of Muslim international arrivals reached 110 million, regaining 68% of the pre-pandemic levels seen in 2019. For 2023, projections indicate that Muslim international arrivals will reach 140 million. This condition would represent a recovery to 87% of 2019 levels, reinforcing the ongoing recovery. By 2024, CrescentRating projects a complete recovery, with the total number of Muslim arrivals expected to match the 2019 figure of 160 million. Thus, this strongly demonstrates that Muslim faith-based needs have become a necessity and must be fulfilled by all stakeholders involved, who must consider them when providing tourism services at their locations. Their fulfillment of demand will, in turn, determine their travel motivations, satisfactions, experiences, and behavioral changes.

To cater to the growing market of Muslim travelers, stakeholders can leverage the newest technology by offering services through mobile applications. This enables more accessible and convenient marketing and service compared to traditional methods such as brochures, newspapers, banners, and pamphlets. The digitization of services and cultural sites plays a crucial role in enhancing the tourist experience, especially in preserving heritage and ensuring a seamless, faith-affirming journey for Muslim travelers. For example, the digitalization of built heritage sites and the use of GIS technology in landscape management have demonstrated how modern technology can enhance both conservation efforts and tourist experiences (Abdullah et al., 2024; Baharuddin et al., 2024). Furthermore, ensuring the safety of tourists, particularly Muslim travelers seeking prayer spaces or Halal services, is another important consideration, and mobile services can effectively address these concerns (Jaelani et al., 2021). However, studies on perceived environmental value in the context of mobile services for Muslim tourists are still relatively scarce (Preko et al., 2020), resulting in a lack of updated references for stakeholders to guide them in serving Muslim tourists through these services. This study highlights a gap in existing research on how Muslim tourists use mobile services to fulfill their faith-based needs during travel and how these services influence their travel behaviour.

While previous studies have examined Muslim faith-based needs, Islamic attributes of destinations, and technology use in tourism as separate topics, there is still limited work that systematically connects these strands from a long-term and global perspective. Building on this gap, this study offers a bibliometric mapping of three interconnected domains: Muslim faith-based needs, psychological experience, and mobile consumption, covering the period

© 2026 by MIP

1990 to 2024, and shows how mobile services have progressively become a key medium through which Muslim tourists fulfil their faith-based needs. By visualising these developments, the paper clarifies emerging research themes. It identifies new opportunities for Muslim-friendly destinations and industry stakeholders better to align mobile services with Muslim tourists' religious requirements.

LITERATURE REVIEW

Interrelation Between Fulfillment of Faith-Based Need and Psychological Experience in Mobile Consumption

The use of this IT application through mobile devices naturally depends on the user's culture (Yuen et al., 2015). It is very common in Muslim tourists' perspective for them to refer to religious apps, such as a prayer app, as part of their daily routine in learning and practicing their religious activities (Nisa, E.F., 2018). Consuming mobile apps compared to surfing websites for geo-locating any Muslim-friendly destinations assists them in deciding to travel to those specific destinations and even determining their revisit intention if it surpasses their satisfaction level and great travel experiences during their stay. Digital platforms are a key component in product and service delivery. Other stakeholders, such as business owners, especially Halal entrepreneurs, can seize this opportunity by creating and providing a new digital platform that can be personalized to meet every aspect of travel needs, specifically for Muslim tourists. They should look for extremely user-friendly apps that enable customers to share everything (Brown, 2006). Hence, there are many opportunities to explore and apply to Muslim-friendly tourism products. This field of tourism not only provides exclusively for Muslim tourists but also serves non-Muslim tourists (Brown, 2006; Faiza & Michelle, 2017; Priyatmoko & Maulana, 2022)

© 2026 by MIP



Figure 1: Contents consumed by Muslim travelers depending on the type of generation

Mastercard and HalalTrip (2017) reported that eight content types are consumed by Muslim tourists, based on a survey conducted via the HalalTrip mobile application. These eight contents are listed, each from a different generation. In Figure 1 above shows that 20% of the respondents, who are Generation Z and are less than 24 years old, use HalalTrip most for its prayer times, qibla, and to search for nearby mosques. Meanwhile, millennials (40%) aged 24 to 37 are likely the most consumers of HalalTrip features, seeking Halal restaurants, Muslim-friendly hotels, destination articles, and top things to do. Then, the next generation is Generation X (20%), aged 38 to 53, which can be considered a middle-aged group, and they consumed information related to attraction guides, city guides, and suggested itineraries. These age classes still prefer brochures and pamphlet presentations, but in online forms.

Meanwhile, the unknown background is seeking city guides and halal restaurants. Hence, this shows that these generations are heavily reliant on technological devices such as tablets and smartphones (Roy & Jasrotia, 2024), which also strongly supports the idea that having a Halal travel mobile app can

© 2026 by MIP

help them in many ways and assist them in always staying well-informed, even in unfamiliar places. They explore the destinations they want to visit by engaging with technology in eager to learn how it works without any fear (Noor, 2019). Recently, many companies have engaged in generational marketing by tailoring their marketing mix to specific generations (Chaney et al., 2017). The latest generation, which is between Millennials, Gen Z, and soon Gen Alpha, will somehow naturally carry an essential role in deciding their family travel selection and destinations (Tiago & Studies, 2013)

Entrepreneurs or business owners, especially Muslim-friendly business owners, might need to be ready for these generations, as they have become the next crucial target of tourists, seeking to be satisfied as they will be reviewing and making decisions, especially from Gen Alpha (Mastercard-Crescent Rating, 2020), based on content through social media before planning and during the trip. Business owners can offer customized edutainment activities or programs tailored to their preferences, along with family package offers and promotions.

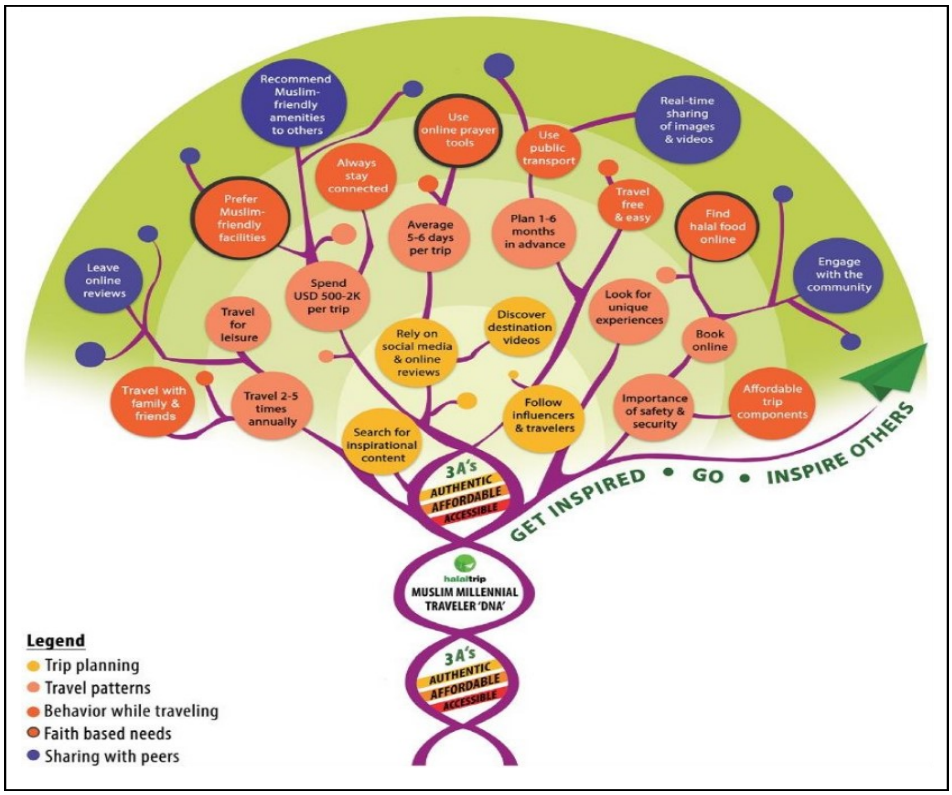


Figure 2: Muslim Millennials Traveller' DNA'
Muslim Millennial Travel Report, 2017

It is reported that MMTs have their own travel needs. Commonly, these travel patterns can be seen in the planning stage, during the travel, and when they share their travel experiences with others, which are called the "Get inspired", "Go", and "Inspire others" phases. With this, stakeholders can easily recognize the Halal tourism market as a means in fulfilling Muslim travellers' demand (Mastercard & HalalTrip, 2017). Figure 2 above shows the Millennial Travel Report 2017, which released Muslim millennial travel trends. It covers overall aspects from pre-trip planning to during-trip and after-trip. During the trip-planning stage, Muslim millennials will search for inspirational content to motivate and serve as references. It also stated that they are relying on social media and online reviews as resources, as these are the most accurate and quickest sources of information a person can get. Plus, they can browse and discover destinations in video form on platforms such as social media, which then increases their satisfaction level as they travel with well-prepared plans. In this digital era, influencers and travellers have become more trustworthy and reliable in promoting real-time online experiences of tourism destinations through mobile devices. Thus, these millennials prefer to believe and are influenced by these social media figures for detailed travel planning. Another fact reported by Battour et al. (2022) is that Muslim women are highly effective in planning trips, regardless of the group they are in, as they are very wise in travel decision-making. Plus, Muslim women tourists are a large community, ranking among the largest groups among Muslim tourists, with 71% travelling with families, 29% travelling in all-female groups, and 28% travelling solo (Mastercard-Crescent Rating, 2019). Therefore, there will be an increase in purchasing power, as many of them are still young, well-educated, and proactive in their workplaces, creating opportunities for entrepreneurs to expand Muslim-friendly tourism services (Devi & Firmansyah, 2019).

METHODOLOGY

Bibliographic analysis

Bibliometric analysis was used in this research to examine bibliographic data on the number of authors, institutions, articles, citations, and countries. Statistical, analytical, and quantitative methods are mainly applied in this research by using past journals and citations to access the literature, a method called Bibliographic analysis has been applied in product mapping and to study the information produced in various fields (Kaushik & Dangwal, 2025), which progressively assesses the efficacy based on the citation and publication outlines of the literature (Vishwakarma & Mukherjee, 2019).

Alternatively, researchers are using bibliometric analysis for several objectives, such as determining trends in journal articles, research mechanisms,

© 2026 by MIP

and cooperation patterns, and studying topics in the existing literature (Donthu et al., 2021). This research paper aims to present a bibliometric analysis, including science mapping, and to describe how the mobile consumption element alters the psychological experience of Muslim tourists in fulfilling their faith-based needs. This descriptive analysis includes the field of research, publication year, popular authors by country, document citations, authors' keywords co-occurrence, and authors' citations and co-citations as part of the mapping.

This research used VOSviewer software for co-citation analysis, with the unit of analysis being all keywords found in most discussions of past journals and the author keywords (Chen & Song, 2019). VOS viewer is commonly used for this kind of network analysis (Chen & Song, 2019; Güzeller & ÇeliKer, 2018; Idamokoro, 2025; Viana-Lora & Nel-lo-Andreu, 2022). The author keywords through co-occurrence feature highlighting on which terms are mostly used, popular, and distinguished (Viana-Lora & Nello-Andreu, 2022). The design of this research is presented in Figure 1.

Clarifying keywords

Identifying keywords from the selected paper is the first stage in producing a bibliometric analysis. Keyword identification begins with the separate elements of this research: Muslim faith-based needs, Psychology of experience, and Mobile consumption. Moreover, the last stage is the identification stage, which will combine these elements, as reflected in the main title of this research. Predicted related concepts commonly used in the past literature are used as keywords when searching for bibliographic journals in Scopus. The Boolean operator (OR) and (AND) is used to search for the following keywords in one search. For Muslim faith-based needs elements, the keywords are combined between the probable terms used for Muslim faith-based needs in past journals with related tourism to widen the document search such as "Muslim-friendly need" OR "halal need" OR "Muslim need*" OR "Islamic need" OR "shariah need" OR "religious need" OR "spiritual need" OR "Islamic attributes" OR "sharia motivation" OR "Muslim cultural needs" AND "Travel" OR "tourism" OR "halal tourism" OR "tourist" OR "travelers" OR "pilgrimage tourism" OR "religious tourism" OR "Islam".

For the Psychology of experience element, keywords are combined between the behavior related characters with the related tourism such as "psychology*" OR "behavior*" OR "behavioral" OR "experience*" OR "expectation" OR "motivation" OR "satisfaction" OR "satisfactory" AND ("muslim" OR "religious" OR "halal" OR "islamic") AND "tourists" OR "travel*" OR "traveller*" OR "tourism".

For the mobile consumption element, keywords used are the combination of Muslim tourists' behavioral alteration in consuming mobile, and

such keywords searched are "Muslim" OR "Muslim- friendly*" OR "halal" OR "Islamic" OR "sharia*" OR "religious" OR "Muslim pilgrimage") AND ("travel" OR "tourist*" OR "halal tourism" OR "travellers" OR "musafir") AND ("mobile" OR "mobile app" OR "GPS" OR "navigation" OR "mobile application" OR "digital" OR "GIS" OR "social media" OR "smartphone" OR "website" OR "mobile phone" OR "online" OR "web" OR "virtual.

For overall research elements, keywords used to search for related documents are those that combine the elements of how Muslim tourists consume mobile services in fulfill their faith-based needs and how this affects their psychological experiences. These keywords are "halal" OR "Muslim" OR "Muslim-friendly" OR "Islamic" OR "pilgrimage" OR "religious" AND "psychology*" OR "tourist behavior*" OR "tourist behavioral" OR "travel experience*" OR "tourist expectation" OR "tourist motivation" OR "tourist satisfaction" OR "tourist satisfactory" AND "mobile" OR "mobile app" OR "GPS" OR "navigation" OR "mobile application" OR "digital" OR "GIS" OR "social media" OR "smartphone" OR "website" OR "mobile phone" OR "online" OR "web" OR "virtual experience" OR "technology" OR "facebook" OR "instagram" OR "flickr" OR "blog" OR "whatsapp" OR "Augmented reality" OR "AI". This identification search was conducted in February 2024, and only documents published from 1990 to 2024 were considered for this analysis.

Initial results

Given the vast number of databases worldwide in this analysis, this research focuses on the Scopus database for bibliographic analysis. Overall, 1,684 related journals were filtered during the initial search for this research, which were then refined using parameters outlined in the subsequent main elements of this research: Muslim faith-based needs, the psychology of experience, and mobile consumption.

Reclarifying the initial research

The initial results were refined to select journals in English only to cover international papers and in produce more specific author keywords through bibliometric mapping. As a result, of the total of 1,684 journals related to this research title, 67 are primarily related to Muslim faith-based needs, 261 are primarily on the psychology of experience, 969 are primarily on mobile consumption, and the rest are related to a combination of these elements, as reflected in the whole research title. The extracted journals are filtered to a limited range of years from 1990 to the newest year, 2024.

© 2026 by MIP

Limitations of Method

This study has several methodological limitations that should be acknowledged. First, the bibliometric data were drawn only from journals indexed in a single database. They were further refined through a manual filtering process, which may have excluded relevant but less visible publications and introduced selection bias. Second, the analysis was restricted to articles published in English, so important work in other languages, especially from non-English-speaking Muslim-majority countries, may not be represented. These limitations mean that the findings should be interpreted as indicative of broader patterns rather than fully exhaustive of all scholarship on Muslim tourists' mobile consumption and faith-based needs.

Quality Components

Based on the responsibilities of the JMB and the MC, the COB evaluates and ranks each strata scheme according to the components of quality management. The quality components include (i) establishment and operation of management bodies, (ii) finance, (iii) maintenance, (iv) risk security management, and (v) population well-being. The evaluated strata schemes are rated on a 5-star scale, with 5 stars representing the highest-quality management. Based on the published COB Annual Reports, the following Table and Figure show the distribution of strata schemes by star rating.

RESULTS AND DISCUSSION

Area of research

The number of journals extracted is represented in Table 1. From the total number of journals extracted from the Scopus database, the highest number is from Islamic marketing, with 145 journals; 65 are from religious tourism and pilgrimage, and 31 are from the sustainability field. It indicates that scholars discussing the topic related to this research are mostly from these fields.

Table 1: Area of research

Area of Research	No of Journal	Percent (%)
Advanced Science Letters	13	0.77%
Current Issues in Tourism	22	1.31%
Geojournal of Tourism and Geosites	12	0.71%
International Journal of Innovation, Creativity and Change	14	0.83%
International Journal of Islamic and Middle Eastern Finance and Management	12	0.71%
International Journal of Religious Tourism and Pilgrimage	**65**	**3.86%**

Area of Research	No of Journal	Percent (%)
International Journal of Tourism Cities	13	0.77%
International Journal of Tourism Research	23	1.37%
ISRA International Journal of Islamic Finance	14	0.83%
Journal of Asian Finance, Economics and Business	10	0.59%
Journal of Destination Marketing and Management	11	0.65%
Journal of Environmental Management and Tourism	21	1.25%
Journal of Environmental Treatment Techniques	10	0.59%
Journal of Islamic Accounting and Business Research	25	1.49%
Journal of Islamic Marketing	**145**	**8.62%**
Religions	12	0.71%
Sustainability (Switzerland)	**31**	**1.84%**
Tourism Management	15	0.89%
Tourism Management Perspectives	18	1.07%
Tourism Review	15	0.89%
WSEAS Transactions on Business and Economics	12	0.71%

Year of publication

Table 2 shows the number of journals from 1990 to 2024. The data shows an increasing interest among scholars from year to year. Table 2 and Chart 1 show that the number of publications on related topics to this research from 1990 to 2006 is quite stagnant (fewer than 10), but then slowly increases after 2007. However, there is a decrease in the number of publications from 2020 to 2021, possibly due to the pandemic, which affected the global tourism market. Then, the publication number increased back to its 2022 levels in 2023, as the global economy healed slowly from the pandemic, resulting in the tourism market bouncing back due to demand.

Table 2: Year of Publication

Years	No. of Journals	Percent (%)
1989–1994	10	0.60%
1995–1999	7	0.42%
2000–2004	13	0.78%
2005–2009	51	3.03%
2010–2014	134	7.96%
2015–2019	421	25.01%
2020–2024*	1,047	62.19%
Total	**1,683**	**100%**

*Note: 2024 data is incomplete as it represents the partial year.

© 2026 by MIP

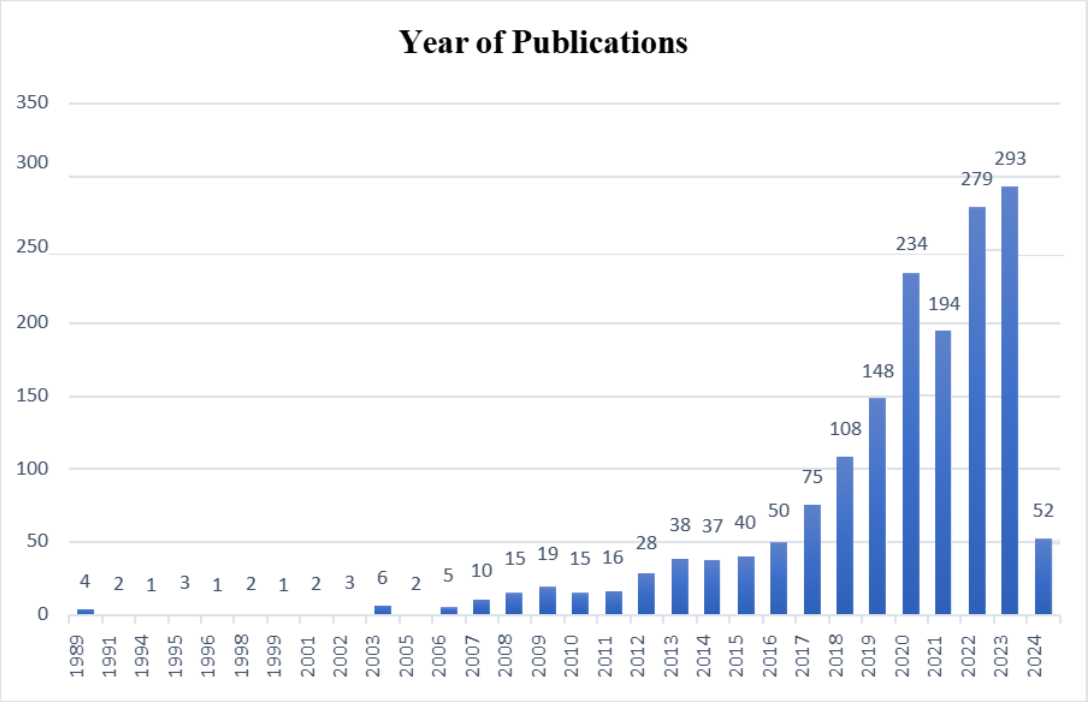


Chart 1: Year of publications

Co-occurrence of author keywords

The dominant keywords were analyzed using VOSviewer's co-occurrence functionality, which produced a graphical overview of the authors' keywords, as shown in Figure 3. The main keywords were analyzed separately according to the main elements of this research to identify the common terms used by scholars in their past journals and the relations among their discussions.

Muslim Faith-Based Needs

Co-occurrence analysis using keywords and the most frequently used terms by authors creates a topic grid and its associations (Merigó et al., 2020). Through this bibliometric analysis, keywords and terms are generated based on term patterns used by past scholars from 1990 to 2024 that are related to this research. Figure 3 below shows that Muslim faith-based needs are most discussed through two main terms, "Islamic attributes" and "Spirituality". The journals discussing Islamic attributes related to travel motives, tourists' satisfaction, and motivation. Islamic attributes: discussing in more detail the needs of a Muslim, and some related aspects, such as Halal tourism and Islamic tourism. Halal food and respectful behaviour, Islamic morality, washroom facilities, entertainment &

worship, Islamic hotel environment, and destination selections are crucial needs when Muslim tourists travel in non-Muslim destinations (Battour et al., 2013). Meanwhile, "Spirituality" discusses general research topics that cover religious aspects, including Islamic needs related to this research, as well as medical aspects such as health, but not travelling. However, these two terms are interconnected by a fine line in the religious aspect, where both share the same religious needs, cultural elements, and the basis of the research topics discussed by these scholars, which are

Figure 3 displays the co-occurrence network of author keywords related to Muslim faith-based needs in tourism. It highlights the central roles of "Islamic attributes" and "spirituality" and their connections to concepts such as travel motives, satisfaction, motivation, halal tourism, and Islamic tourism. It indicates how faith-based needs are framed in the literature.

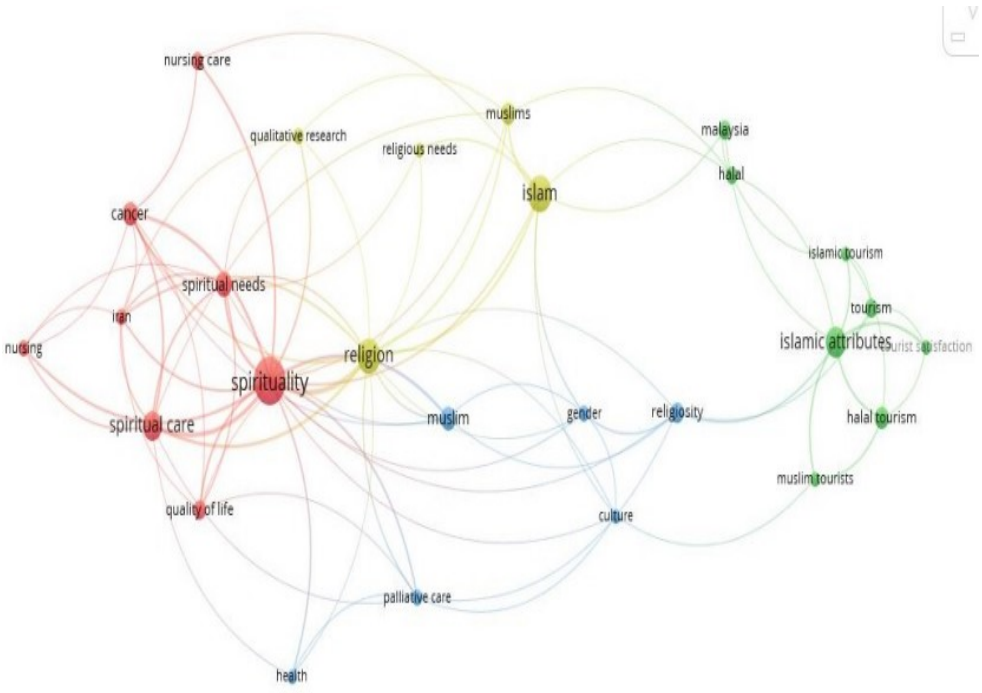


Figure 3: Bibliometric map of Muslim faith-based needs.

Psychology of Experience

Figure 4 presents the co-occurrence network of keywords associated with psychological experience in tourism, including religious and pilgrimage-related

© 2026 by MIP

terms. It shows how constructs such as satisfaction, expectations, motivation, and risk perceptions cluster around religious and pilgrimage tourism, providing a basis for linking psychological experiences to Muslim tourists' travel behaviour.

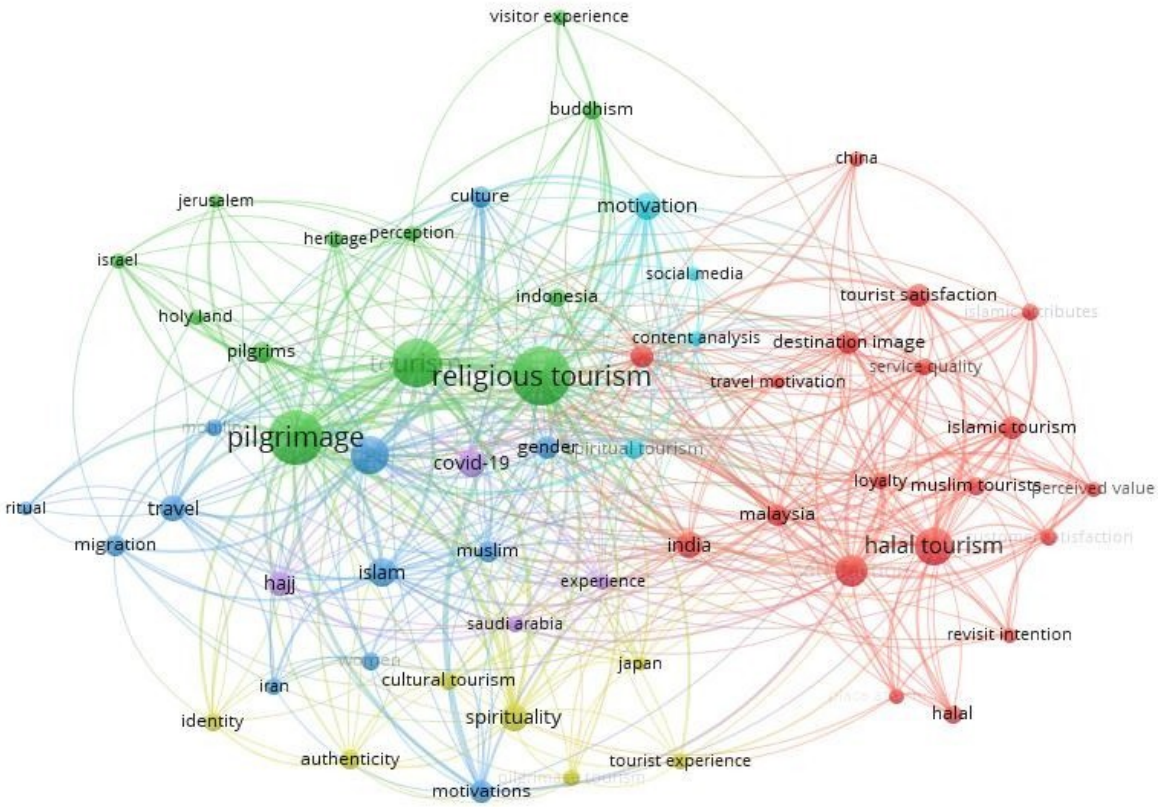


Figure 4: Bibliometric map of psychology of experience in tourism.

In Figure 4, many scholars discuss the psychology of experience during travelling using the terms "Religious" and "Pilgrimage," which are general for all types of religious activities, including Islam. Halal tourism is mostly discussed in terms of pilgrimage and religious tourism, but it actually focuses more on Muslim tourists' travel satisfaction. Additionally, Halal tourism, often referred to as Islamic or Muslim-friendly tourism, is a new concept in the tourism industry that offers exciting opportunities to boost economic growth. In fact, Halal tourism is closely related to 17 Sustainable Development Goals (SDGs) that contribute to sustainability. Hence, it is crucial to clarify misconceptions, especially among non-Muslim tourists, to help them better understand the segments (Uula, 2025).

In Figure 5 below shows that, starting from the early 90s, two keywords were commonly discussed in past tourism publications, with scholars mostly focusing on risk-related diseases and mobility. The keyword mobility appeared because it was an era of human mobility as per stated by Kaufmann et al. (2004), based on previous studies conducted by Riaño et al. (2022), presented the typology of human mobility, which consists of four kinds of movements: residential mobility (with reference to residential cycle); migration (international and interregional immigration and emigration); travel (tourism and business travel); daily mobility (daily journeys such as commuting). These kinds of mobility increase the risk of disease spreading. This phenomenon is when people travel for medical care, and the study of travel medicine may have expanded somewhat by the 1990s (Fagence & Kevan, 1998).

Then, ten years later, from 2000 to 2010, the tourism keyword pattern shows new tourism segments and tourists becoming more aware of expectations and perceptions of physical activities and service qualities. A few past scholars who discussed tourists' expectations during these years, such as Ratih and Noer (2024), found a positive relationship between tourist satisfaction and revisit intention.

According to the literature above, many scholars offer different definitions of satisfaction. This study considers satisfaction to be an evaluation of the actual cognitive process in relation to the individual's expectations and experiences. This evaluation is satisfactory or unsatisfactory. Another scholar, namely Szymanski and Henard (2001), classifies the satisfaction method as a holistic concept, measuring satisfaction with a single question to understand the customer's overall attitude towards products and services. This condition proves that tourists' perceptions and behaviors regarding service quality have been discussed for a long time, since the early 2000s.

Then, the keyword trends keep revolving in the next 14 years. Mobile devices have been blooming over these years and have seen increasing demand among tourists, including Muslim tourists, during travel. As stated by Tussyadiah (2015), the capability of mobile technologies as a medium for communication in sharing information has led to widespread adoption of smartphones in the tourism industry as a way for them to find mobile guides and location-based services. With highly developed social media and virtual realities year to year, scholars are also getting up to date in their publishing, discussing how consuming mobile services can alter their travel behaviours. The widespread use of smartphones and the accessibility of information services can potentially change the entire travel experience by altering the nature and role of travel planning, thereby revolutionizing the very meaning of tourism and transforming both tourists and places (Gretzel et al., 2024).

© 2026 by MIP

Figure 5 illustrates the evolution of key psychological and health-related terms in tourism research from the early 1990s to the 2010s. It traces the shift from topics such as mobility and travel-related diseases to themes of expectations, service quality, and satisfaction, and finally to mobile technologies and digitally mediated experiences.



Figure 5: Temporal evolution of psychological-experience keywords.

Mobile Consumption

In Figure 6 shows that journals discussed under the term "pilgrimage" in relation to mobile consumption of Muslim or Islamic travels. The journals discussing shariah finance and banking were mostly published in Indonesia, Saudi Arabia, and the UAE. The second most discussed topic in mobile consumption among Muslim tourists is hajj or umrah, for which mobile services are developed through apps to ease hajj and umrah performers in performing their activities, including visits to religious sites. The Android platform for mobile applications is cost-effective, and the open-source model is very popular among all generations today (Nurhayati et al., 2020). This application lso also helps Android device users learn, understand, and perform the Hajj and Umrah rituals perfectly (Neidhardt & Wörndl, 2020). This condition demonstrates the need to develop better mobile apps for pilgrims to use during hajj and umrah. Indonesia, the UAE, and Saudi Arabia are participating in app development through their scholarly journals, as they see pilgrimage as part of the tourism niche, and Saudi Arabia is initiating this to expand its tourism niche. Indonesia also can be seen progressively developing their tourism market align with technology updates especially after the pandemic era via mobile apps such as social medias.

Figure 7 shows that the pattern of mobile consumption over the years has changed drastically, aligning with the evolution of telephone technology. The

first ten years of the patterns (1990-1999) show that past scholars discussed mobile computing extensively as cellphones became popular in the 90s and early 2000s (Moss, 2021), which many are still unfamiliar with and are getting used to computers. Within the next 10 years, scholars will shift their focus to mobile communication and mobile commerce. M-commerce history began in the early 2000s, when retailers offered mobile device add-ons such as ringtones, games, screen savers, and wallpapers. By 2009, the offers for mobile phones had evolved significantly. Specifically, most consumers who purchased goods through m-commerce channels in the United States: 58% purchased digital content such as music or apps, 51% consumer electronics, 37% computers, laptops, or related equipment, 36% on books, 31% on apparel, and even 20% on jewelry (Salih & Almutaa, 2023). Scholars have extensively discussed M-commerce until the end of 2020, when they shifted their focus back to mobile apps, location-based services such as Waze and Google Maps, augmented reality (AR), route planning, social media consumption, Bluetooth features, mobile learning technology, GPS, and mobility activities in tourism. Until now, mobile apps and location-based services have mostly been discussed in past journals, as they are heavily relied on by Muslim travellers during travel (Mastercard-CrescentRating, 2022).

Figure 6 shows the keyword co-occurrence network related to mobile consumption in the context of Muslim and Islamic travel. It emphasizes clusters around pilgrimage, hajj and umrah applications, shariah finance and banking, and location-based services, illustrating how mobile technologies are embedded in Muslim travel practices.

© 2026 by MIP

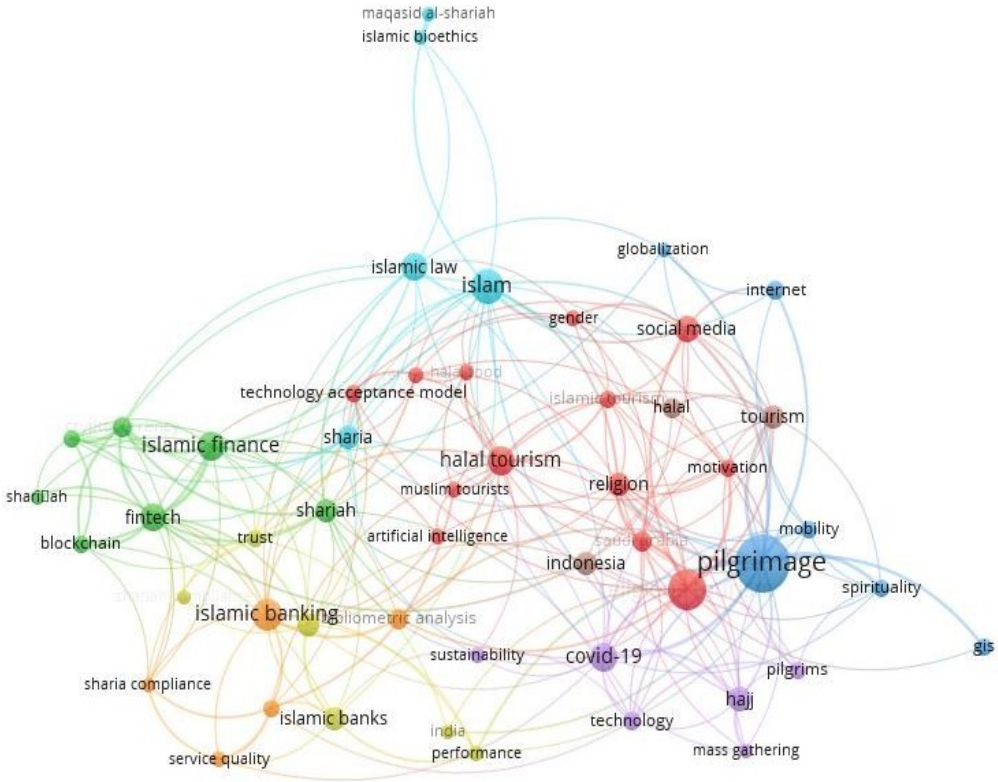


Figure 6: Bibliometric map of mobile consumption in Muslim travel.

Figure 7 depicts the changing focus of mobile-related research from 1990 to 2024, moving from mobile computing to mobile communication and m-commerce, and, more recently, to mobile apps, GPS, augmented reality, social media, and tourism mobility. It demonstrates how mobile services have become central to tourism behaviour, including among Muslim travellers.

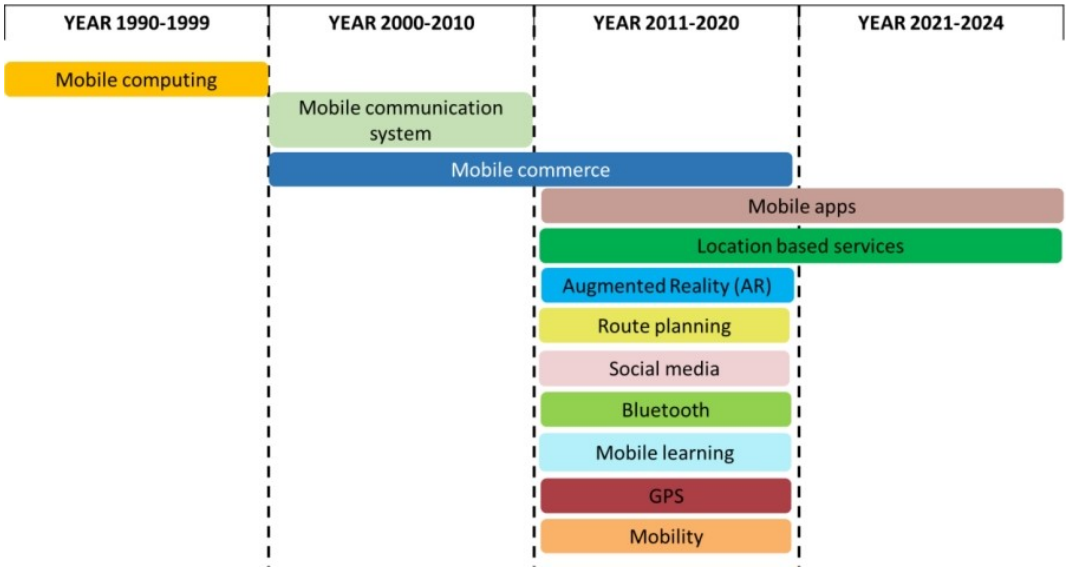


Figure 7: Temporal patterns of mobile consumption keywords.

Interrelation Between Fulfillment of Faith-Based Need and Psychological Experience in Mobile Consumption

Figure 8 integrates the three main keyword networks to show how Muslim faith-based needs, psychological experience, and mobile consumption converge within the broader field of halal, Islamic, and religious tourism. It reveals shared clusters and bridging terms that clarify how mobile services are increasingly used to satisfy faith-based needs and shape Muslim tourists' travel experiences.

© 2026 by MIP

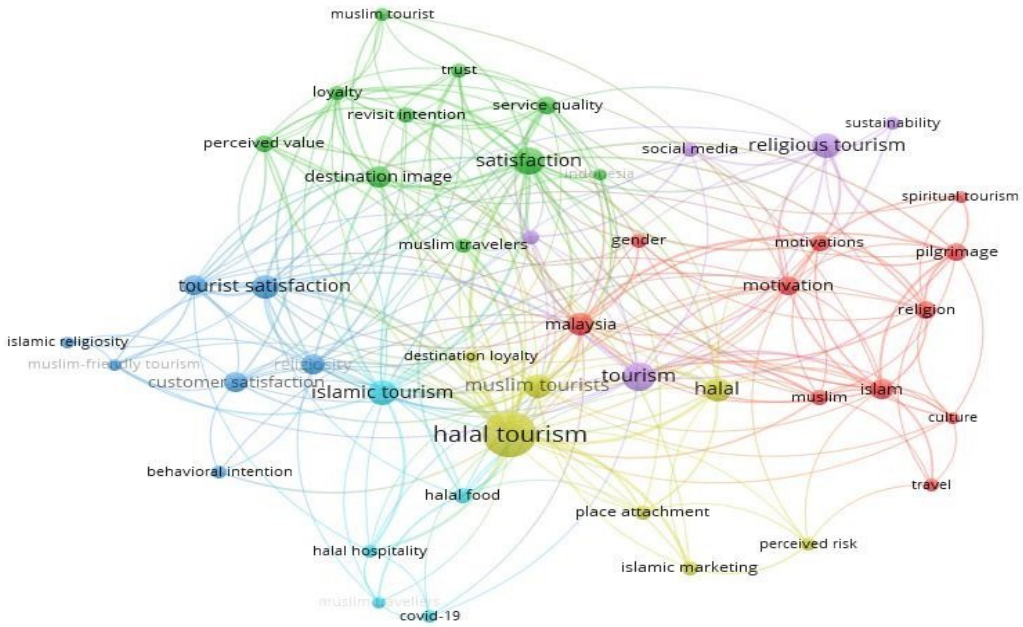


Figure 8: Integrated bibliometric map of Muslim faith-based needs, psychological experience, and mobile consumption.

Figure 8 shows that most of the related topics from Muslim faith-based needs, the psychology of Muslim tourists' experiences, and Muslim tourists' mobile consumption fall into the same field: Halal tourism, including Islamic and religious tourism. The Muslim tourism market is well-known for Halal tourism, which an showing increasing growth in terms of both the total number of Muslim arrivals worldwide and the total amount spent per trip. As is known, Muslim tourists are loyal to products and services tailored to fulfill their faith-based needs (Battour & Ismail, 2016). This information explains that scholars are discussing halal aspects, such as halal food and halal hospitality, as shown in the bibliometric map above. The Muslim population is predominantly younger than the global average (Pew Research Center, 2017). On average, 1 billion young people are well educated and demand products and services that comply with their religious beliefs (Licsandru & Cui, 2019). As per reported by (Mastercard & HalalTrip, 2017), young Muslim tourists concluded as major key to the Muslim tourism growth as they are more higher and active income and always prepare to spend on them, hyper-connected, actively with their high-tech experiences in seeking for information on Halal products, services and trips then influenced by opinions sourced from digital medias such as social medias where people nowadays

sharing their own opinions, and leave comments on past Halal related travel experiences they had before comparing to older Muslim tourists. This shows that they are very attached to and rely on new technologies (Kurnia et al., 2024), and they are simply comfortable using their smartphones for any purpose throughout the travel planning stages (Femenia-serra et al., 2018).

Young Muslim tourists prefer to download apps that guide them before performing their faith-based practices, such as prayer apps that provide adhan notifications, prayer times, qibla direction, Quran and hadith reading, and Halal-locate eateries and places of worship, especially when they are in Muslim-majority countries (Ichwan et al., 2024). This condition explains the relations of social media and Islamic marketing in the bibliometric map. Occasionally, these apps have made it easier for them to travel in comfort and have enabled them to access additional information from past Muslim tourists' comments in each app (Salih & Almutaa, 2023). Consuming mobile services, such as social media and marketing, affects travel behavior in terms of perceived value, satisfaction level, revisit intention, and destination loyalty, and this is strongly interconnected through social media, as shown in the bibliometric map above.

CONCLUSION

Rapid transformation in tourists' technological, social, and consumer behaviour in the tourism segment is proving to be a powerful factor in influencing authorities and the private tourism sector to adopt mobile services for Muslim tourists' consumption during travel. The aim is not only to enhance or facilitate their travel experience but also to obtain optimal economic advantages. Indeed, the contemporary Muslim needs during travelling set a new representative, in line with the new global era in which religious elements intersect with the mechanisms of social networking technologies in global capitalism.

However, establishing the individual motivations in fulfilling their Muslim faith-based needs through mobile consumption needs to be marked up in terms of effort from all involved stakeholders, from the scholars to give clear guides to the tourism authorities as policymakers, until the tourism business owners implement the actions needed. Mobile consumption among tourists is growing, and Muslim tourists should be included in using online services as much as other tourists do during their travel time. It is clear that a new era has emerged: very modern Muslim tourists. To conclude, this research has revealed that interconnection brings both advantages in terms of access to information and security, and Muslim faith-based needs determine Muslim tourists' travel behavior. This condition will influence their daily lives before and after returning from their trips, which may, in turn, affect their expectations for future trips.

© 2026 by MIP

ACKNOWLEDGEMENT

The authors would like to express their deepest gratitude to the Ministry of Higher Education Malaysia for providing financial support under the Fundamental Research Grant Scheme (FRGS) for the project ID (FRGS/1/2023/WAB01/UIAM/02/1). We sincerely appreciate this funding, which has significantly advanced our research. We are also grateful to the International Islamic University Malaysia (IIUM) for its continuous support and facilitation throughout this project. Special thanks to all team members, collaborators, and participants for their valuable contributions and commitment. This research would not have been possible without the dedication and efforts of everyone involved, and we look forward to the meaningful outcomes this work will yield**.**

ETHICAL STATEMENT

REFERENCES

Abdullah, S., Hussain, N. H. M., Hashim, I. C., & Hashim, H. (2024). Digitizing Tree Inventory Using GIS for Effective Landscape Monitoring in Puncak Iskandar, Perak, Malaysia. *Planning Malaysia*, *32*(3), 167–186. https://doi.org/https://doi.org/10.21837/pm.v22i34.1610

Baharuddin, M. N., Bahardin, N. F., Nawawi, A. H., Harun, S. N., & Hussaain, A. H. (2024). Digitalisation in Built Heritage Towards Promoting A Conservation Management Plan by National Heritage Act 2005: Assessing The Difficulties in Managing Data Information During Conservation Process of Heritage Building in Malaysia. *Planning Malaysia*, *22*(6), 30–44. https://doi.org/https://doi.org/10.21837/pm.v22i34.1611

Battour, M., Battor, M., & Bhatti, M. A. (2013). Islamic Attributes of Destination: Construct Development and Measurement Validation, and Their Impact on Tourist Satisfaction. *International Journal of Tourism Research*, *113*(November 2012), 101–113. https://doi.org/10.1002/jtr

Battour, M., & Ismail, M. N. (2016). Halal tourism: Concepts, practises, challenges and future. *Tourism Management Perspectives*, *19*, 150–154. https://doi.org/10.1016/j.tmp.2015.12.008

Brown, G. (2006). Tourism and Pilgrimage: Paying Homage to Literary Heroes. *International Journal of Tourism Research*, *113*(November 2012), 101–113. https://doi.org/10.1002/jtr

Chaney, D., Touzani, M., & Ben Slimane, K. (2017). Marketing to the (new) generations: summary and perspectives. *Journal of Strategic Marketing*, *25*(3), 179–189. https://doi.org/10.1080/0965254X.2017.1291173

Chen, C., & Song, M. (2019). Visualizing a field of research: A methodology of systematic scientometric reviews. *PLoS ONE*, *14*(10). https://doi.org/10.1371/journal.pone.0223994

Devi, A., & Firmansyah, I. (2019). Developing Halal Travel and Halal Tourism To

Promote Economic Growth: a Confirmatory Analysis. *Journal of Islamic Monetary Economics and Finance*, *5*(1), 193–214. https://doi.org/10.21098/jimf.v5i1.1054

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*(March), 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Fagence, M., & Kevan, S. (1998). Migration, Recreation and Tourism: Human Responses to Climate Differences. In *Human Bioclimatology* (pp. 133–160). https://doi.org/10.1007/978-3-642-80419-9_6

Faiza, K., & Michelle, C. (2017). The "Halalification" of tourism. *Journal of Islamic Marketing*, *8*(4), 558–577. https://doi.org/https://doi.org/10.1108/JIMA-01-2016-0001

Femenia-serra, F., Neuhofer, B., & Ivars-baidal, J. A. (2018). Towards a conceptualisation of smart tourists and their role within the smart destination scenario. *The Service Industries Journal*, *39*(2), 1–33. https://doi.org/https://doi.org/10.1080/02642069.2018.1508458 Towards

Gretzel, U., Fesenmaier, D. R., & O'Leary, J. T. (2024). *ConsumerBehavior_Gretzel_Fesenmaier_OLeary_Revised1b*.

Güzeller, C. O., & ÇeliKer, N. (2018). Bibliometric analysis of tourism research for the period 2007-2016. *Advances in Hospitality and Tourism Research*, *6*(1), 1–22. https://doi.org/10.30519/ahtr.446248

Ichwan, M. N., Amin, F., Khusairi, A., & Andrian, B. (2024). Digitalization and the shifting religious literature of Indonesian Muslims in the Era of Society 5.0. *Islamic Communication Journal*, *9*(2), 245–266. https://doi.org/10.21580/icj.2024.9.2.22515

Idamokoro, M. (2025). An Evaluation of Childhood Overweight Studies from South Africa: A Bibliometric Review from 2003-2023. *OnLine Journal of Biological Sciences*, *25*(2), 343–356. https://doi.org/10.3844/ojbsci.2025.343.356

Jaelani, A., Firdaus, S., Sukardi, D., Bakhri, S., & Muamar, A. (2021). Smart City and Halal Tourism during the Covid-19 Pandemic in Indonesia. *Revista Rosa Dos Ventos - Turismo e Hospitalidade*, *13*(4 covid 19), 1–29. https://doi.org/10.18226/21789061.v13i4p29

Kaufmann, V., Bergman, M. M., & Joye, D. (2004). Motility: Mobility as capital. *International Journal of Urban and Regional Research*, *28*(4), 745–756. https://doi.org/10.1111/j.0309-1317.2004.00549.x

Licsandru, T. C., & Cui, C. C. (2019). Ethnic marketing to the global millennial consumers: Challenges and opportunities. *Journal of Business Research*, *103*(February), 261–274. https://doi.org/10.1016/j.jbusres.2019.01.052

Mastercard-Crescent Rating. (2019). *Muslim Women in Travel 2019*. https://www.crescentrating.com/reports/muslim-women-in-travel-2019.html

Mastercard-CrescentRating. (2022). *Global Muslim Travel Index 2022 (GMTI 2022)*. https://www.crescentrating.com/reports/global-muslim-travel-index-2025.html

Mastercard & HalalTrip. (2017). *Muslim Millennial Travel Report 2017 (MMTR2017)*. https://www.halaltrip.com/muslim-millennial-travel-report/

Merigó, J. M., Mulet-Forteza, C., Martorell, O., & Merigó-Lindahl, C. (2020). Scientific

 © 2026 by MIP

research in the tourism, leisure and hospitality field: a bibliometric analysis. *Anatolia*, *31*(3), 494–508. https://doi.org/10.1080/13032917.2020.1771602

Neidhardt, J., & Wörndl, W. (2020, January 1). Workshop on Recommenders in Tourism (RecTour). *Information and Communication Technologies in Tourism 2020*. https://doi.org/10.1007/978-3-030-36737-4

Nurhayati, N., Nanang, H., Faujiah, S., & Busman, B. (2020). Mobile Application Tutorial Hajj and Umroh on Android Smartphone. *Proceedings of the 2nd International Conference on E-Learning and E-Technologies in Education.* https://doi.org/10.4108/eai.2-10-2018.2295290

Pew Research Center. (2017). *The changing global religious landscape.* https://www.pewresearch.org/religion/2017/04/05/the-changing-global-religious-landscape/

Preko, A., Mohammed, I., & Ameyibor, L. E. K. (2020). Muslim tourist religiosity, perceived values, satisfaction, and loyalty. *Tourism Review International*, *24*(2–3), 109–125. https://doi.org/10.3727/154427220X15845838896341

Priyatmoko, R., & Maulana, A. (2022). Halal Tourism And Its Misconceptions: A Study on The Rejection of Indonesian Non-Muslim Destinations. *Dinar: Jurnal Ekonomi Dan Keuangan Islam*, *9*(1), 74–87. https://doi.org/10.21107/dinar.v9i1.13976

Riaño, Y., Mittmasser, C., & Sandoz, L. (2022). Spatial Mobility Capital: A Valuable Resource for the Social Mobility of Border-Crossing Migrant Entrepreneurs? *Societies*, *12*(3). https://doi.org/10.3390/soc12030077

Salih, A., & Almutaa, A. (2023). *Mobile E-commerce : The Growing Influence of Smartphones on Online Shopping*. *2023*(1), 146–154.

Tiago, M., & Studies, M. (2013). The influence of teenagers on a family's vacation choices. *Tourism & Management Studies*, *9*(1), 28–34.

Uula, M. M. (2025). A Note on Halal Sustainable Tourism. *Halal Tourism and Pilgrimage*, *4*(2). https://doi.org/10.58968/htp.v4i2.615

Viana-Lora, A., & Nel-lo-Andreu, M. G. (2022). Bibliometric analysis of trends in COVID-19 and tourism. *Humanities and Social Sciences Communications*, *9*(1), 1–8. https://doi.org/10.1057/s41599-022-01194-5

Vishwakarma, P., & Mukherjee, S. (2019). Forty-three years journey of Tourism Recreation Research: a bibliometric analysis. *Tourism Recreation Research*, *44*(4), 403–418. https://doi.org/10.1080/02508281.2019.1608066

Yuen, Y. Y., Yeow, P. H. P., & Lim, N. (2015). Internet banking acceptance in the United States and Malaysia: a cross-cultural examination. *Marketing Intelligence & Planning*, *33*(3), 292–308. https://doi.org/10.1108/MIP-08-2013-0126

Received: 14th February 2025. Accepted: 8th August 2025

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 691 – 704

EVALUATING AND ENHANCING SUSTAINABLE LIVELIHOODS AMONG URBAN POOR COMMUNITIES IN KUALA LUMPUR

Mohd Khairi Ismail[1,2], Muhammad Nooraiman Zailani[3], Suhaiza Hanim Mohd Zailani[2], Muhammad Faizuddin Ahmad Fadullah[1] & Nurul Ashikin Alias[2]

[1] *Faculty of Business and Management,*
UNIVERSITI TEKNOLOGI MARA CAWANGAN TERENGGANU
[2] *Ungku Aziz Centre for Development Studies,*
UNIVERSITI MALAYA
[3] *Faculty of Business and Economics,*
UNIVERSITI MALAYA

Abstract

The sustainable livelihoods of urban poor groups in Kuala Lumpur have emerged as a critical emphasis due to the ongoing challenge of urban poverty faced by cities worldwide. Accelerated urbanization has exacerbated the socioeconomic divide, resulting in numerous urban poor individuals grappling with challenges related to housing, work, and access to essential services. To tackle these difficulties, sustainable strategies, such as community-driven initiatives and partnerships with local authorities, are essential for empowering citizens and equipping them to endure economic disruptions. This study assesses and improves the sustainable livelihoods of poor urban neighbourhoods in Kuala Lumpur. The study, grounded in the Sustainable Livelihood Framework (SLF), involved a survey of 394 participants, with data gathered via questionnaires and analysed using SPSS version 25 and Microsoft Excel. The results demonstrate that governmental actions substantially contribute to improving the sustainable livelihoods of urban residents in Kuala Lumpur. Mean analysis indicates that poor areas in Kuala Lumpur exhibit high well-being solely in the environmental factor.

Keywords: Sustainable livelihoods; urban; poor; communities; Kuala Lumpur

[3] Corresponding author. Email: aiman@um.edu.my

INTRODUCTION

Urban poverty remains a significant challenge for cities worldwide, including Kuala Lumpur. Recent urbanization has widened the socioeconomic divide, with many urban poor facing difficulties in housing, employment, and access to essential services (Kamal et al., 2020; Hassan et al., 2021). Achieving sustainable and resilient living for these communities requires addressing immediate needs such as food, shelter, and healthcare while also establishing pathways for long-term stability and self-sufficiency through inclusive policies and community-based initiatives (Shah et al., 2023; United Nations, 2019).Community-driven initiatives and collaborations with local authorities are essential for empowering communities and enhancing their ability to adapt to economic shocks and disruptions, which have become increasingly common due to global crises and climate change (World Bank, 2020). Resilience is crucial, as it enables communities to recover and thrive despite challenges. Research indicates that urban poor populations with access to education, skill development, and support networks are better equipped to overcome economic hardships and improve their quality of life over time (Mokhtar & Rahman, 2022).Efforts to promote sustainable and resilient living for Kuala Lumpur's urban poor must adopt a comprehensive strategy encompassing financial aid, skill development, healthcare, and housing assistance to achieve lasting transformation and improved welfare (UN-Habitat, 2020). This introduction establishes the framework for examining effective methods and policies aimed at fostering sustainable and resilient urban living for low-income residents of Kuala Lumpur.

Furthermore, current research highlights a lack of empirical studies on the sustainable and resilient living conditions of urban poor communities in Kuala Lumpur. While extensive studies have examined global urban poverty and resilience, research specifically addressing sustainable and resilient living among Kuala Lumpur's urban poor remains limited. Existing studies often focus on broader issues such as urban poverty, housing affordability, and access to basic needs but lack empirical investigations into holistic frameworks tailored to Kuala Lumpur's unique socio-economic context (Zainal et al., 2019; Ariffin & Yusof, 2021). This gap limits our understanding of how these communities navigate economic and environmental challenges and the potential impact of government interventions in strengthening their resilience. This study aims to assess and enhance the sustainable livelihoods of poor urban neighbourhoods in Kuala Lumpur.

© 2026 by MIP

LITERATURE REVIEW

Concept of Sustainable Livelihood Framework (SLF)

The notion of Sustainable Livelihood is an effort to extend beyond the conventional view and strategies for poverty elimination. From this perspective, emphasize given to several areas of human well-being that could hamper their life progress in a sustainable manner. Historically, the concept of sustainable livelihood was established by the Brundtland Commission on Environment and Development as a medium to form an interconnection between socioeconomic and ecological aspect of human well-being. In 1992, the United Nations Conference on Environment and Development (UNCED) has broaden the idea, primarily in the context of Agenda 21 and uphold the achievement of sustainable livelihood as an ultimate means of poverty eradication.

Karki (2021) highlighted that the term livelihood refers to activities, resources and entitlements a person acquires to make a living. The ability to earn a livelihood is a critical factor of a person's role and existence within society, as it encompasses the means through which people fulfil their basic needs and achieve economic security. Individuals earn their livelihoods from a mix of both movable and immovable resources, drawing on a wide range of assets and activities that help them sustain their daily lives and meet their needs. Chambers and Conway (1992) define livelihood as the combination of people's capabilities, resources, and the activities they engage in to secure their means of living and pursue their goals and aspirations. These resources include a broad spectrum of assets, including social, human, natural, and financial capital, all of which play a critical role in shaping individuals' ability to achieve sustainable well-being.

The Sustainable Livelihoods Approach (SLA) has emerged as a vital framework within contemporary development policy aimed at mitigating poverty and reducing vulnerability among rural households (Stirrat, 2004). By analysing the interplay between livelihood strategies and livelihood capitals, the SLA applies the capital and capabilities framework (Chambers and Conway, 1992; Bebbington, 1999) to identify strategies to alleviate poverty and enhancing sustainable livelihoods. The evolution of sustainable livelihoods from SLA approach to an established framework, Sustainable Livelihood Framework (SLF) was evidenced by the publication of a seminal IDS working paper authored by Ian Scoones in 1998. Later, the Department for International Development (DFID) advanced this progression by simplifying some of the complexities of Scoones' original diagram, transforming his framework into a more practical methodology (Carney, 1999). The SLF integrate five aspects that influence people's livelihoods including livelihood assets, vulnerability context, transforming structures and processes, livelihood strategies and livelihood outcomes. The central feature of DFID framework emphasizes the concept of capital assets and examine how these are affected by any vulnerable events. At

© 2026 by MIP

the core of the framework is the assets that households use to sustain their livelihoods. These assets are formed by the vulnerability context, which include the various sources of insecurity that could affect both individuals and their resources. The access to and effective utilization of these assets are further conditioned by the role of government policies, institutional structures, and the dynamics of relationships between individuals, organizations, and governing authorities.

While the SLF was initially developed to understand rural poverty, it has increasingly been applied in urban poverty contexts, particularly in rapidly urbanising developing economies. Urban poverty is characterised by distinct vulnerabilities such as unstable employment, high living costs, overcrowded housing, and environmental risks associated with urban infrastructure (Rakodi, 2002). As a result, implementing the SLF in urban environments need modification to address urban-specific difficulties and institutional dynamics.

In the Malaysian context, several studies have utilised the SLF to examine livelihood conditions among vulnerable communities. For instance, Ibrahim et al (2018) confirm that physical asset, natural asset and social asset are significantly related to the achievement of sustainable livelihoods in Kedah and Kelantan. Meanwhile, Kunjuraman (2022) also applied the SLF framework to analyse livelihood impacts of community-based ecotourism in Sabah. Given the complexity of urban poverty in Kuala Lumpur, the SLF provides a comprehensive framework to capture the interaction between vulnerability factors, livelihood assets, institutional structures, and livelihood outcomes among urban poor households.

Conceptual Framework

Figure 1 depicts the modified conceptual framework of the study, based on the Department for International Development (DFID) (1999). The conceptual framework comprises five primary components: vulnerability setting, assets, structures and processes, tactics, and livelihood outcomes. Vulnerability has three dimensions: economic, social, and physical, as well as environmental. Economic hazards encompass the loss of money sources or work opportunities. Social and physical risks pertain to the physical state of the residence, including insufficient furnishings and inadequate basic amenities. Environmental concerns encompass water contamination, industrial emissions, and flooding. Institutional aspects denote entities that guarantee the execution of legislation and policies, deliver services, facilitate exchanges, and perform specific duties that impact individuals or families. These institutions dictate and shape the interactions of individuals or households. The institutional setting influences the vulnerability experienced by individuals and their access to life assets. This study has discovered multiple organizations directly associated with the respondents, indicating that agencies

tied to rural communities are either engaged in assisting or providing services to urban communities and the poor.

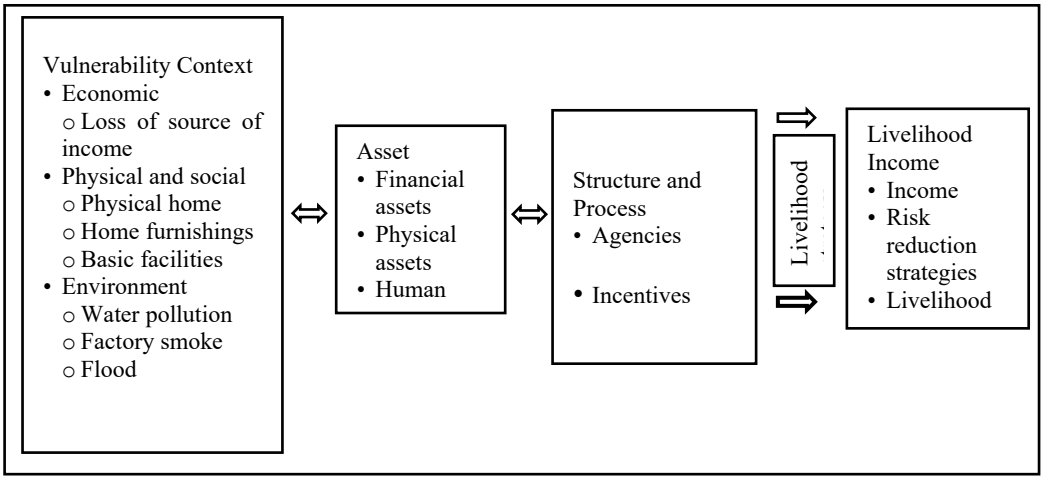


Figure 1. Conceptual Framework of the Study: Sustainable Livelihood Framework of the urban poor communities in Kuala Lumpur

In this study, livelihood strategy denotes the economic activities undertaken by individuals, encompassing both primary and secondary employment. Livelihood income influences household welfare and long-term growth potential. This study identifies three criteria as components of livelihood outcomes: income, well-being, and the mitigation of vulnerability experienced by individuals, pertaining to the method of vulnerability reduction.

RESEARCH METHODOLOGY

This study adopts a quantitative research design to examine sustainable livelihood conditions among urban poor communities in Kuala Lumpur. The study focuses on households living in identified low-income neighbourhoods within Kuala Lumpur, which represent areas with a higher concentration of urban poverty. To identify suitable respondents, the study employs a purposive sampling technique. Purposive sampling enables the deliberate selection of participants who possess relevant characteristics and experiences related to the phenomenon under investigation, particularly individuals residing in urban poor communities (Patton, 2015). This approach is appropriate for studies that aim to obtain insights from specific populations that are directly affected by the research issue, in this case households experiencing socioeconomic vulnerability in urban settings.

Respondents were selected from urban poor neighbourhoods identified through secondary information from relevant government agencies and

© 2026 by MIP

community records. The sampling focused on households classified as low-income or vulnerable according to local socioeconomic indicators. To reduce potential selection bias, respondents were approached across multiple neighbourhood locations and demographic groups within the targeted communities. Although purposive sampling was used to identify eligible respondents, the sample size was determined based on population size to ensure sufficient statistical power. According to data from the Department of Statistics Malaysia (DOSM), approximately 18,445 households in Kuala Lumpur are classified as experiencing deep poverty. Based on the Krejcie and Morgan (1970) sample size determination table, a minimum sample of 377 respondents is required for populations exceeding 15,000. To enhance reliability and reduce sampling error, this study collected data from 394 respondents, exceeding the minimum required sample size.

Data for this study were collected using a structured questionnaire consisting of both closed-ended and open-ended questions. A five-point Likert scale was used to measure respondents' perceptions regarding livelihood conditions, vulnerability factors, and asset ownership. For data analysis, this study utilised several statistical tools. Descriptive and statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) Version 25. In addition, two indices were constructed to assess livelihood conditions: the Vulnerability Index and the Asset Ownership Index. These indices were used to evaluate the level of vulnerability and access to livelihood assets among urban poor households in Kuala Lumpur, thereby revealing more about their sustainable and resilient living conditions.

Vulnerability Index

This study's Vulnerability Index is a composite index methodology introduced by Hahn (2009). The Vulnerability Index for the study encompasses three categories of vulnerability: economic, social, and physical, as well as environmental. The inquiries for each indicator are structured as a dichotomy, represented by 1 (facing/ever facing) and 0 (not facing). This indicator for vulnerability categories is selected based on the Sustainable Livelihood Framework (SLF) by DFID (1999), tailored to the context of this study. All vulnerability indicators are standardized (composite) for the creation of this index. The construction of the Vulnerability Index employs a uniform weighting value for each category of vulnerability and its corresponding indication. This weighting factor is derived from Sullivan et al. (2002), wherein each indication contributes equally to each category of vulnerability. According to Hahn (2009), index calculation should employ a comprehensible procedure, with the application of uniform weights being one of the suggested approaches. Nonetheless, it may be modified by the researcher to align with the study's

requirements. This study used nominal data represented as 1 (facing/ever facing) and 0 (not facing). The nominal data for each indicator will be computed as a % and transformed into an index value utilizing the 92-conversion process employed in the Human Development Index, which takes into account three principal values: the actual data value, the minimum value, and the maximum value.

Asset Ownership Index

The Asset Ownership Index utilized in this study is a composite index methodology introduced by Han (2009). This study's Asset Ownership Index comprises five categories of assets: financial, physical, human, social, and natural assets. Twenty indicators represent these five assets. The selection of indicators for these assets is grounded in the Sustainable Livelihood Framework (SLF) by DFID (1999), tailored to the context of this study. Only standardized asset indicators are utilized in the computation of the asset ownership index. Asset indicators that cannot be standardized for calculation will be addressed descriptively only. The computation of the Asset Ownership Index employs an identical weighting value for each asset and its corresponding indication. This weighting factor is derived from Sullivan et al. (2002), wherein each indication contributes equally to each asset category. According to Hahn (2009), constructing the Asset Ownership Index should employ a comprehensible procedure, with the application of uniform weights being one of the recommended approaches. Nonetheless, it may be modified by the researcher to align with the study's requirements.

Due to the varying measurement scales of each asset indicator, researchers may opt to utilize the original scale or select items with a consistent measurement. This study exclusively considers uniform asset indicators in the construction of the asset ownership index. This study used nominal data represented as 1 (presence) and 0 (absence). The nominal data for each indicator will be computed as a percentage and transformed into an index value utilizing the conversion method employed in the Human Development Index, which takes into account three primary values: the actual data value, the minimum value, and the maximum value (UNDP 2007; Hahn 2009).

EMPIRICAL ANALYSIS OF SUSTAINABLE LIVELIHOODS OF URBAN POOR COMMUNITIES IN KUALA LUMPUR

Table 1 presents the vulnerability index across three dimensions, namely economic, social, physical and environmental, for urban poor communities in Kuala Lumpur between 2018 and 2022. The results reveal notable changes in the magnitude and nature of vulnerabilities experienced by households during this

© 2026 by MIP

period. Economic vulnerability represents the predominant factor influencing households. The index value for economic vulnerability declined from 0.852 in 2018 to 0.600 in 2022, signifying an improvement in household economic stability. The indicator for loss of primary income source or employment demonstrates a significant rise in vulnerability, escalating from 0.07 in 2018 to 0.600 in 2022. The pronounced increase indicates that urban poor households had considerable employment volatility during this timeframe, probably mirroring extensive economic disturbances, including labour market shocks and the economic ramifications of the COVID-19 pandemic. Social and physical vulnerabilities show a noticeable decline over time. The overall index value for this dimension decreased from 0.320 in 2018 to 0.187 in 2022, suggesting improvements in housing conditions and basic household facilities. Specifically, the vulnerability associated with the physical condition of housing (cramped or poor housing conditions) declined from 0.42 to 0.200, while lack of home furnishings decreased from 0.322 to 0.133. Similarly, the vulnerability related to lack of basic facilities such as prayer spaces, kindergartens, or local shops fell from 0.063 to 0.044. These improvements may reflect ongoing urban development initiatives, housing assistance programmes, and infrastructure upgrades implemented by local authorities and social support agencies in Kuala Lumpur.

Nonetheless, environmental vulnerability appears to have intensified. In particular, the environmental vulnerability index increased from 0.250 in 2018 to 0.352 in 2022, indicating growing environmental risks faced by urban poor communities. For example, the indicator for polluted rivers or contaminated water sources went up from 0.038 to 0.089, and the number of floods that damaged crops and property went up from 0.012 to 0.044. In addition, exposure to factory smoke remains consistently high, increasing slightly from 0.893 to 0.933, suggesting persistent environmental pollution in areas where vulnerable communities reside. These findings indicate that despite improvements in social and housing conditions, environmental hazards continue to cause serious harm to the well-being of urban poor households.

Table 1. Vulnerability Index of urban poor communities in Kuala Lumpur

Construct	**The value of the index according to the indicator**		**Type of Vulnerability**	**The value of the index is according to the type of vulnerability**	
	2018	**2022**		**2018**	**2022**
Loss of main source of income/job	0.07	0.600	Economic	0.852	0.600
Physical condition of the house (cramped/bad house)	0.42	0.200	Social and Physical	0.320	0.187
Lack of home furnishings	0.322	0.133			

Construct	The value of the index according to the indicator		Type of Vulnerability	The value of the index is according to the type of vulnerability	
Lack of basic facilities (prayer, kindergarten, shop lot)	0.063	0.044			
There is a polluted river/source of water	0.038	0.089	Environment	0.250	0.352
Floods that damage crops and property	0.013	0.044			
Factory smoke	0.893	0.933			

Source: Field Study (2022)

Table 2 presents the Asset Ownership Index of poor communities in Kuala Lumpur across five livelihood asset categories including human, physical, social, natural, and financial assets for the years 2018 and 2022. Overall, the aggregate asset ownership index slightly declined from 0.620 in 2018 to 0.590 in 2022, suggesting that although certain asset categories improved, the overall asset base of urban poor households did not strengthen substantially during the period.

First, human assets demonstrate a notable improvement over time. The index value increased from 0.536 in 2018 to 0.606 in 2022, reflecting an enhancement in human capital among urban poor households. In particular, the indicator for respondents' highest education level increased substantially from 0.145 to 0.334, suggesting improvements in educational attainment. Similarly, knowledge of how to obtain assistance rose from 0.213 to 0.378, indicating increased awareness of available support services and institutional mechanisms. In addition, work experience improved from 0.219 to 0.267, while health conditions increased from 0.654 to 0.778. Similarly, physical assets also recorded an improvement during the period under study. The index value increased from 0.478 in 2018 to 0.543 in 2022, indicating better access to basic infrastructure and household facilities. For instance, access to water sources improved from 0.462 to 0.532, while toilet facilities increased from 0.532 to 0.632, reflecting improved sanitation conditions. Furthermore, home conditions improved significantly from 0.169 to 0.321, suggesting improvements in housing quality among low-income households. In addition, vehicle ownership increased from 0.413 to 0.600, potentially enhancing mobility and access to employment opportunities. However, despite these improvements, home ownership declined sharply from 0.354 to 0.121, highlighting the growing challenges of housing affordability in urban areas and the increasing reliance on rented accommodation among the urban poor.

Furthermore, natural assets also declined during the study period. The index decreased from 0.547 in 2018 to 0.466 in 2022, largely due to a reduction in land ownership from 0.242 to 0.144. This trend reflects the limited access to

© 2026 by MIP

land resources among urban poor households, which is commonly observed in rapidly urbanising environments where land availability is scarce and property prices are rising. Meanwhile, financial assets recorded a modest improvement. The financial asset index increased from 0.389 in 2018 to 0.430 in 2022, suggesting some improvement in financial capacity among urban poor households. In particular, household income increased from 0.564 to 0.666, indicating improved income-generating capacity. Moreover, acceptance of financial aid increased slightly from 0.762 to 0.800, highlighting the continued role of government assistance programmes and social protection mechanisms in supporting vulnerable households. Access to loans increased from 0.132 to 0.144, while savings improved from 0.087 to 0.111, although the latter remains relatively low. This suggests that while households may have better access to financial support, their ability to accumulate savings and build long-term financial resilience remains limited.

Table 2. Asset Ownership Index of poor communities in Kuala Lumpur

Asset component	**Index value according to indicator**		**Asset type**	**The value of the index depends on the type of asset**	
	2018	**2022**		**2018**	**2022**
Respondent's highest education	0.145	0.334	Human assets	0.536	0.606
Current work experience	0.219	0.267			
Health	0.654	0.778			
Knowledge get help	0.213	0.378			
Water source	0.462	0.532	Physical assets	0.478	0.543
Toilet	0.532	0.632			
Home conditions	0.169	0.321			
Home ownership	0.354	0.121			
Vehicle ownership	0.413	0.600			
Association position	0.312	0.289	Social assets	0.327	0.242
Parent-Teacher Associations (PTA)	0.421	0.411			
Society	0.692	0.600			
Cooperative	0.031	0.00			
Land ownership	0.242	0.144	Natural assets	0.547	0.466
Income	0.564	0.666	Financial assets	0.389	0.430
Acceptance of financial aid	0.762	0.800			
Loan	0.132	0.144			
Savings	0.087	0.111			
Overall				0.620	0.590

Source: Field Study (2022)

STRATEGIES FOR ENHANCING SUSTAINABLE LIVELIHOODS IN KUALA LUMPUR'S URBAN POOR COMMUNITIES

The findings of this study provide important implications for urban planning and poverty alleviation strategies in Kuala Lumpur. Using the SLF, the analysis reveals that while human, physical, and financial assets have shown moderate improvement, economic vulnerability remains high and both social and natural assets have declined. These patterns suggest that improving sustainable livelihoods among the urban poor requires integrated and targeted planning interventions that address multiple livelihood dimensions simultaneously. First, the results indicate a pressing need to strengthen economic resilience and employment stability among urban poor households. The vulnerability index shows a significant increase in the indicator related to the loss of the main source of income, indicating that many households remain highly exposed to economic shocks and unstable employment conditions. Addressing this issue requires coordinated policy efforts aimed at improving income-generating opportunities within low-income communities. In particular, employment and skills development programmes should be expanded through initiatives led by the Ministry of Human Resources and the Ministry of Economy, in collaboration with Kuala Lumpur City Hall (DBKL). These agencies can facilitate vocational training programmes, job placement initiatives, and entrepreneurship support schemes targeted specifically at residents of urban poor neighbourhoods. In addition, integrating small-scale business zones and local enterprise spaces within urban development plans can enable residents to participate more actively in the local economy by providing them with accessible resources, training opportunities, and support networks that foster entrepreneurship and job creation.

Next, the findings indicate persistent challenges related to housing affordability and physical infrastructure, particularly reflected in the sharp decline in home ownership among urban poor households. This trend highlights the increasing difficulty faced by low-income households in accessing stable and affordable housing within rapidly urbanising environments. Consequently, expanding affordable housing supply should remain a key priority in urban planning policies. This can be addressed through programmes implemented by the Ministry of Housing and Local Government (KPKT), the National Housing Department, and DBKL, particularly through the expansion of low-cost housing and rental housing schemes such as the People’s Housing Programme (PPR). At the same time, improvements in basic urban infrastructure, including reliable access to water supply, sanitation, public transportation, and healthcare services should be prioritised. Infrastructure development efforts coordinated by DBKL, the Ministry of Transport, and the Ministry of Health can significantly enhance access to essential services and improve overall living conditions for urban poor communities.

© 2026 by MIP

In addition, the study also identifies a decline in social assets, particularly in terms of participation in associations, cooperatives, and community organisations. Social capital plays a crucial role in enhancing community resilience by facilitating access to informal support networks, information sharing, and collective action. Therefore, strengthening social capital should form an integral component of urban development strategies. Local authorities such as DBKL, together with community-based organisations (CBOs) and non-governmental organisations (NGOs), should promote participatory community development initiatives. These may include the establishment of neighbourhood associations, cooperative programmes, and community engagement platforms that encourage active participation of residents in local planning processes. Such initiatives can strengthen community cohesion while enabling residents to collectively address shared socioeconomic challenges. Furthermore, the study reveals increasing environmental vulnerability, particularly related to pollution exposure and flood risks. These findings suggest that environmental risk management must be more effectively integrated into urban planning policies for low-income neighbourhoods. The incorporation of green infrastructure and urban green spaces can help mitigate environmental risks while enhancing residents' physical and psychological well-being.

SUMMARY

This study enhances existing knowledge on sustainable and resilient living among urban poor populations. The results of this study demonstrate the value of adopting a multidimensional and coordinated approach to urban poverty reduction. While economic interventions are necessary to stabilise household income, improvements in housing, infrastructure, social capital, and environmental resilience are equally important for sustaining long-term livelihood security. Therefore, effective policy responses require collaboration among multiple government agencies, local authorities, and community organisations, ensuring that planning strategies are aligned with the actual needs and vulnerabilities identified in this study.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Faculty of Business and Economics, Universiti Malaya, for providing partial funding support for this publication.

REFERENCES

Bebbington, A. (1999). Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. *World development*, *27*(12), 2021-2044.

Bennett, J. (2010). Vibrant matter: A political ecology of things. In *Vibrant Matter*. Duke University Press.

Carney, D. (1999). *Approaches to sustainable livelihoods for the rural poor* (p. 32). London: Overseas Development Institute.

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: practical concepts for the 21st century.* Brighton: Institute of Development Studies. http://opendocs.ids.ac.uk/opendocs/handle/123456789/775.

Dercon, S. (2002). *The Impact of Economic Reforms on Rural Households in Ethiopia: a study from 1989 to 1995*. World Bank Publications.

DFID. (1999). *Sustainable livelihoods guidance sheets*. London: Department for International Development.

Hahn, M. B., Riederer, A. M., & Foster, S. O. (2009). The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change. A case study in Mozambique. *Global Environmental Change 19*(1): 74-88.

Hardoy Jorge, E. and S. David, (1986). A survey of empirical material on the factors affecting the development of small and intermediate urban centres. Dlm. *Small and Intermediate Urban Centres*, Jorge E. Hardoy and David Satterthwaite (pynt.). hlm 279–328. Boulder: Westwiew Press.

Hassan, N., et al. (2021). *Challenges and Opportunities of Urban Poor in Kuala Lumpur*. Journal of Urban Studies.

Ibrahim, A. Z., Hassan, K. H., Kamaruddin, R., & Anuar, A. R. (2018). The level of livelihood assets ownership among vulnerability group in East Coast of Malaysia. *European Journal of Sustainable Development*, *7*(3), 157-157.

Kamal, E. M., Lai, K. S., & Yusof, N. A. (2020). The low-middle income housing challenges in Malaysia. *Planning Malaysia*, *18*(1), 102-117.

Karki, S. (2021). Sustainable livelihood framework: monitoring and evaluation. *International Journal of Social Sciences and Management*, *8*(1), 266-271.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement 30*(3): 607-610.

Kunjuraman, V. (2023). A revised sustainable livelihood framework for community-based tourism projects in developing countries. Current Issues in Tourism, 26(4), 540-546.

Mokhtar, R., & Rahman, A. (2022). *Community Resilience and Sustainable Development in Urban Malaysia*. Malaysian Journal of Development Studies.

Patton, M. Q. (2015). *Qualitative Research and Evaluation Methods*. Thousand Oaks, CA: Sage Publications.

Scoones, I. (1998). *Sustainable rural livelihoods: A framework for analysis* (IDS Working Paper No. 72). Institute of Development Studies

Shah, J. M., Hussin, R., & Idris, A. (2023). Poverty Eradication Project In Sabah, Malaysia: New Initiative, New Challenges? *Planning Malaysia*, *21*(6),477-492.

Sohaimi, N. S., Abdullah, A., & Shuid, S. (2018). Determining housing affordability for young professionals in Klang Valley, Malaysia: Residual income approach. *Planning Malaysia*, *16(2),*89-98.

Stirrat, R. L. (2004). Yet another 'magic bullet': the case of social capital. *Aquatic Resources, Culture and Development*, *1*(1), 25-33.

© 2026 by MIP

Sullivan, C. (2002). Calculating a water poverty index. *World development*, *30*(7), 1195-1210.

UN-Habitat. (2020). *Supporting Sustainable and Resilient Urban Growth*. UN-Habitat.

United Nations. (2019). *Sustainable Cities and Communities: The Role of Urban Planning in Poverty Alleviation*. UN Publications.

World Bank. (2020). *Building Resilience in Urban Communities: A Global Report on Cities and Poverty*. World Bank.

Received: 5th May 2025. Accepted: 3rd July 2025

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 705 – 724

COASTAL ENGINEERING USING *RHIZOPHORA SP.* MANGROVE NATURAL STRUCTURE FOR WAVE DAMPING

Ahmad Herison[1], Yuda Romdania[1], Masdar Helmi[1], Laksmi Irianti[1], Arif Mahasin Sondani[2], M. Fariq Khadafi[3], M. Fatih Naban[3]

[1]*Civil Engineering Major, Faculty of Engineering,*
[3]*Student of Department of Civil Engineering, Faculty of Engineering,*
UNIVERSITY OF LAMPUNG
[2]*Accounting Major,*
POLYTECHNIC STATE OF SRIWIJAYA

Abstract

The purpose of the study is to analyze the value of wave damping by the thickness, density, and resilience of the supporting roots of Rhizophora sp. mangrove as a wave damper. The method used in the study is the transect-squared method and laboratory tests. Wave measurements were done using SBE 26 during the highest waves. The value of ΔE (%) at Dewi Mandapa Beach rised from 10.74% to 92.79% at a thickness of 5 meters to 50 meters, while at Tanjung Putus Beach rised from 26.23% to 92.41% at a thickness of 5 meters to 30 meters. It is stated that the relationship between them is directly proportional. The root resilience value decreased from 3.1331 (J/m2) to 2.4059 (J/m2), while the energy damping value increased from 3.7578E-04 (J/m2) to 5.5943E-04 (J/m2) at a thickness of 5 meters to 30 meters. It is stated that the relationship of root resilience with wave energy attenuation is inversely proportional. It is concluded that high-density Rhizophora sp. mangroves have substantial wave damping ability as a result of the bounciness of the supporting roots.

Keywords: Tanjung Putus Beach, Dewi Mandapa Beach, thickness, density, abrasion barrier

[1] Corresponding author. Email: ahmad.herison@eng.unila.ac.id

INTRODUCTION

Mangrove forest is an individual or community type of biome in the intertidal zone that naturally functions as a wave damper and abrasion barrier (Wang, Jia, & Tian, 2019; Friess et al., 2019; Krauss and Osland, 2020). There are various types of mangroves such as *Soneratia* mangrove, *Avicennia marina* mangrove, *Rhizophora* mangrove, *Bruguiera* mangrove, *Nypa* mangrove and others (Srikanth, Lum, and Chen, 2016; Srivastava and Prasad, 2019; Herison et al., 2024b). that have an important role in the coastal ecosystem. Factors such as mangrove trees, roots, litter, sediment and others contribute to wave damping (Herison et al., 2023; Woodroffe et al., 2016; Herison, 2024a). *Rhizophora sp.* mangrove with large and dense supporting roots are useful in breaking waves (Mantiquila, 2021; Sreelekshmi et al., 2018; Herison et al., 2023) while the litter part contributes to filtering water and reducing some of the wave energy, then the presence of sediments around the mangrove also plays a role in absorbing and reducing the strength of waves.

Large waves gradually erode the coastline causing damage to infrastructure and settlements (Bagindo et al., 2023). Uncontrolled wave energy will pose a threat along coastal areas (Rimba et al., 2023; Hamid et al., 2021). Mangroves have an important role to play in mitigating such issues by acting as natural wave damper. Its dense root system stabilizes the shoreline and reduces abrasion (Stachew, Houette, and Gruber, 2021).

Perhaps wave attenuation research has already been done with other types of mangroves. But in this study, Rhizophora sp. mangroves were used as the bounciness of the supporting roots act as wave damper. So, this research is a novelty in wave attenuation with this type of mangrove. The research objective is to analyze the wave damping value by thickness, density, and resilience of *Rhizhophora sp.* mangrove supporting roots as a wave damper.

METHODOLOGY

Research Location

The research was conducted in two different locations but with the same type of mangrove, *Rhizopora sp.* The first location was in Gebang Village, Padang Cermin District, Pesawaran Regency. The second location was in Sukarame Village, Punduh Pidada District, Pesawaran Regency. The location was chosen because there was a fairly thick *Rhizophora sp.* mangrove forest (See Figure 1).

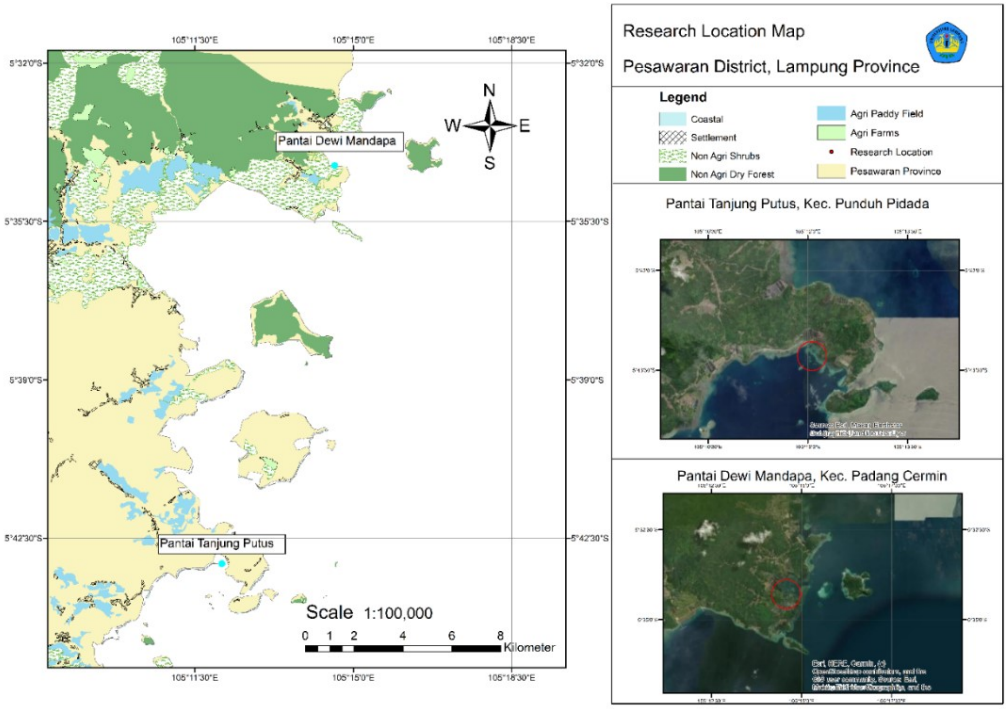


Figure 1: Map of Research Location

Data Collection Equipment

Wave Data

Wave height measurements were made with the SBE 26 tool. This tool is used in previous research on wave damping (Herison et al., 2019). Mangrove thickness that was measured on Dewi Mandapa beach were done on 10 stations with 5 meters intervals of 0-50 meters. On Tanjung Putus beach, it was done on 6 stations with 5 meters intervals of 0-30 meters adjusting to the thickness of the mangrove forest.

Vegetation Data

The tools used to collect mangrove vegetation samples at the research site are as follows:

1. 50 m roll meter to measure the circumference and thickness of the mangrove forest.
2. Rope to mark the quadrat transect plot area.
3. Saw to take supporting root samples.

© 2026 by MIP

4. GPS to determine the coordinates of the research location.
5. Buoys for the safety of the researchers and the team.
6. Waterproof camera to document data collection.
7. First aid kit prepared in case of accidents on site.
8. Controls Universal Testing Machine (UTM)/Tensile Testing Machine (See Figure 2).



Figure 2: Universal Testing Machine (UTM)

Controls Tensile Testing Machine is used to determine the strength of supporting roots through tensile testing. It can test specimens up to 500 mm long and the maximum tensile load is up to 500 kN.

Data Collection Process

Waveform Data Collection Process

Wave measurements were conducted using an SBE 26 pressure sensor with a recording duration of 12 hour during peak tidal conditions. Wave data was collected for 12 hours to determine the tidal range. After that, the data collected

was 1-hour data with substantial wave attenuation. Tools were installed one in front of the mangrove forest to measure incident waves and another behind the mangrove stand to record attenuated waves. The steps taken to obtain wave data are as follows:

1. Conduct a pre-survey with the wave measuring instrument technician to check the installation location of the equipment.
2. Determine the location point where wave data will be recorded.
3. Preparing equipment, transportation, backup and safety equipment and illustration of wave data collection (See Figure 3).
4. Travel to the research location using boat transportation.
5. Carry out measurements with each tool installed according to its stations.
6. Retrieval of tools and uploading raw data of wave measurement results.
7. Processing and analysis of wave data at each STA using Microsoft Excel.

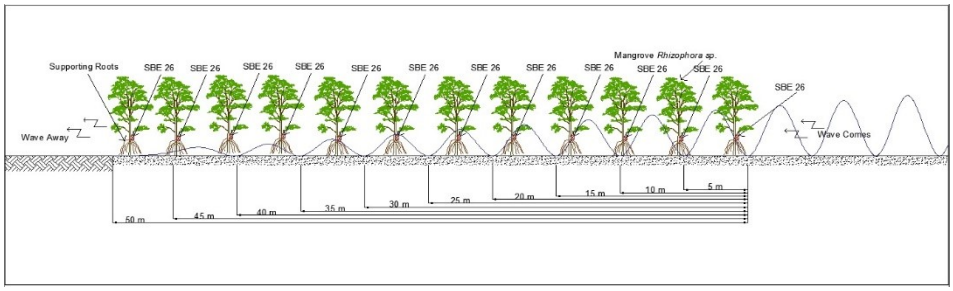


Figure 3: Illustration of wave data collection (side view)

Vegetation Data Collection Process

The methods used in collecting vegetation data are quadrat transect (Sari and Rosalina, 2016 and laboratory tests. Vegetation data were collected using 10 × 10 m plots established along transects perpendicular to the shoreline at 5 m intervals, ranging from the seaward edge to the landward boundary.

For laboratory test, Rhizophora sp. supporting roots were randomly sampled at each interval. To ensure a representative average tensile strength value, 10 root specimens per tree were collected from five different trees per station, categorized by diameter class. These specimens underwent tensile testing using a Universal Testing Machine (UTM) at the Materials and Construction Laboratory, Faculty of Engineering, University of Lampung.

Data Processing

Data processing using Microsoft Office applications including Ms. Word and Ms. Excel. Microsoft Excel is a data processing application in the form of numbers.

© 2026 by MIP

This application is needed for calculating wave energy, forming graphs that illustrate the relationship between wave damping variables on mangroves, and identifying equations that show the relationship between these variables.

Ocean Wave Data Processing

Ocean waves refer to the movement of water that occurs due to the rise and fall of air molecules. The prevailing wind transfers its energy to the water so that the stronger the wind blows, the bigger the waves formed. The presence of mangrove forests located on the beach causes damping of wave energy. Wave damping results in a reduction in wave height (Ginting, Putra, and Simanjuntak, 2019). The wave damping value can be seen from the energy difference between the incident wave and the outgoing wave passing through the mangrove. To calculate wave energy, use the following formula (Brown, 1999):

$E_i = 1/8 \times \rho \times g \times H_i^2$ ..... (1)
$\Delta E = 1/8 \times \rho \times g \times (H_i^2 - H_t^2)$..... (2)
$\Delta H = H_i - H_t$..... (3)
$\Delta E\ (\%) = (\Delta E / E_i) \times 100\%$..... (4)

Description:
E= Wave energy (J/m^2)
ρ= Water density (Kg/m^3)
g= Earth's gravitational acceleration (m/s^2)
H= Wave height (meter)

Mangrove Tree Density Data Processing

Density is the number of mangrove trees in an area. In this density, an ecosystem is formed that plays a role in reducing waves. To calculate the density (D_i) of marine mangrove trees then use the formula (Herison et al., 2017):

$$D_i = \frac{n_i}{A} \quad \text{..... (5)}$$

Description:
D_i= Tree density ($tree/m^2$)
ni= Number of trees in the area (tree)
A= Area (m^2)

Using certain criteria, such as number of trees per square meter or percentage, this table divides mangrove density into categories varying from very low to very dense, for mangrove density classification (Rahman, 2020) (See Table 1).

Table 1: Mangrove Density Classification

Classification	Number of trees per m^2
Very low	<0.05
Low	>0.05-0.10
Medium	>0.10-0.15
Dense	>0.15-0.20
Very solid	>0.20

Data Processing of Rhizophora sp. Mangrove Roots

Roots have the ability to return to their original state after being subjected to a wave called a gradient (Southwick et al., 2014; Duncan et al. 2018). Laboratory tests were conducted to obtain the maximum load that a single root can withstand. To calculate the resilience of the roots, you can use the following formula (Herison et al., 2023):

$$\text{Resilience} = F_{average} \times \Sigma \text{ root} \quad (6)$$

Description:
$F_{average}$= Root maximum load (joule)
Σ root= Number of roots in area (root/m^2)

Data Analysis

Data analysis is carried out after the data processing is complete. The data analysis includes a comparison between wave damping variables as follows:

1. Relationship of ΔH, ΔE, ΔH (%), ΔE (%) with the thickness of Dewi Mandapa beach mangrove.
2. Relationship of ΔH, ΔE, ΔH (%), ΔE (%) with the thickness of mangrove at Tanjung Putus beach.
3. Relationship of energy reduction percentage ΔH (%), ΔE (%) with time.
4. The relationship between the closeness of the supporting root and ΔE.
5. The relationship of pneumatophores of roots to ΔE.

Natural Structures of *Rhizophora sp* Mangrove

Natural structures are structures that are formed naturally by nature. Everything in nature is formed by the laws of the universe. Mangroves are natural structures that have the ability to reduce the energy of ocean waves. So, mangroves can protect coastal buildings for the survival of the community.

© 2026 by MIP

RESULTS AND DISCUSSION

Wave Data Processing

Wave observations were done at the highest wave. The recording results can be viewed with Microsoft Excel in the form of incident and outgoing waves.

The results of data processing are in the form of wave height and wave energy on mangroves. From the data in the table. It can be seen that there is a substantial decrease in energy from a thickness of 5 meters to 10 meters because the first wave to touch the mangrove experiences the greatest damping. As the thickness of the mangrove increases, the percentage value of energy damping increases (See Table 2 & 3).

Table 5: Wave Data Processing Results of Dewi Mandapa Beach

No.	Mangrove Thickness (m)	H Incoming (m)	H Outcoming (m)	ΔH (m)	ΔH (%)	Damping Percentage ΔH (%)	Ei (J/m^2)	ΔE (J/m^2)	ΔE (%)	Damping Percentage ΔE (%)
1	5	0.7009	0.2297	0.4712	67.23	32.77	0.61799	0.551632	89.26	10.74
2	10	0.2297	0.1088	0.1209	52.65	47.35	0.06636	0.051481	77.58	22.42
3	15	0.1088	0.0819	0.0268	24.67	75.33	0.01488	0.006436	43.25	56.75
4	20	0.0819	0.0664	0.0155	18.98	81.02	0.00844	0.002901	34.36	65.64
5	25	0.0664	0.0572	0.0092	13.84	86.16	0.00554	0.001428	25.77	74.23
6	30	0.0572	0.0503	0.0069	12.06	87.94	0.00411	0.000932	22.66	77.34
7	35	0.0503	0.0453	0.0050	9.98	90.02	0.00318	0.000604	18.97	81.03
8	40	0.0453	0.0413	0.0039	8.70	91.30	0.00258	0.000429	16.64	83.36
9	45	0.0413	0.0387	0.0026	6.31	93.69	0.00215	0.000263	12.23	87.77
10	50	0.0387	0.0373	0.0014	3.67	96.33	0.00189	0.000136	7.21	92.79

Table 3: Wave Data Processing Results of Tanjung Putus Beach

No.	Mangrove Thickness (m)	H Incoming (m)	H Outcoming (m)	ΔH (m)	ΔH (%)	Damping Percentage ΔH (%)	Ei (J/m^2)	ΔE (J/m^2)	ΔE (%)	Damping Percentage ΔE (%)
1	5	0.0354	0.0181	0.0173	51.22	48.78	0.0016	0.001165	73.77	26.23
2	10	0.0181	0.0106	0.0075	41.39	58.61	0.0004	0.000272	65.65	34.35
3	15	0.0106	0.0077	0.0029	27.72	72.28	0.0001	0.000068	47.76	52.24
4	20	0.0077	0.0065	0.0012	15.36	84.64	0.0001	0.000021	28.36	71.64
5	25	0.0065	0.0060	0.0005	7.99	92.01	0.0001	0.000008	15.35	84.65

No.	Mangrove Thickness (m)	H Incoming (m)	H Outcoming (m)	ΔH (m)	ΔH (%)	Damping Percentage ΔH (%)	Ei (J/m^2)	ΔE (J/m^2)	ΔE (%)	Damping Percentage ΔE (%)
6	30	0.0060	0.0058	0.0002	3.87	96.13	0.0000	0.000003	7.59	92.41

From the wave data processing value, the following relationship can be obtained (See Figure 4 & 5):

1. The relationship between wave parameters and mangrove thickness across both research locations exhibits a consistent physical pattern where the seaward zone, specifically between 5 and 20 meters, provides the most effective coastal protection. At both Dewi Mandapa and Tanjung Putus Beach, absolute wave height ΔH and wave energy ΔE show a substantial decrease within this initial range. For absolute wave height reduction ΔH, Dewi Mandapa follows an exponential decay model $y = 0.2762e^{(-0.112x)}$ ($R^2 = 0.8717$), while Tanjung Putus exhibits a steeper decay rate described by $y = 0.041e^{(-0.174x)}$ with a higher coefficient of determination ($R^2 = 0.9996$). Similarly, the absolute energy attenuation ΔE at Dewi Mandapa ($y = 0.1858e^{(-0.158x)}$) and Tanjung Putus ($y = 0.0029e^{(-0.233x)}$) confirms that while the incident wave energy levels differ, the physical mechanism of dissipation through the Rhizophora sp. prop root system remains consistent.
2. The efficiency of wave height damping ΔH shows a substantial decrease as thickness increases beyond 20 meters at both sites. This trend is modeled by the quadratic equation $y = 0.0484x^2 - 3.8805x + 81.933$ for Dewi Mandapa and $y = 0.0384x^2 - 3.3394x + 68.477$ for Tanjung Putus. The decline in interval efficiency in the landward zone (20–50 m for Dewi Mandapa and 20–30 m for Tanjung Putus) is attributed to the fact that the majority of wave energy has already been dissipated by the dense frontal vegetation. Conversely, the cumulative percentage of energy attenuation ΔE increases substantially between 5 and 20 meters. Dewi Mandapa reaches high cumulative efficiency following $y = -0.0522x^2 + 4.5442x - 9.471$, while Tanjung Putus follows $y = -0.0153x^2 + 3.3978x + 6.5764$. These results indicate that the front side of the mangrove forest acts as the primary wave damper, where the most significant energy reduction occurs before the remaining minimal energy penetrates the inner forest zones.

The front side of the mangrove forest that hits the wave is the wave damper with the largest damping value. It is stated on the graph that there is a substantial decrease in energy at a distance of 5 - 20 meters, but at a distance of

© 2026 by MIP

20 meters back the energy decrease is no longer substantial. This is due to the energy passing through the mangroves at a distance of 20 meters only a little left.

Relationship of Wave Damping Percentage with Time

The relationship between wave damping percentage and time is a reflection of the interaction between waves and the structure that dampens them. As time passes, the process of energy damping progresses gradually, providing an interesting picture of how a system adapts to the natural stresses of ocean waves.

Based on the percentage relationship graph, there is a substantial difference with a thickness ranging from 5-10 meters, to a thickness of 15-50 meters. This is because wave energy attenuation near the shoreline is less effective at a thickness of 15-50 meters (See Figure 6).

Mangrove Tree Density Data Processing

Mangrove tree density factor acts as a natural barrier that can help protect coastal areas from coastal abrasion hazards. The results of mangrove tree density using equation (6), (See Table 4 & 5).

The results of *Rhizophora sp*. mangrove density on Dewi Mandapa and Tanjung Putus beach are classified into Very dense. The largest mangrove density is located at the front of the mangrove in contact with the first wave. Therefore, the greatest energy attenuation is located at the front of the mangrove forest.

Comparison of Support Roots and Pneumatophores against ΔE

The results of the supporting root samples that have been taken to the laboratory and tested for tensile tests (See Table 6).

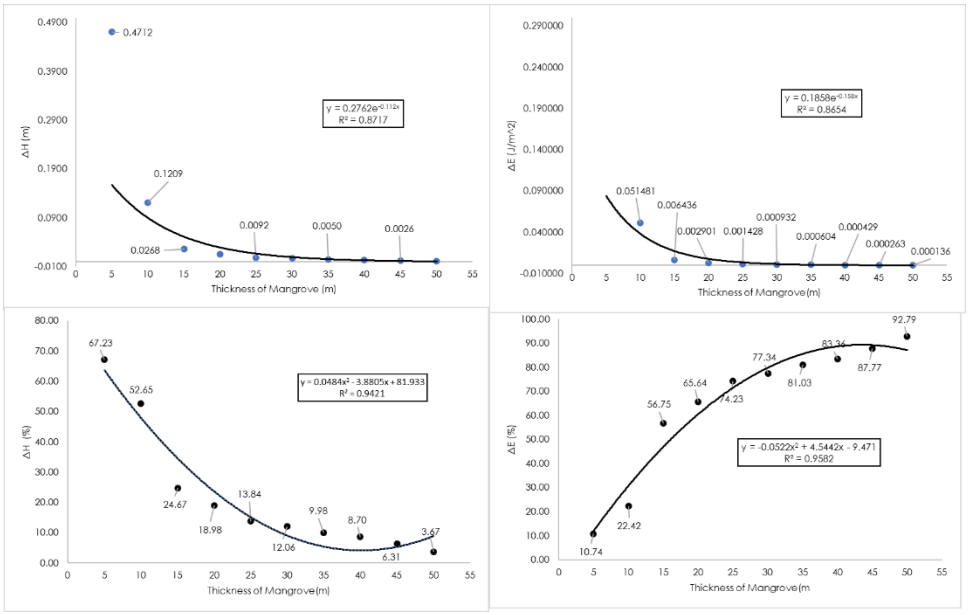


Figure 4: Relationship of ΔH, ΔE, ΔH (%), ΔE (%) with the thickness of mangrove at Dewi Mandapa beach.

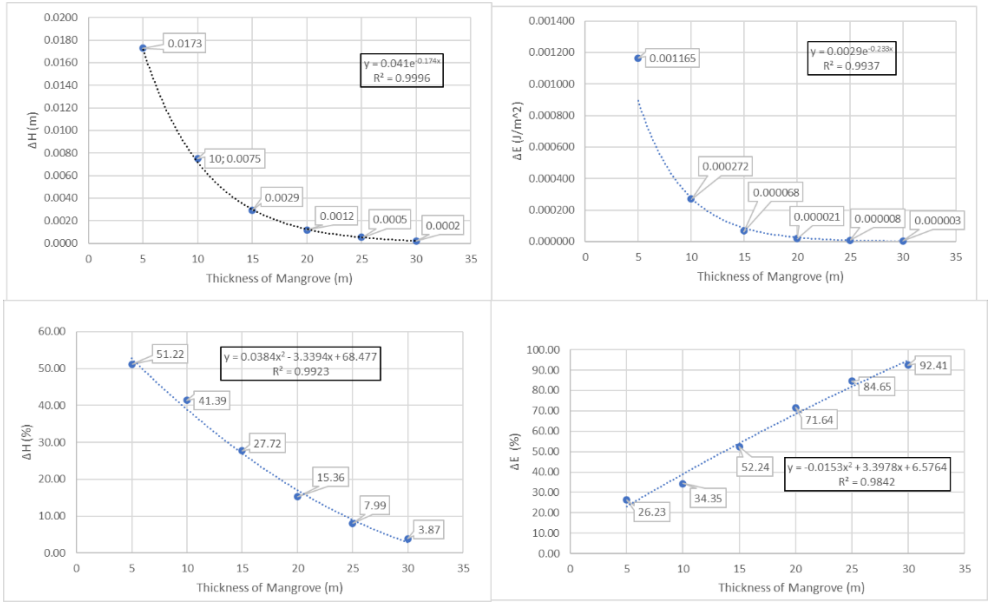


Figure 5: Relationship of ΔH, ΔE, ΔH (%), ΔE (%) with the thickness of mangrove at Tanjung Putus beach.

© 2026 by MIP

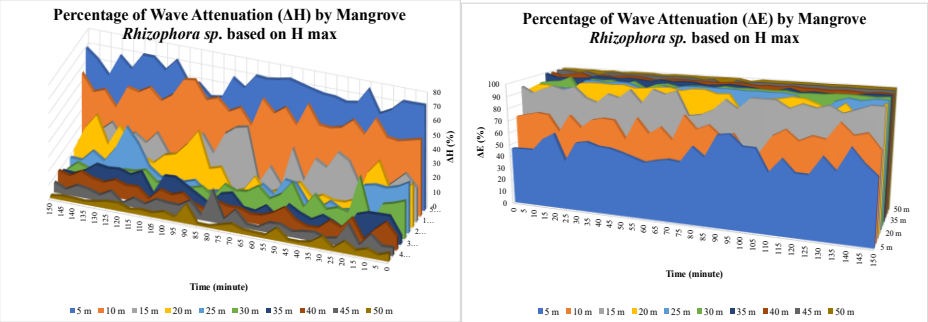


Figure 6: Relationship of energy reduction percentage ΔH (%), ΔE (%) with time.

Table 4: Density Data for Dewi Mandapa Beach

NO	Mangrove Thickness (meter)	Area Observation (m^2)	Mangrove Tree Quantity (tree)	Mangrove Density (number of tree/m^2)
1	10	200	37	0.19
2	20	400	46	0.12
3	30	600	49	0.08
4	40	800	52	0.07
5	50	1000	55	0.05

Table 5: Density Data for Tanjung Putus Beach

NO	Mangrove Thickness (meter)	Area Observation (m^2)	Mangrove Tree Quantity (tree)	Mangrove Density (number of tree/m^2)
1	10	200	52	0.31
2	15	300	76	0.26
3	20	400	97	0.25
4	25	500	118	0.24
5	30	600	136	0.24

Table 6 Results of Rhizopora sp Root Data Processing

Thickness (m)	F average (Joule)	Number of roots (items/m^2)	Resilience (J/m^2)	Wave Energy Attenuation (J/m^2)
5	1.0107	310	3.1331	3.7578E-04
10	1.0107	520	2.6277	4.4674E-04
30	1.0107	970	2.4509	4.5943E-04

Table 7: Results of *Avicennia marina* Root Data Processing (Herison et al., 2023)

Thickness (m)	F average (Joule)	Number of roots (items/m^2)	Resilience (J/m^2)	Wave Energy Attenuation (J/m^2)
5	1.6E-06	19,140	3.06E-04	0.7485
10	1.6E-06	35,640	2.85E-04	1.3389
30	1.6E-06	66,240	2.64E-04	1.6115

Laboratory tests were conducted to determine the capacity of the roots to withstand the load. It is determined that one root can withstand an average wave of 1.0107 Joules on the supporting root and 1.6E-06 Joules on the pneumatophores (Herison et al., 2023). This difference in value is based on the difference in physical form between the supporting roots and the pneumatophores. The root thickness value is inversely proportional to the dampened energy because the thicker the mangrove, the less energy dampened by the roots.

The relationship between resilience and energy reduction is as follows:

1. The relationship between resilience and wave energy attenuation of *Rhizophora sp* mangrove species with mangrove thickness of 5 meters to 30 meters is described by the equation $y = -8E+07x^2 + 59934x – 7.8768$ with a coefficient of determination (R^2) of 0.9768. At a thickness of 5 meters the y-value of 3.1131 J/m^2 at a thickness of 30 meters drops to 2.4509 J/m^2. This shows a decrease in the value of resilience along with the increase in the thickness of *Rhizophora sp* mangrove (See Figure 7).
2. The relationship between the resilience and wave energy attenuation of *Avicennia marina* mangrove species with mangrove thickness of 5 meters to 30 meters is described by the equation $y = -4E-05x^2 + 6E-05xx – 0.0003$ with a coefficient of determination (R^2) of 0.9709. At a thickness of 5 meters the y value of 3.06E-04 J/m^2 at a thickness of 20 meters dropped to 2.64E-04 J/m^2. This shows a decrease in the value of resilience along with the increasing thickness of Avicennia *marina* mangrove (See Figure 8).

It is stated that the resilience value of *Rhizophora sp* supporting roots is greater than *Avicennia marina* Pneumatophores based on the research results.

© 2026 by MIP

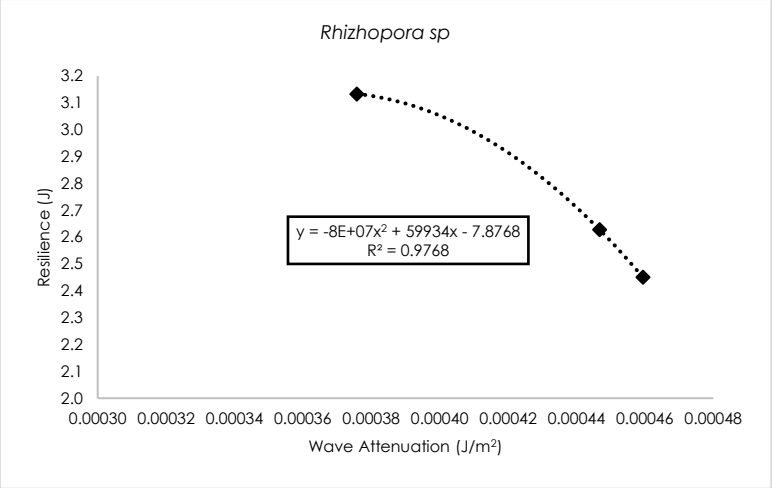


Figure 7: Relationship between the resilience of the supporting root and ΔE, *Rhizopora Sp*

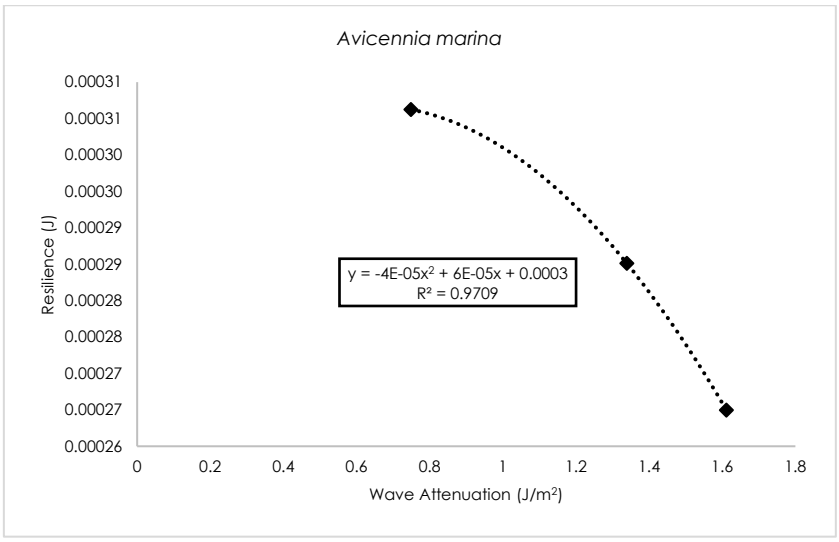


Figure 8: Relationship between the resilience of the pneumatophores and ΔE, *Avicennia marina* (Herison et al., 2023)

Comparison of Wave Energy Absorption (ΔE) Values with *Avicennia marina* Mangrove

In mangrove ecosystems, wave attenuation is an important function performed by mangrove vegetation to protect the coast from abrasion due to ocean waves.

Among the various mangrove species in nature, *Rhizophora sp*. with its strong and serpentine root system, often stands out in this role compared to other mangrove species.

The main difference in wave attenuation between *Rhizophora sp*. and other mangrove species lies in their physical structure. *Rhizophora sp*., with its towering, densely growing supporting roots, effectively catches and breaks waves. These towering roots form a strong barrier to water flow, dampening the energy of waves and reducing their speed before they reach the shore. This helps reduce coastal erosion and stimulates sediment deposition, gradually expanding the coastal area.

On the other hand, other mangroves may not have root systems as strong and complex as *Rhizophora sp*. While they still provide protection against waves, their ability to dampen waves may be less effective than that of *Rhizophora sp*..

Rhizophora sp. mangrove produces wave attenuation values, namely at a thickness of 5 meters obtained 10,74%, up to a thickness of 50 m obtained 92.79%. With the equation $y = -0.0522x^2 + 4.5442x - 9.471$, with a value of $R^2 = 0.9582$. Whereas in previous studies using *Avicennia marina* mangroves and produced a wave attenuation value of 3 meters obtained 50%, at a thickness of 5 meters obtained 54%, up to a thickness of 50 meters obtained 92% with the equation $y = -0.0592x^2 + 4.0142x + 39.267$ nilai $R^2 = 0.9265$. To see the comparison of the percentage of wave attenuation by *Rhizophora sp*. with *Avicennia marina* mangrove (See Table 8).

Table 8: Percentage of wave attenuation by mangroves.

Station	Wave attenuation percentage (%)	
	Rhizophora sp.	*Avicennia marina*
STA 1(5)	10.74	54
STA 2 (10)	22.42	83
STA 3 (20)	65.64	91
STA 4 (50)	92.79	92

From the table 8, a comparison chart can be seen (See Figure 9).

The wave attenuation graph between *Rhizophora sp*. and *Avicennia marina* mangroves shows a substantial difference in the efficiency of coastal protection against ocean waves. The wave attenuation graph for *Rhizophora sp*. shows a steeper rise than that of *Avicennia marina*.

In the zoning of mangrove growth, *Avicennia marina* formerly do the damping because the mangrove is in the zone seaward zone (area near the sea) while *Rhizophora sp*. do waves damping after being dampened by mangrove *Avicennia marina* foremost because mangrove *Rhizophora sp*. is in the mid zone (mid area).

© 2026 by MIP

At a thickness of 5-10 meters, *Avicennia marina* mangrove performs greater damping than *Rhizophora sp*. mangrove, while at a distance of 5-20 mangrove *Rhizophora sp*. performs damping more consistently up to a thickness of 20 m. (See Figure 9)

Comparison Graph of Percentage of Wave Energy with Mangrove *Avicennia marina* with Time

The wave energy percentage graph is a reflection of how the two mangrove species, *Avicennia marina* and *Rhizophora sp*., evolved and adapted to changes in the water environment over time. *Avicennia marina*, with its wider roots and denser branches, shows a steady trend in absorbing wave energy over time. On a continuously changing surface, *Avicennia marina* remains a consistent coastal guard, serving a critical role in stabilizing the shoreline and providing protection against erosion.

From the two graphs, *Rhizophora sp*. mangroves display more complicated dynamics in interaction with wave energy over time. This comparison between the two mangrove species reflects their unique adaptations to a changing environment. While *Avicennia marina* showed stability in response to wave energy over time, *Rhizophora sp*. showed the ability to adapt and evolve as their environmental conditions changed. Both, albeit with different strategies, play an important role in maintaining the balance of valuable mangrove ecosystems (See figure 10).

© 2026 by MIP

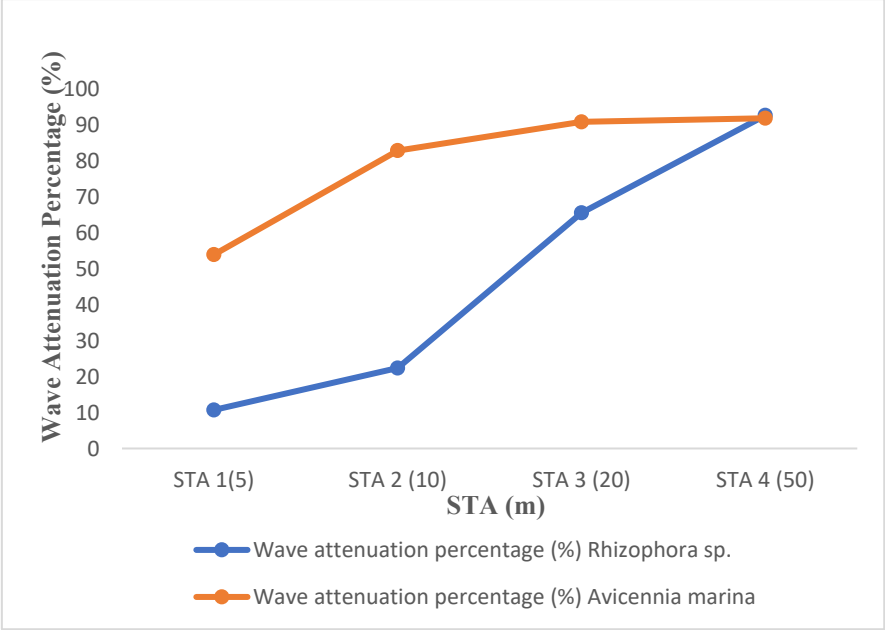


Figure 9: Comparison graph of wave attenuation between *Rhizophora sp* and *Avicennia marina*.

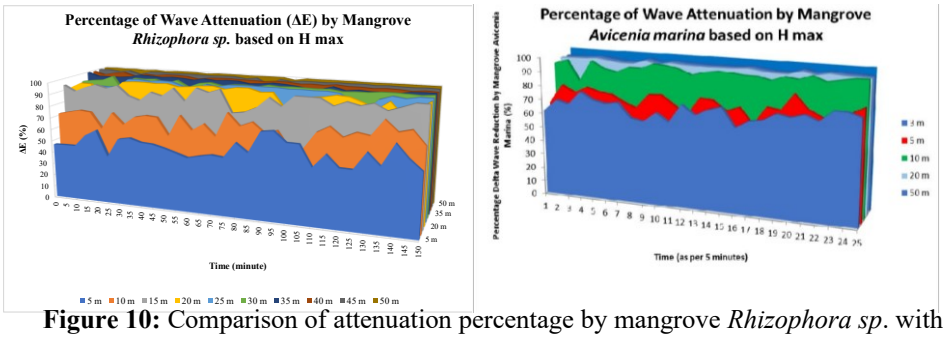


Figure 10: Comparison of attenuation percentage by mangrove *Rhizophora sp*. with *Avicennia marina*

Mangroves as Natural Structure

Considering the results of wave attenuation by mangroves that are large enough, this can be utilized for the survival of coastal communities. Mangroves can become a natural structure that can replace man made structures, namely breakwater to protect shore buildings such as ports, groins, and beaches as tourist attractions.

© 2026 by MIP

CONCLUSION

It is concluded that high-density *Rhizophora sp*. mangroves have substantial wave damping ability as a result of the bouncing power of the supporting roots. When the wave first touches the mangrove forest, there is a decrease in wave energy by approximately 50%. This shows that *Rhizophora sp*. mangroves play an important role as a natural structure in protecting the coast from ocean waves.

ACKNOWLEDGEMENT

Thank you to Lembaga Penelitan dan Pengabdian Masyarakt (LPPM) Universitas Lampung for its support and contribution. I appreciate the valuable guidance and cooperation from all related parties.

REFERENCES

Bagindo, M. N., Herwandi, H., Chaniago, M. I., & Saga, S. S. (2023). Socio-Economic Changes in Coastal Fishermen of West Sumatra as the Impact of Coastal Abrasion. *Asian Journal of Environment-Behaviour Studies*, *8*(26), 37–54. https://doi.org/10.21834/aje-bs.v8i26.433

Brown, J. (1999). *Waves, Tides and Shallow-Water Processes*. Elsevier. https://doi.org/10.1016/B978-0-08-036372-1.X5000-4

Duncan, C., Owen, H. J. F., Thompson, J. R., Koldewey, H. J., Primavera, J. H., & Pettorelli, N. (2018). Satellite remote sensing to monitor mangrove forest resilience and resistance to sea level rise. *Methods in Ecology and Evolution*, *9*(8), 1837–1852. https://doi.org/10.1111/2041-210X.12923

Fadholi, A. (2013). UJI PERUBAHAN RATA-RATA SUHU UDARA DAN CURAH HUJAN DI KOTA PANGKALPINANG. *Jurnal Matematika Sains Dan Teknologi*, *14*(1), 11–25. https://doi.org/10.33830/jmst.v14i1.309.2013

Friess, D. A., Rogers, K., Lovelock, C. E., Krauss, K. W., Hamilton, S. E., Lee, S. Y., Lucas, R., Primavera, J., Rajkaran, A., & Shi, S. (2019). The State of the World's Mangrove Forests: Past, Present, and Future. *Annual Review of Environment and Resources*, *44*(1), 89–115. https://doi.org/10.1146/annurev-environ-101718-033302

Ginting, J. W., Putra, I. A. I. D. R., & Simanjuntak, E. M. (2019). Model Fisik Redaman Energi Gelombang Dengan Breakwater Tiang. *JURNAL TEKNIK HIDRAULIK*, *10*(1), 55–70. https://doi.org/10.32679/jth.v10i1.606

Hamid, N., Setyowati, D. L., Juhadi, Priyanto, A. S., Hardati, P., Soleh, M., Wijayanti, N. R., & Aroyandini, E. N. (2021). The Effect of Human Activities Towards Coastal Dynamics and Sustainable Coastal Management. *International Journal of Sustainable Development and Planning*, *16*(8), 1479–1493. https://doi.org/10.18280/ijsdp.160809

Herison, A. (2024a). SEDIMENTATION AND WAVE ATTENUATION BY *Avicennia marina* MANGROVES: IMPLICATIONS FOR SUSTAINABLE COASTAL PROTECTION. *ASEAN Engineering Journal*, *14*(2), 103–110. https://doi.org/10.11113/aej.v14.20795

Herison, A., Bengen, D. G., Putra, A. D., Romdania, Y., & Arief, F. D. (2024b). EFFECTS OF Avicennia marina MANGROVE SEDIMENTATION ON WAVE ATTENUATION. *Jurnal Teknologi*, *86*(2), 9–15. https://doi.org/10.11113/jurnalteknologi.v86.19492

Herison, A., Bengen, D. G., Romdania, Y., & Kurniawati, R. (2019). Comparison of Waves Reduction by Mangrove Avicennia Marina in East Lampung and Indah Kapuk Beach, Indonesia. *Journal of Physics: Conference Series*, *1376*(1), 012006. https://doi.org/10.1088/1742-6596/1376/1/012006

Herison, A., Bengen, D. G., Romdania, Y., Zakaria, A., Luthfiyani, H. N., al Safar, M. R., & Arief, F. D. (2023). THE CONCEPT OF SUSTAINABLE DEVELOPMENT WITH THE MANGROVE AVICENNIA MARINA AS A REDUCTOR OF WAVE ENERGY. *ASEAN Engineering Journal*, *13*(2), 165–174. https://doi.org/10.11113/aej.v13.19274

Herison, A., Romdania, Y., Bengen, D. G., & Al Safar, M. R. (2017). Contribution of Avicennia Marina Mangrove to Wave Reduction for the Importance of Abrasion as an Alternative to Coastal Buildings. *International Journal of Advances in Mechanical and Civil Engineering*, *4*(6), 2394-2827. Available: http://iraj.in

Krauss, K. W., & Osland, M. J. (2019). Tropical cyclones and the organization of mangrove forests: a review. *Annals of Botany*. https://doi.org/10.1093/aob/mcz161

Mantiquilla, J. A., Shiao, M.-S., Shih, H.-C., Chen, W.-H., & Chiang, Y.-C. (2021). A review on the genetic structure of ecologically and economically important mangrove species in the Indo-West Pacific. *Ecological Genetics and Genomics*, *18*, 100078. https://doi.org/10.1016/j.egg.2020.100078

Rahman, R., Wardiatno, Y., Yulianda, F., & Rusmana, I. (2020). Sebaran spesies dan status kerapatan ekosistem mangrove di pesisir Kabupaten Muna Barat, Sulawesi Tenggara. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, *10*(3), 461–478. https://doi.org/10.29244/jpsl.10.3.461-478

Rimba, A. B., Arumansawang, A., Utama, I. P. W., Chapagain, S. K., Bunga, M. N., Mohan, G., Setiawan, K. T., & Osawa, T. (2023). Cloud-Based Machine Learning for Flood Policy Recommendations in Makassar City, Indonesia. *Water*, *15*(21), 3783. https://doi.org/10.3390/w15213783

Sari, S. P., & Rosalina, D. (2016). Mapping and Monitoring of Mangrove Density Changes on tin Mining Area. *Procedia Environmental Sciences*, *33*, 436–442. https://doi.org/10.1016/j.proenv.2016.03.094

Southwick, S. M., Bonanno, G. A., Masten, A. S., Panter-Brick, C., & Yehuda, R. (2014). Resilience definitions, theory, and challenges: interdisciplinary perspectives. *European Journal of Psychotraumatology*, *5*(1). https://doi.org/10.3402/ejpt.v5.25338

Sreelekshmi, S., Preethy, C. M., Varghese, R., Joseph, P., Asha, C. V., Bijoy Nandan, S., & Radhakrishnan, C. K. (2018). Diversity, stand structure, and zonation pattern of mangroves in southwest coast of India. *Journal of Asia-Pacific Biodiversity*, *11*(4), 573–582. https://doi.org/10.1016/j.japb.2018.08.001

Srikanth, S., Lum, S. K. Y., & Chen, Z. (2016). Mangrove root: adaptations and

 © 2026 by MIP

ecological importance. *Trees*, *30*(2), 451–465. https://doi.org/10.1007/s00468-015-1233-0

Srivastava, J., & Prasad, V. (2019). Evolution and paleobiogeography of mangroves. *Marine Ecology*, *40*(6). https://doi.org/10.1111/maec.12571

Stachew, E., Houette, T., & Gruber, P. (2021). Root Systems Research for Bioinspired Resilient Design: A Concept Framework for Foundation and Coastal Engineering. *Frontiers in Robotics and AI*, *8*. https://doi.org/10.3389/frobt.2021.548444

Wang, L., Jia, M., Yin, D., & Tian, J. (2019). A review of remote sensing for mangrove forests: 1956–2018. *Remote Sensing of Environment*, *231*, 111223. https://doi.org/10.1016/j.rse.2019.111223

Woodroffe, C. D., Rogers, K., McKee, K. L., Lovelock, C. E., Mendelssohn, I. A., & Saintilan, N. (2016). Mangrove Sedimentation and Response to Relative Sea-Level Rise. *Annual Review of Marine Science*, *8*(1), 243–266. https://doi.org/10.1146/annurev-marine-122414-034025

Received: 3rd June 2025. Accepted: 13th January 2025

© 2026 by MIP

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 725 – 740

MAPPING THE SCIENTIFIC LANDSCAPE OF URBAN EMISSIONS IN PORT CITIES: A BIBLIOMETRIC REVIEW

Ibnu Fauzi[1], Ade Ratih Ispandiari[2], Maria Nooza Airawati[3], Nofika Cahyani Putri[4], Destianingrum Ratna Prabawardani[5]

[1,3,4,5] *Research Center for Hydrodynamics Technology,*
[2] *Research Center for Transportations Technology,*
NATIONAL RESEARCH AND INNOVATION AGENCY, INDONESIA

Abstract

Port cities face increasing pressure due to their significant role in global greenhouse gas emissions and air pollution, impacting both environment and public health. This study conducts a systematic bibliometric review of 220 Scopus-indexed publications from 2014 to 2025 to map the evolving scientific landscape of urban emissions in these maritime hubs. Findings reveal a "productivity paradox": while research output has surged by 660%, the average citation impact has declined by 96%, indicating thematic fragmentation. The analysis identifies a critical disconnect between technical maritime engineering—such as port electrification and "cold ironing"—and urban spatial governance frameworks. Furthermore, advanced digital tools like artificial intelligence for real-time monitoring remain underutilized. Theoretically, this study advances urban environmental governance by positioning emission mitigation as a central variable in municipal spatial growth rather than a localized technical issue. The review calls for a paradigmatic shift toward "Integrated Port-City Governance" to align maritime decarbonization with resilient urban planning. By bridging environmental engineering and spatial policy, this research provides a strategic foundation for transforming port cities into low-carbon, sustainable urban ecosystems.

Keywords: Decarbonization, Air Quality Management, Maritime Logistics, Urban Sustainability, Environmental Policy

[1] Corresponding author. Email: ibnu.fauzi@brin.go.id

INTRODUCTION

Port cities serve as strategic spatial entities that integrate global logistics functions with the complexities of urban dynamics. Approximately 80% of international trade volume is transported via maritime routes, positioning port cities as critical nodes in global supply chains and distribution systems (Amdaoud et al., 2022; Fauzi & Ispandiari, 2024; Setyaningsih et al., 2024). However, the high intensity of economic and maritime transport activities in these areas disproportionately contributes to greenhouse gas (GHG) emissions and air pollution, posing severe environmental and public health challenges (Meng et al., 2022; Mîndroiu et al., 2025; Wang et al., 2021).

Key emission sources include vessel berthing, cargo handling, and heavy vehicle traffic, which collectively account for up to 45% of fine particulate matter (PM2.5) emissions in European coastal regions and are linked to 14,500–37,500 premature annual deaths globally (Amdaoud et al., 2022; Ducruet et al., 2024; Logothetis et al., 2021). The shipping sector alone contributes 2.89% of global CO2 emissions (2018 baseline), with projections indicating a 90–130% increase by 2050 if no mitigation measures are implemented (IMO, 2021). These emissions degrade air quality, exacerbate climate change, and elevate public health risks (Girard & Nocca, 2020; Shen et al., 2024; Sun et al., 2025), necessitating integrated spatial planning approaches that align energy policy, environmental management, and low-carbon urban development.

While existing studies have examined the environmental impacts of port activities, most focus narrowly on technical aspects (e.g., emission measurements, localized air quality analyses) (Abbass et al., 2022; Fei et al., 2025; Türkistanlı et al., 2025; UNCTAD, 2009), with limited integration into urban planning frameworks or spatial policy (Chib et al., 2015; Shim & Shin, 2022). Furthermore, research remains geographically skewed toward developed nations, leaving a gap in understanding emissions from small-to-medium ports in rapidly urbanizing regions like Southeast Asia (Merk, 2013; Qu et al., 2023; Roy & Chakraborty, 2025).

This study employs a bibliometric analysis of 220 Scopus-indexed publications (2014–April 2025) to: Map global research trends on port-city emissions, analyze collaboration patterns and knowledge distribution and Identify policy-relevant research gaps and opportunities for sustainable port-city development. By synthesizing interdisciplinary insights from environmental science, engineering, and governance, this review aims to bridge the divide between technical emission studies and actionable urban planning strategies.

Despite the growing literature on maritime emissions, a significant gap persists in aligning technical advancements with urban spatial governance. To address this, this bibliometric review explores four key research questions: (1) how have scientific landscape and publication trends evolved over the past

decade; (2) what are the dominant research clusters regarding the integration of technology and urban planning; (3) to what extent does current research address spatial governance challenges for low-carbon transitions; and (4) what emerging frontiers can inform holistic, evidence-based environmental frameworks? By addressing these questions, this study bridges environmental engineering and urban governance, providing a structured foundation for future interdisciplinary policy and research

RESEARCH METHODOLOGY

This study employs a bibliometric approach to systematically map and analyze the evolution of scholarly research on emissions in port cities. Bibliometric methods allow for quantitative and visual exploration of publication patterns, scientific collaboration, and thematic development within academic discourse. Data were sourced from the Scopus database, selected for its comprehensive multidisciplinary coverage, reliable metadata quality, and international recognition (Elkhayat et al., 2024; Lim et al., 2024). To ensure transparency, certain methodological boundaries are acknowledged. This study is restricted to English-language publications to maintain terminological consistency, which may introduce a linguistic bias by overlooking local-scale research from specific maritime regions. Additionally, the exclusive reliance on Scopus-indexed literature may exclude "grey literature" or emerging regional journals, potentially affecting regional coverage and thematic representation.

The dataset includes journal articles, conference papers, and reviews published between January 2014 and April 2025. A structured search strategy used Boolean combinations of keywords such as “port city,” “emission,” “air pollution,” and “GHG.” Inclusion criteria focused on publications explicitly addressing emissions in port-city contexts, while exclusions removed unrelated or incomplete records.

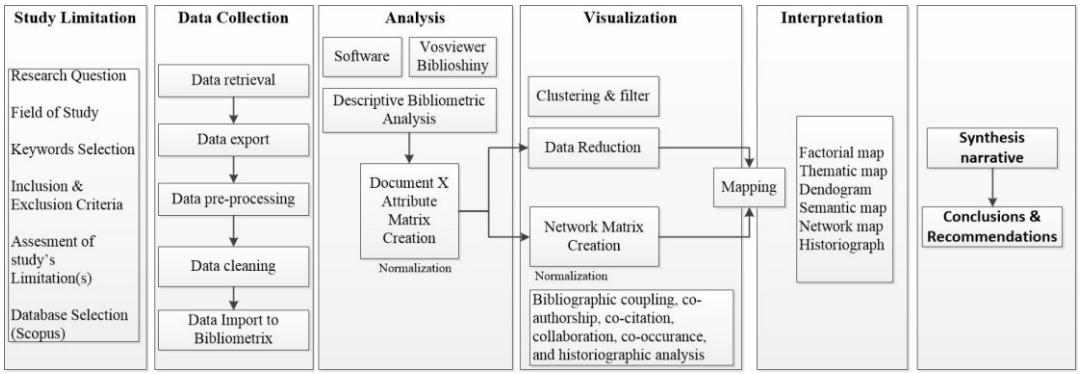


Figure 1. Research flow diagram

© 2026 by MIP

The research workflow (Figure 1) ensures traceability and reproducibility. Data were analyzed using Bibliometrix (R package) and VOSviewer to generate citation metrics, co-authorship networks, and keyword co-occurrence maps. These analyses reveal patterns of knowledge production and highlight gaps linking emission research with spatial planning and environmental policy. The approach offers a rigorous and replicable framework for evaluating scholarship on sustainable urban emissions management. As the study uses publicly available metadata without human subjects, formal ethical approval was not required, while academic integrity was maintained.

ANALYSIS AND DISCUSSION

Growth and Trends in Scholarly Publications

The analysis identifies a consistent upward trajectory in academic interest regarding port-city emissions over the past decade. Between 2014 and April 2025, a total of 220 documents were published, reflecting an average annual growth rate of 8.28%. As illustrated in Figure 2, publication output surged dramatically from only five articles in 2014 to a peak of 38 in 2022, representing a 660% increase. This sharp growth, particularly between 2019 and 2022, suggests heightened scholarly attention toward the environmental challenges inherent in maritime and port activities.

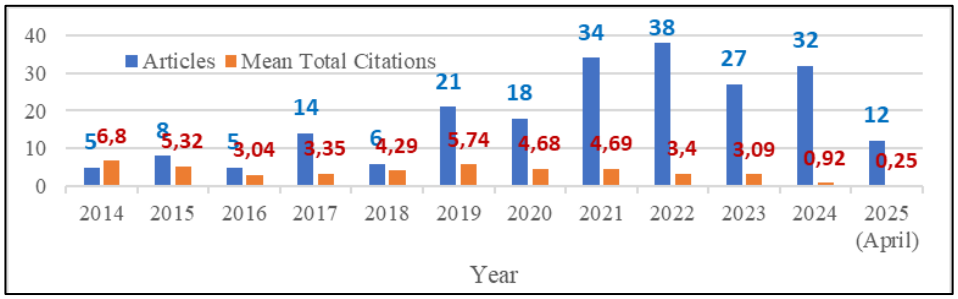


Figure 2. Annual Scientific Production and Average Citations per Year

As shown in Figure 2, publication output has increased significantly, yet this growth has not produced a comparable academic impact. Average citations per document declined by 96%, dropping from 6.8 in 2014 to only 0.25 in 2025. This paradox indicates that rising productivity coincides with diminishing scholarly influence. The trend likely reflects thematic fragmentation, an overemphasis on narrow engineering technicalities, and weak integration with urban planning or spatial policy. These findings highlight the need for interdisciplinary research linking environmental science and spatial governance to strengthen the relevance and impact of port-city decarbonization studies.

Most Active and Influential Countries and Institutions

The bibliometric analysis reveals significant disparities in research contributions across nations and institutions. While China dominates total publication volume with 408 articles, it demonstrates a relatively low citation impact of 16.9 citations per publication. In contrast, the United Kingdom achieves the highest scholarly influence, averaging 108.5 citations across its 52 publications, which indicates a focus on high-impact, high-quality research. Other notable performers include Greece (48.9 citations/article) and Malaysia (41 citations/article), both exhibiting strong impact-to-volume ratios

Table 1: Top Journals, Contributing Countries, and Leading Institutions

Journal	Freq	H	Country	#Pub	#Cit	Avg Cit	Institution	Inst Country	#Art
Science of The Total Environment	831	13	China	408	1163	16.9	Shanghai Maritime University	China	57
Transportation Research Part D	392	8	Italy	113	680	35.8	Zhejiang University	China	18
Sustainability (Switzerland)	164	7	Spain	72	438	31.3	Lingnan Normal University	China	17
Atmosphere	59	5	Greece	67	391	48.9	Shanghai	China	17
Journal of Environmental Management	115	5	Korea	55	355	20.9	Institute of Atmospheric Sciences and Climate	Italy	16
Atmospheric Environment	171	4	United Kingdom	52	217	108.5	Shanghai Jiao Tong University	China	16
Journal of Cleaner Production	164	4	Malaysia	38	123	41.0	Xiamen University	China	16
Journal of Environmental Sciences (China)	215	4	Poland	25	103	17.2	National Kaohsiung University of Science and Tech.	Taiwan	15
Marine Pollution Bulletin	61	4	USA	24	88	29.3	University of Rijeka	Croatia	14
Aerosol And Air Quality Research	104	3	Canada	21	85	14.2	Nankai University	China	13

© 2026 by MIP

At the institutional level, Shanghai Maritime University leads in productivity with 57 publications. However, European institutions—most notably Italy's ISAC-CNR and Croatia's University of Rijeka—demonstrate outsized influence per publication. As shown in Table 1, Science of the Total Environment emerges as the most cited outlet with 831 co-citations, reflecting the heavy environmental science orientation of this domain. These patterns underscore a concentration of research capacity in East Asia and Europe, yet suggest growing opportunities for ASEAN-based researchers to address context-specific emission challenges in rapidly urbanizing tropical port regions.

Most influential Article, Authors and Collaboration Networks

The analysis of scholarly collaboration networks reveals significant fragmentation in port-city emissions research. As presented in Table 2, Beatriz Tovar from TIDES emerges as the most influential researcher with eight publications and 496 citations (H-index 8), followed by Chen Jihong (seven publications, 284 citations) and Contini D. (six publications, 406 citations), the latter demonstrating the highest impact per publication (67.7 citations/article). In contrast, researchers such as Mifka Boris and Dinoi A. exhibit high productivity (4–5 publications) but low citation impact (19 citations), indicating variability in research quality.

Table 2: Top 10 researchers by publications and citation counts

Author	Affiliation	Number of Publications	Number of Citations	Articles Fractionalized	H-index	M-index
TOVAR, BEATRIZ	The University Institute for Tourism and Sustainable Economic Development (TIDES)	8	496	3,7	8	0,73
CHEN, JIHONG	Shenzhen University, College of Management, China	7	284	1,35	6	0,86
CONTINI, D.	Institute of Atmospheric Sciences and Climate (ISAC-CNR), Italy	6	406	0,83	6	0,5
ALEBIĆ-JURETIĆ, ANA	University of Rijeka, Faculty of Medicine, Department of Environmental Medicine, Croatia	5	258	1,05	5	0,42
MERICO, EVA	Institute of Atmospheric Sciences and Climate (ISAC-CNR), Italy	5	418	0,69	5	0,45

Author	Affiliation	Number of Publications	Number of Citations	Articles Fractionalized	H-index	M-index
MIFKA, BORIS	University of Rijeka, Faculty of Medicine, Department of Environmental Medicine, Croatia	5	19	1,05	4	0,67
TICHAVSKA, MILUŠE	MarineTraffic, London, UK	5	117	2,2	4	0,67
DINOI, A.	Institute of Atmospheric Sciences and Climate (ISAC-CNR), Italy	4	19	0,56	4	0,67
HE, HONG-DI	School of Naval Architecture, Ocean and Civil Engineering, Shanghai Jiao Tong University	4	112	0,76	3	0,33
SCHWAB, JAMES J.	Atmospheric Sciences Research Center, University at Albany	4	75	0,66	3	0,6

Figure 3 visualizes five dominant collaboration clusters centered in China, Italy, and the UK, with Xiao Hang as the primary node (link strength 38, 117 citations). However, cross-cluster collaboration remains weak, evidenced by low link strength (<10) for 90% of authors. While Chinese institutions like Shanghai Maritime University dominate publication volume (Table 3), European institutions such as Italy's ISAC-CNR excel in per-publication impact. These findings underscore the need for global collaboration platforms to integrate cross-regional perspectives, particularly from underrepresented developing regions.

© 2026 by MIP

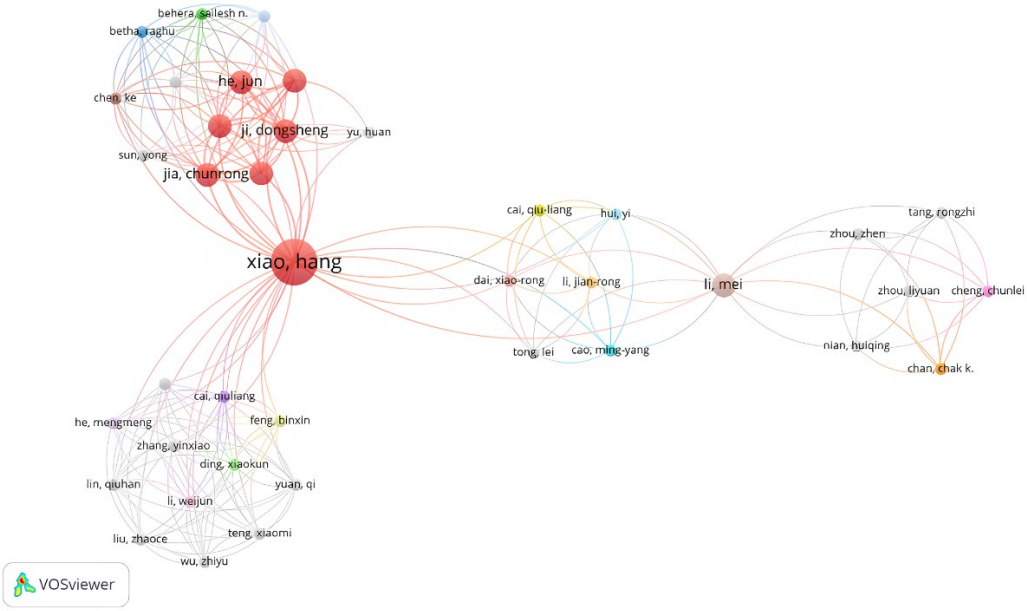


Figure 3. Science mapping of co-authorship network

Analysis and Mapping of Research Keywords

The keyword co-occurrence analysis, visualized through VOSviewer (Figure 4), reveals five dominant thematic clusters in port-city emissions research. The green cluster, centered on air pollution (26 occurrences, TLS: 29), underscores the primary focus on atmospheric contaminants. The red cluster highlights analytical approaches like source apportionment (11 occurrences) and particulate matter (6 occurrences), while the blue cluster emphasizes technological solutions (cold ironing, electrification). Spatial dynamics (ship emissions, port-city nexus) dominate the yellow cluster, whereas emerging trends (COVID-19, machine learning) form the purple cluster.

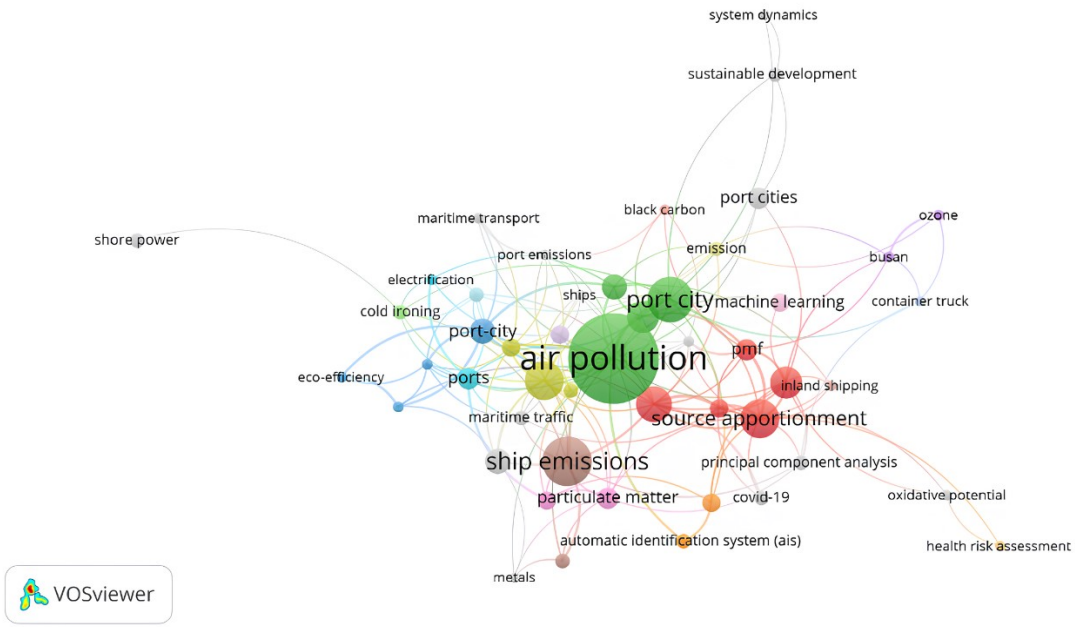


Figure 4. Network visualization of Keywords analysis

The tree map (Figure 5) reinforces these findings, with air pollution and related terms occupying 12–15% of the area, followed by shipping emissions (8%). Notably, the absence of urban planning and land use keywords in core clusters indicates a disconnect between technical emission studies and spatial policy discourse. The thematic map (Figure 6) further polarizes these trends, classifying air pollution and particulate matter as motor themes, while sustainability and climate change remain niche, underdeveloped themes. This fragmentation underscores the need for interdisciplinary integration, particularly linking emission science with urban governance and public health frameworks.

© 2026 by MIP

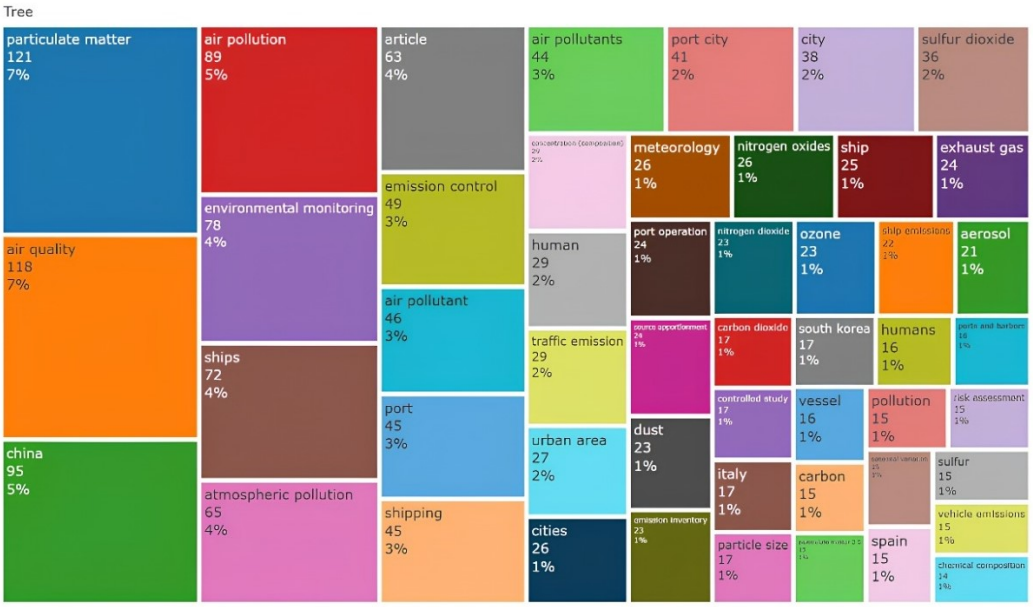


Figure 5. Top 20 authors' keywords Illustrated in a tree map

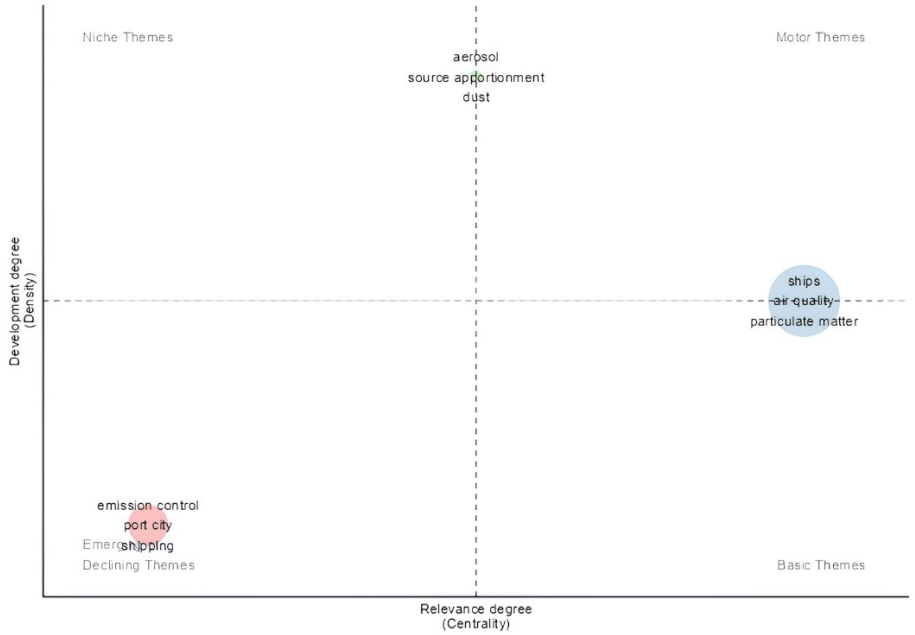


Figure 6. Thematic map of keywords

Research Gaps and Opportunities

This subsection was developed through a triangulated approach, integrating findings from performance analysis, science mapping, and a close examination of the top ten most-cited publications in the domain of port-city emissions. By combining bibliometric evidence with qualitative review, the aim was to identify underexplored areas and guide future research directions that intersect with urban planning, environmental governance, and smart port development.

Table 3: Top 10 Most Cited Studies (2014–April 2025)

Author	Method	Findings	Relevance to Spatial Planning	Total Citations
(Grange & Carslaw, 2019)	Machine learning (random forest) used to normalize time series and assess impacts of air quality interventions.	Normalized data revealed pollution reductions linked to fuel sulfur limits and traffic policies.	Demonstrates how advanced statistical methods improve assessment of spatial air quality interventions in urban environments.	212
(Tichavska & Tovar, 2015b)	Bottom-up exhaust emission model using AIS data for cruise and ferry operations in Las Palmas.	Passenger vessels identified as key air pollution sources; cruise and ferry emissions spatially mapped.	Enables emission zoning and prioritization of mitigation strategies in port-city urban planning.	154
(Cesari et al., 2014)	PMF receptor model with chemical and meteorological data for source apportionment.	Ship emissions contribute 2.8% to primary PM2.5 and 11% to secondary PM2.5 via oil combustion.	Helps quantify maritime contributions to air pollution, supporting urban-industrial port land-use regulation.	148
(Maragkogianni & Papaefthimiou, 2015)	Activity-based emissions inventory and external cost estimation for five cruise ports.	Cruise ship emissions cost up to €24.3 million annually; hotelling responsible for 88.5% of emissions.	Emphasizes the need for spatial policies to manage tourist port emissions and health impacts.	136
(Lee et al., 2014)	Combined bottom-up emissions inventory and top-down external cost estimation.	Maps emission hotspots and eco-efficiency indicators across port activities.	Supports spatially-informed cost-benefit strategies for emission reduction in dense port-city areas.	124
(Yau et al., 2020)	Literature review of smart port ICT applications, including IoT and emissions reduction technologies.	Highlights ICT role in energy efficiency, emissions reduction, and port automation.	Frames smart port development as central to spatial planning for sustainable urban logistics hubs.	120
(Chen et al., 2019)	Fuzzy DEMATEL model used to identify and rank 12 barriers to AMP implementation.	Policy support, standardization, and legal frameworks are key barriers in China.	Reveals systemic barriers to clean port technology adoption, crucial for spatial environmental and infrastructural policy.	116
(D'Amico et al., 2021)	Systematic literature review building a multidimensional	Identifies enabling factors, domains, and goals for smart,	Provides a framework for integrating digital technologies into spatial port planning and urban logistics.	110

© 2026 by MIP

Author	Method	Findings	Relevance to Spatial Planning	Total Citations
	framework of logistics elements.	sustainable port logistics.		
(Tichavska & Tovar, 2015a)	Full bottom-up emission inventory and top-down cost estimation integrated with eco-efficiency analysis.	Ferry and tanker sectors are least eco-efficient; emissions cost €180 million.	Offers a spatial emission assessment to guide planning and mitigation in densely populated port cities.	98
(Tichavska et al., 2019)	STEAM model with AIS data to analyze emissions under different regulatory regimes.	Ports with strict regulations like Hong Kong show lower emissions.	Supports differentiated regulatory strategies in port design and zoning for emission abatement.	91

As summarized in Table 3, the most influential studies emphasize advanced quantitative techniques, such as machine learning (Grange & Carslaw, 2019), bottom-up emissions modeling (Tichavska & Tovar, 2015b), and receptor-based PM2.5 apportionment (Cesari et al., 2014). These works contribute significantly to technical understanding and air quality management. However, only a few studies explicitly integrate spatial planning dimensions or assess implications for urban zoning, health-oriented land-use, or regulatory frameworks—gaps particularly relevant to the Planning Malaysia Journal's focus on urban and regional planning and environmental infrastructure.

Table 4 elaborates key research gaps within the literature. A critical disconnect is observed between rising publication quantity and declining citation impact, suggesting a need for higher-quality, policy-relevant research. Furthermore, the dominance of studies from China and Europe highlights the underrepresentation of Southeast Asia and other developing regions—areas where rapid port urbanization calls for context-specific planning frameworks. Thematic fragmentation is also evident; keywords such as "climate change," "sustainability," and "public health" remain peripheral in the bibliometric mapping, reflecting a missed opportunity for interdisciplinary integration.

Equally concerning is the underutilization of artificial intelligence and real-time monitoring technologies, despite their potential for spatial modeling and emissions forecasting. Finally, institutional and regulatory factors are insufficiently explored, with only one or two studies addressing policy implementation challenges. Overall, this analysis calls for a paradigmatic shift toward integrative, policy-responsive, and regionally contextualized research. Bridging emission studies with urban planning, governance, and digital infrastructure will not only enhance scholarly impact but also contribute directly to sustainable development strategies in port cities worldwide

Table 4: Research Gaps and Opportunities in Port-City Emission Studies

Identified Research Gaps	Bibliometric Evidence	Research Opportunities
Polarization between publication quantity and scientific impact	Figure 2 shows an increase in publications (2014–2025) but a decline in average citations from 6.8 to 0.25 (2025)	New research should focus on the quality of contributions, with strong theoretical approaches and comparative empirical studies across regions.
Fragmentation of scientific collaboration networks	Co-authorship network (Figure 3) and VOSviewer analysis indicate regional collaboration, not yet globally integrated	Significant opportunities exist to build international cross-institutional consortia for more coordinated maritime urban emission projects.
Lack of integration between public health themes and spatial modeling	Thematic map (Figure 6) shows "exposure" and "modeling" in the emerging/declining quadrant, not in core themes	Developing spatial models of health risk based on port emissions is a promising research area.
Limited socio-political and regulatory approaches	Among the top 10 cited articles (Table 5), most are technical and quantitative; only one or two address policy aspects like AMP adoption (Chen, 2019)	Interdisciplinary studies are needed on policy barriers, socio-economic dynamics, and adoption of green technologies.
Dominance of research by certain institutions and countries (particularly China)	Table 1: China leads in volume; the UK excels in quality	Expansion of studies to other developing countries with different port contexts, e.g., Southeast Asia, Africa, and Latin America.
Sustainability and climate change issues not yet integrated into core themes	Figure 6 shows "sustainability" and "climate change" as niche themes, not strongly connected to motor themes	Opportunities to integrate sustainability and climate change perspectives into emission models and mitigation strategies.
Inequality in researcher-level publication impact	Table 2: Some prolific researchers (e.g., Mifka and Dinoi) have low citations, indicating relevance or niche topic issues	Future research should address broader impact topics with high policy relevance.
Imbalance between quantitative approaches and artificial intelligence in emission mitigation	Table 3 notes the use of AI and deep learning only in a few studies	Greater integration of machine learning technologies for real-time port emission prediction and detection is encouraged.

CONCLUSION

This bibliometric review of 220 Scopus-indexed publications (2014–2025) provides a critical synthesis of the port-city emissions landscape, revealing a significant "productivity paradox" where a 660% increase in output is countered by a 96% decline in citation impact. This study's unique contribution lies in uncovering the systemic disconnect between technical maritime engineering and urban spatial governance. While the literature is saturated with localized technical measurements, this review identifies a profound lack of integration into broader

© 2026 by MIP

urban planning and land-use frameworks. Theoretically, this study advances urban environmental governance by positioning emission mitigation not merely as a technical challenge, but as a central variable in municipal spatial growth. It highlights that current research fails to bridge the gap between "hard" port infrastructure (e.g., electrification, cold ironing) and the "soft" institutional-regulatory policies required for sustainable transitions.

To align with the needs of urban planners, the findings call for a shift toward Integrated Port-City Governance. This framework suggests that emerging digital frontiers—such as AI-based spatial monitoring—must be coupled with health-oriented zoning and cross-sectoral policy assessment to be effective. By mapping these gaps, particularly in the underrepresented contexts of rapidly urbanizing tropical port regions, this study provides a strategic foundation for planners to transform port cities from isolated logistics hubs into low-carbon, resilient urban ecosystems.

REFERENCES

Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, *29*(28), 42539–42559. https://doi.org/10.1007/s11356-022-19718-6

Amdaoud, M., Ducruet, C., & Faure, M. A. (2022). The mutual specialization of port and urban functions: The case of France. *Papers in Regional Science*, *101*(2), 439–460. https://doi.org/10.1111/pirs.12659

Cesari, D., Genga, A., Ielpo, P., Siciliano, M., Mascolo, G., Grasso, F. M., & Contini, D. (2014). Source apportionment of PM2.5 in the harbour-industrial area of Brindisi (Italy): Identification and estimation of the contribution of in-port ship emissions. *Science of the Total Environment*, *497–498*, 392–400. https://doi.org/10.1016/j.scitotenv.2014.08.007

Chen, J., Zheng, T., Garg, A., Xu, L., Li, S., & Fei, Y. (2019). Alternative Maritime Power application as a green port strategy: Barriers in China. *Journal of Cleaner Production*, *213*, 825–837. https://doi.org/10.1016/j.jclepro.2018.12.177

Chib, A., May, J., & Barrantes, R. (2015). Impact of information society research in the global south. In *Impact of Information Society Research in the Global South*. https://doi.org/10.1007/978-981-287-381-1

D'Amico, G., Szopik-Depczyńska, K., Dembińska, I., & Ioppolo, G. (2021). Smart and sustainable logistics of Port cities: A framework for comprehending enabling factors, domains and goals. *Sustainable Cities and Society*, *69*(February). https://doi.org/10.1016/j.scs.2021.102801

Ducruet, C., Polo Martin, B., Sene, M. A., Lo Prete, M., Sun, L., Itoh, H., & Pigné, Y. (2024). Ports and their influence on local air pollution and public health: A global analysis. *Science of the Total Environment*, *915*(January). https://doi.org/10.1016/j.scitotenv.2024.170099

Elkhayat, Y., Mohamed, B., Zayat, M. El, & Marzouk, M. (2024). Bibliometric analysis

and visualization of sustainable infrastructure. *Innovative Infrastructure Solutions*, *9*(1), 1–16. https://doi.org/10.1007/s41062-023-01319-y

Fauzi, I., & Ispandiari, A. R. (2024). Green LNG Supply Chain: Optimizing Distribution in Eastern Indonesia. *Evergreen*, *11*(3), 2624–2637. https://doi.org/10.5109/7236902

Fei, H., Shi, H., & Pan, X. (2025). A Systematic Review of Green Port Evaluation: Methods, Subjects, and Indicators. *Journal of Marine Science and Engineering*, *13*(3). https://doi.org/10.3390/jmse13030604

Girard, L. F., & Nocca, F. (2020). Climate change and health impacts in urban areas: Towards hybrid evaluation tools for new governance. *Atmosphere*, *11*(12). https://doi.org/10.3390/atmos11121344

Grange, S. K., & Carslaw, D. C. (2019). Using meteorological normalisation to detect interventions in air quality time series. *Science of the Total Environment*, *653*, 578–588. https://doi.org/10.1016/j.scitotenv.2018.10.344

Lee, T., Yeo, G. T., & Thai, V. V. (2014). Environmental efficiency analysis of port cities: Slacks-based measure data envelopment analysis approach. *Transport Policy*, *33*, 82–88. https://doi.org/10.1016/j.tranpol.2014.02.009

Lim, W. M., Kumar, S., & Donthu, N. (2024). How to combine and clean bibliometric data and use bibliometric tools synergistically: Guidelines using metaverse research. *Journal of Business Research*, *182*(June), 114760. https://doi.org/10.1016/j.jbusres.2024.114760

Logothetis, I., Antonopoulou, C., Sfetsioris, K., Mitsotakis, A., & Grammelis, P. (2021). Comparison Analysis of the Effect of High and Low Port Activity Seasons on Air Quality in the Port of Heraklion. *Evironmental Sciences Proceedings*, *8*(3). https://doi.org/10.3390/ecas2021-10329

Maragkogianni, A., & Papaefthimiou, S. (2015). Evaluating the social cost of cruise ships air emissions in major ports of Greece. *Transportation Research Part D: Transport and Environment*, *36*, 10–17. https://doi.org/10.1016/j.trd.2015.02.014

Meng, L., Liu, K., He, J., Han, C., & Liu, P. (2022). Carbon emission reduction behavior strategies in the shipping industry under government regulation: A tripartite evolutionary game analysis. *Journal of Cleaner Production*, *378*(1550), 134556. https://doi.org/10.1016/j.jclepro.2022.134556

Merk, O. (2013). OECD Regional Development Working Papers 2013/13 The Competitiveness of Global Port-Cities: Synthesis Report. In *OECD Regional Development Working Papers*. https://doi.org/https://dx.doi.org/10.1787/5k40hdhp6t8s-en

Mîndroiu, B. I., Scurtu, I. C., Boșneagu, R., & Naval, B. (2025). The Present Landscape Of Greenhouse Gas Emissions In Maritime Transportation. *Technium Sustainability*, *8*, 84–94. https://doi.org/https://doi.org/10.47577/sustainability.v8i.12489

Qu, Y., Kong, Y., Li, Z., & Zhu, E. (2023). Pursue the coordinated development of port-city economic construction and ecological environment: A case of the eight major ports in China. *Ocean and Coastal Management*, *242*(March), 106694. https://doi.org/10.1016/j.ocecoaman.2023.106694

Roy, A., & Chakraborty, M. (2025). A review of ship emissions impacts on

 © 2026 by MIP

environmental, health, societal impacts and IMO's mitigation policies. *Regional Studies in Marine Science*, *81*(December 2024), 103964. https://doi.org/10.1016/j.rsma.2024.103964

Setyaningsih, O., Hehamahwa, J. L., Fauzi, I., & Putriani, O. (2024). Port Electrification: A Review of the Development of Electricity and New Renewable Energy Utilization. *Evergreen*, *11*(4), 3626–3639.

Shen, J., Ren, X., Feng, Z., & Nie, J. (2024). The impact of public environmental concerns on port sustainability: evidence from 44 port cities in China. *Frontiers in Marine Science*, *11*(January), 1–16. https://doi.org/10.3389/fmars.2024.1454242

Shim, H., & Shin, K. (2022). Empirical analysis of evidence-based policymaking in r&d programmes. *Sustainability (Switzerland)*, *14*(1), 1–15. https://doi.org/10.3390/su14010311

Sun, L., Zhang, J., Ducruet, C., Itoh, H., & Liu, X. (2025). The impact of shipping activities on air quality and residents' health in China's port cities. *Journal of Transport Geography*, *123*(December 2024). https://doi.org/10.1016/j.jtrangeo.2024.104099

Tichavska, M., & Tovar, B. (2015a). Environmental cost and eco-efficiency from vessel emissions in Las Palmas Port. *Transportation Research Part E: Logistics and Transportation Review*, *83*, 126–140. https://doi.org/10.1016/j.tre.2015.09.002

Tichavska, M., & Tovar, B. (2015b). Port-city exhaust emission model: An application to cruise and ferry operations in Las Palmas Port. *Transportation Research Part A: Policy and Practice*, *78*, 347–360. https://doi.org/10.1016/j.tra.2015.05.021

Tichavska, M., Tovar, B., Gritsenko, D., Johansson, L., & Jalkanen, J. P. (2019). Air emissions from ships in port: Does regulation make a difference? *Transport Policy*, *75*(February 2017), 128–140. https://doi.org/10.1016/j.tranpol.2017.03.003

Türkistanlı, T. T., Özispa, N., & Tu, G. (2025). Exploring Research Trends on Climate Change : Insights into Port Resilience and Sustainability. *Sustainability*, *17*, 1–20. https://doi.org/https:// doi.org/10.3390/su17083542

UNCTAD. (2009). UNCTAD (United Nations Conference on Trade and Development)-Review of Maritime Transport, 2009. In *Review of Maritime Transport*. http://www.unctad.org/en/docs/rmt2009_en.pdf

Wang, S., Zhen, L., Psaraftis, H. N., & Yan, R. (2021). Implications of the EU's Inclusion of Maritime Transport in the Emissions Trading System for Shipping Companies. *Engineering*, *7*(5), 554–557. https://doi.org/10.1016/j.eng.2021.01.007

Yau, K. L. A., Peng, S., Qadir, J., Low, Y. C., & Ling, M. H. (2020). Towards Smart Port Infrastructures: Enhancing Port Activities Using Information and Communications Technology. *IEEE Access*, *8*(c), 83387–83404. https://doi.org/10.1109/ACCESS.2020.2990961

Received: 14th April 2025. Accepted: 8th August 2025

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 24 ISSUE 2 (2026), Page 741 – 756

FROM POLICY TO PRACTICE: ANALYSING BEHAVIOURAL PATTERNS IN THE UTILISATION OF TEACHERS' QUARTERS IN MALAYSIA

Nur Nabila Ahmad Azam[1], Mariana Mohamed Osman[2], Abdul Razak Sapian[3], Syafiee Shuid[4]

[1,2,3,4]*Kulliyyah of Architecture and Environmental Design,*
UNIVERSITI ISLAM ANTARABANGSA MALAYSIA

Abstract

Despite continuous provision, the underutilisation of Malaysian teacher quarters persists, highlighting a mismatch between housing availability and actual occupancy. While previous research heavily focuses on housing supply, the underlying behavioural dynamics driving utilisation remain underexplored. This research conceptualises housing utilisation as a sequential journey from awareness to application and eventual access. Drawing on a survey of 6,496 Ministry of Education personnel, this study investigates application tendencies alongside perceptions of living conditions. Results indicate a substantial disconnect between basic awareness and active application, proving awareness alone cannot guarantee engagement. While perceptions of housing quality hold statistical significance, their overall impact is marginal. Conversely, systemic barriers regarding limited availability and outcome uncertainty strongly dictate application decisions. Ultimately, these results emphasise addressing both behavioural hurdles and access limitations to optimise the use of current public housing assets.

Keywords: housing utilisation; sustainable development goals (SDG), behavioural process; public housing; teacher quarters; awareness-application gap

[1] Corresponding author. Email: nabilazam@gmail.com

INTRODUCTION

Public housing is allocated to assist civil servants, notably educators, in executing professional duties across varied geographical environments (Abdul Rani et al., 2021). Within Malaysia, these quarters serve a crucial function in optimising workforce distribution and enhancing employee welfare, especially in regions lacking sufficient private residential options. Despite ongoing supply, the underutilisation of such facilities constitutes a chronic challenge, with 36.6% (17,524) of residences standing vacant (Sissoho et al., 2025). This indicates an incongruity between facility provision and practical occupancy which remains inadequately rationalised through mere supply or geographic variables alone.

Prior literature concerning public housing has predominantly emphasized provision (Yaacob et al., 2022), policy frameworks (Khair et al., 2022), alongside structural performance (Teo et al., 2025), affording marginal consideration towards behavioural dimensions of facility utilisation. Specifically, the psychological conversion from mere awareness of housing availability towards active application remains poorly theorised, despite being fundamental for dictating final occupancy outcomes. The coexistence of broad awareness alongside minimal application indicates that underutilisation likely exposes systemic fractures within cognitive pathways bridging recognition to active engagement, rather than strictly indicating material shortages or spatial disadvantages.

This research investigates the utilisation of teacher quarters throughout Malaysia as a behavioural continuum encompassing awareness, application, and access. Utilising a comprehensive questionnaire survey among Ministry of Education (MoE) personnel (n = 6,496), the empirical analysis evaluates application tendencies alongside residential perceptions. The results uncover a profound divergence between awareness and application, whereas perceptual variables demonstrate restricted explanatory capacity in determining formal application conduct. Conversely, tangible limitations concerning physical availability and unpredictable administrative outcomes exert a noticeably superior impact. Consequently, these discoveries emphasise conceptualising residential utilisation as a behavioural trajectory simultaneously dictated by individual decision-making frameworks and structural access constraints.

LITERATURE REVIEW

Public Housing and Underutilisation

Public housing discourse frequently attributes housing shortages to insufficient construction, assuming that increased physical output will automatically resolve unmet need (Ebekozien et al., 2022; Sujith et al., 2021). This supply-centric framing, however, fails to account for a recurring paradox within public housing systems: the coexistence of substantial vacancy alongside persistent demand

pressures (Ebekozien et al., 2022; Zulkanain et al., 2021). The presence of unoccupied units, particularly within government housing, challenges the assumption that vacancy reflects excess supply.

Housing mismatch literature suggests instead that vacancy in non-market systems often reflects allocative distortion rather than aggregate demand failure (Van Ommeren & Van der Vlist, 2016). Units may be technically "supplied," yet effectively removed from consumption due to structural constraints and behavioural responses. Underutilisation is empirically linked to multidimensional demand–supply mismatch, where misalignment between housing attributes, location, access conditions, and user expectations prevents effective occupancy. Underutilisation, therefore, emerges from misalignment between housing provision and user engagement.

Behavioural Perspectives in Housing Utilisation

Housing demand is not simply determined by demographic need or housing supply but emerges through decision-making processes in which individuals evaluate housing options, navigate constraints, and adjust behaviour in response to available alternatives. Within this perspective, housing choice is best understood as conditional and constrained behaviour, shaped by the interaction between household preferences, housing attributes, and contextual conditions.

A foundational contribution to this perspective is the argument that housing demand reflects the evaluation of bundles of attributes, rather than a simple acceptance of available housing supply (Lancaster, 1966). Accordingly, rejection of a housing option does not necessarily indicate absence of need but rather dissatisfaction with the attributes offered relative to household expectations or constraints (Dauda, 2019; Głuszak, 2015; Han, 2010). Housing demand is therefore evaluative and adaptive, reflecting how households respond to contextual conditions and available alternatives. Bramley (2013) emphasises that housing demand is elastic and conditional, shaped by behavioural adjustment rather than fixed demographic projections.

The Transition from Awareness to Application in Housing Decisions

Beyond evaluation, housing demand unfolds through sequential stages of engagement rather than a single-point decision (Megbolugbe et al., 1991). Gaetano (2023) distinguishes between potential demand (underlying need), actual demand (active search or application), and realised demand (successful occupancy), highlighting that movement between these stages is not automatic. Attrition may occur when housing options fail to meet expectations or when procedural barriers discourage participation.

Similarly, Khair et al. (2022) describe housing demand as a dynamic pathway comprising entry, living, and exit stages. Within this staged perspective,

© 2026 by MIP

activation represents the transition from latent eligibility and awareness to the formal expression of demand through application (Gaetano, 2023). This transition is influenced by awareness of availability, perceived eligibility, perceived suitability, and trust in the application and allocation process. A low number of applications may therefore signal informational barriers, perceived procedural risk, or reduced confidence in the application process, rather than lack of interest in housing per se.

The Interplay Between Perception and Structural Limitations

Housing choice does not occur in isolation from structural and access conditions. In many public housing systems, allocation mechanisms, matching rules, and waiting costs significantly influence acceptance behaviour (Murra-Anton & Thakral, 2024). Housing demand is therefore shaped not only by preferences or attributes but also by structural and procedural conditions that regulate access.

Perception plays a critical role in shaping engagement. Perceptions of procedural fairness have been shown to influence acceptance of housing allocation systems (Newlands & Lutz, 2020). Administrative burdens, including learning costs, compliance costs, and psychological costs, further shape how individuals experience housing application processes (Moynihan & Herd, 2023). Where procedures are opaque, complex, or unpredictable, they generate disengagement and reduce programme take-up.

At the behavioural level, eligible households may delay or refuse housing offers due to perceived value deficits, stigma, safety concerns, or dissatisfaction with maintenance standards (Cui & Osborne, 2023). These responses demonstrate that utilisation outcomes are shaped by both subjective evaluation and structural constraints affecting access and certainty

Research Gap

Despite the growing body of literature, existing behavioural models remain insufficient in explaining how structural conditions shape progression across demand stages, from awareness and application to eventual access. Existing studies tend to examine these dimensions in isolation, focusing either on housing attributes, behavioural responses, or structural conditions independently. This fragmentation limits the ability to explain how behavioural gaps, particularly between awareness and application, translate into observable utilisation outcomes.

As a result, underutilisation may arise not from the absence of housing need but from disruptions in the behavioural process linking awareness to application and access. There remains a need for an integrated perspective that examines how behavioural decision-making interacts with structural constraints to shape housing utilisation in public housing systems.

© 2026 by MIP

Research Design and Methodology

This study adopts a quantitative approach to examine behavioural patterns in the utilisation of teacher quarters in Malaysia, with particular focus on application behaviour and underlying perceptions. A questionnaire survey was employed as the primary data source to capture user-level responses, enabling demand to be analysed as a behavioural process reflected in awareness, application, and access decisions.

The survey instrument was developed based on the study's conceptual framework and informed by relevant literature. It comprises two main components: (i) socio-demographic variables, including income, job grade, marital status, and years of service; and (ii) perception-based measures covering physical condition, living environment, location, safety, and awareness of quarters provision. Perception items were measured using Likert-scale responses, while behavioural variables such as application status were operationalised as categorical indicators.

The study targeted employees under the Ministry of Education (MoE) across Malaysia, including both teaching and non-teaching staff whereby a purposive–voluntary response approach was adopted. Data were collected between December 2022 and February 2023 using a mixed-mode strategy combining online distribution through official communication channels and limited on-site administration. A total of 6,496 valid responses were obtained after data cleaning, providing sufficient variation for descriptive and inferential analysis, although the sample does not claim strict probabilistic representativeness.

Quantitative analysis was conducted in two stages. Descriptive statistics, including frequencies and percentages, were used to profile respondents and establish baseline patterns of occupancy, awareness, and application behaviour. Analyses were conducted using different respondent subsets depending on the variables examined. Perception-related analyses were based on the full sample (n = 6,496), while analyses of application behaviour were restricted to non-resident respondents (n = 3,562). Analysis of application outcomes was further limited to applicants only (n = 510).

Inferential analysis was then employed to examine behavioural relationships. Chi-square tests were used to assess associations between socio-demographic variables and application behaviour among non-residents. Exploratory Factor Analysis (EFA) with varimax rotation was conducted to identify latent perception dimensions. These factors were subsequently used in binary logistic regression to evaluate their association with application behaviour.

All data were cleaned and standardised prior to analysis. Reliability of perception constructs was assessed using Cronbach's alpha, with all factors demonstrating acceptable internal consistency. Statistical findings are interpreted

© 2026 by MIP

as associative rather than causal, consistent with the behavioural focus of the study.

ANALYSIS AND DISCUSSION

Respondent Profile and Occupancy Context

Table 1 summarises the socio-demographic profile of respondents and their quarters occupancy status. Occupancy is higher among male teachers (51.1%) than females (41.8%), and declines consistently with age, from over 60% among those below 30 to 33.0% among those aged 50 and above. A similar pattern is observed across marital status and career stage, with higher occupancy among single (59.9%) and early-career teachers (up to 60.6%), compared to married and long-serving personnel.

Income and job category further reinforce this trend. Lower-income groups (≤ RM5,000) exhibit substantially higher occupancy (57.6–64.0%), while participation declines sharply among higher-income respondents (17.7%). Members of the implementing group (58.8%) also record higher occupancy than academic staff. Overall, these patterns indicate that teacher quarters are primarily utilised by younger, lower-income, and early-career employees, suggesting that utilisation is shaped by life stage and housing needs rather than uniformly distributed across the workforce.

Table 1: Crosstab: Socio-demographic Characteristics and Quarters Occupancy

Item	Variable	Total (n = 6,496)		Occupying Quarters (%)
		F	%	
Gender	Male	2321	35.7	51.1
	Female	4175	64.3	41.8
Age	Less than 25	50	0.8	60.0
	25 - 29	708	10.9	63.5
	30 - 34	926	14.3	54.4
	35 - 39	1036	15.9	48.5
	40 - 44	1275	19.6	42.5
	45 - 49	915	14.1	41.6
	50 and above	1586	24.4	33.0
Marital status	Single	1253	19.3	59.9
	Married	5243	80.7	41.6
Job grade	Academic Teacher (DG 41/42, DG44 DG48 DG52 DG54)	4798	73.9	41.2
	Academic Teacher (DG29 DG32 DG34 DG38 DG40)	362	5.6	47.0
	Members of Implementing Group (AKP)	1336	20.6	58.8
Household income	RM 2,500 and below	417	6.4	64.0
	RM 2,501 – RM 5,000	2184	33.6	57.6
	RM 5,001 – RM 8,000	2313	35.6	41.5

Item	Variable	Total (n = 6,496)		Occupying Quarters
		F	%	(%)
	RM 8,001 – RM 11,000	949	14.6	33.1
	RM 11,001 – RM 14,000	435	6.7	22.8
	RM 15,000 and above	198	3.0	17.7
Education level	Certificate (Sijil)	1063	16.4	58.9
	Diploma	438	6.7	54.1
	Bachelor's Degree	4449	68.5	41.9
	Master's Degree	536	8.3	37.5
	Doctorate or its equivalent	10	0.2	50.0
Years of service	Less than a year	253	3.9	54.9
	1-5	960	14.8	60.6
	6-10	944	14.5	50.8
	11-15	1206	18.6	42.8
	16-20	1056	16.3	45.5
	21-25	768	11.8	39.6
	26-30	786	12.1	30.8
	More than 30 years	523	8.1	36.3

Source: Author's Calculation.

While occupancy patterns indicate selective utilisation, the transition from awareness to application reveals a more fundamental behavioural gap.

Quantifying the Awareness-Application Gap

Figure 1 illustrates a substantial gap between awareness and application among non-resident teachers. While awareness of quarters provision is nearly universal (94.6%), only a small proportion (14.3%) reported having applied. This indicates that awareness alone does not translate into application behaviour, suggesting the presence of a significant activation gap.

The disparity highlights that barriers to utilisation emerge not at the level of information access, but at the decision-making stage. Despite widespread awareness, a large majority of eligible individuals do not proceed to apply, implying that factors beyond awareness such as perceived suitability, preferences, or constraints play a critical role in shaping initial engagement with teacher quarters.

© 2026 by MIP

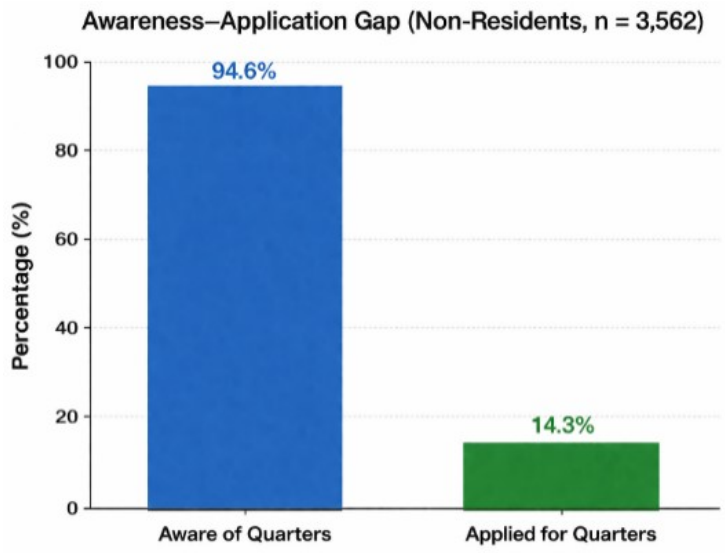


Figure 1: Awareness–Application Gap in Teacher Quarters Utilisation (Non-Residents, n = 3,562).
Source: Author's Calculation

Given this gap, it is important to examine whether application behaviour varies across different socio-demographic groups.

The Impact of Socio-Demographic Factors on Application Decisions

As outlined in Table 2, the propensity of non-resident teachers to apply for quarters is subject to distinct socio-demographic variations. The analysis reveals an uneven distribution in application behaviour, highlighting statistically significant correlations with the applicants' age group (p = .004), marital status (p = .041), job grade (p = .024), years of service (p = .025), and geographical zone (p = .002). In contrast, underlying factors such as gender, overall household income, and highest level of education demonstrate no significant statistical bearing on the decision to apply.

These findings suggest that application decisions are shaped more by life stage, employment context, and spatial factors than by basic demographic or socioeconomic characteristics. The significance of age and years of service indicates that career progression influences engagement with quarters, while the effect of geographical zone points to contextual variation in access or availability. Overall, application behaviour appears to be selectively patterned rather than broadly determined by general demographic attributes.

Table 2: Chi-Square Results: Application Status × Socio-Demographic Variables (non-residents, n = 3,562)

Socio-Demographic Variable	χ^2	df	p (Sig.)	Relationship
Gender	1.684	1	.194	Not significant
Age Group	19.003	6	.004	**Significant**
Marital Status	4.183	1	.041	**Significant**
Job Grade	7.499	2	.024	**Significant**
Household Income	6.128	5	.294	Not significant
Education Level	5.887	4	.208	Not significant
Years of Service	15.995	7	.025	**Significant**
Zone (Geographical Region)	17.085	4	.002	**Highly significant**

Beyond demographic variation, understanding why eligible individuals do not apply provides further insight into behavioural constraints.

Factors Deterring Application

As depicted in Figure 2, the rationales for non-application among non-resident teachers are multifaceted. The predominant factor is current home ownership, accounting for 55.2% of responses, succeeded by concerns regarding the overall suitability of the living environment (27.3%). Remaining variables, encompassing building typology, perceived safety, and specific locational preferences, exert a marginal individual influence (each below 10%). Consequently, the decision to abstain from applying is primarily dictated by personal housing status, compounded by a variety of qualitative housing concerns.

© 2026 by MIP

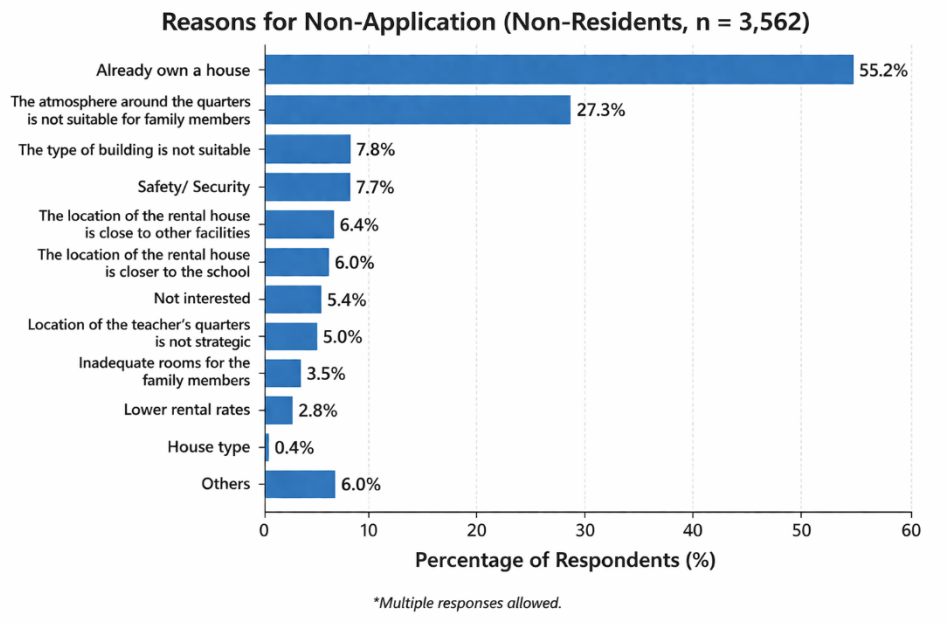


Figure 2: Reasons for Non-Application (Non-Residents, n = 3,562)
Source: Author's Calculation

The findings reflect both behavioural and structural influences on application decisions. Ownership and preference-based factors suggest that some individuals opt out due to alternative housing arrangements, while concerns related to environment and design indicate evaluative judgments about suitability. However, open-ended responses further reveal that structural constraints play a substantial role, with 83.9% of responses referring to issues such as lack of vacancy, absence of quarters, or long waiting lists. This indicates that non-application is not solely a matter of preference, but is also shaped by perceived or experienced limitations in housing availability and access.

In addition to reported reasons, broader perception patterns offer a more comprehensive view of residential decision-making.

Perceived Barriers to Residing in Teacher Quarters

Respondents were asked about their perception of barriers to residing in teacher quarters. Table 3 presents respondents' perceptions of factors influencing unwillingness to reside in teacher quarters. The highest levels of agreement are associated with physical and environmental conditions, with over 85% of respondents indicating poor physical condition (86.6%) and non-conducive living environments (85.4%). Maintenance-related concerns (78.7%) and home

ownership (75.6%) also feature prominently, followed by locational advantages of alternative housing (69.8%) and safety-related issues (66.4%).

Table 3: Perceived Barriers to Residing in Teacher Quarters (All respondents, n = 6,496)

No	Perceived Barriers to Residing in Teacher Quarters	% Agree
1	Poor physical condition of quarters	86.6
2	Non-conducive physical environment	85.4
3	High maintenance costs	78.7
4	Already own a house	75.6
5	Better access to facilities in alternative housing	69.8
6	Security and social concerns	66.4
7	Unsuitable building type	63.8
8	Unsuitable house type	65.2
9	Inadequate space for family	60.3
10	Unsuitable living environment for family members	58.7
11	Preference for housing closer to school	58.1
12	High proportion of vacant units	53.8
13	Unstrategic location of quarters	48.2
14	Lower rental cost of alternative housing	46.5

Source: Author's Calculation

The pattern suggests a clear perception hierarchy, where decisions are primarily shaped by evaluations of physical quality and living conditions, followed by comparative considerations with alternative housing options. Design-related factors, including building type and space adequacy (60.3–65.2%), and locational preferences further reinforce this pattern, while financial considerations such as lower rental costs of alternative housing (46.5%) appear comparatively less influential.

Overall, the findings indicate that reluctance to reside in teacher quarters is driven more by perceived inadequacy of physical conditions and comparative housing advantages than by cost considerations alone, highlighting the importance of perceived quality and suitability in shaping residential decisions.

To further examine how these perceptions are structured, an exploratory factor analysis was conducted.

Latent Perception Structure (Exploratory Factor Analysis)

Table 4 presents the results of the exploratory factor analysis, which identifies four underlying dimensions shaping perceptions of teacher quarters, explaining a total of 67.69% of variance. The first factor, *Family and Design Suitability* (21.49%), captures concerns related to spatial adequacy, housing design, and environmental suitability for family living. The second factor, *Physical and*

© 2026 by MIP

Maintenance Condition (17.74%), reflects perceptions of structural quality and the burden of upkeep.

The third factor, *Locational and Ownership Alternatives* (14.77%), represents preferences for private housing options, including proximity to amenities and schools, as well as home ownership. The fourth factor, *Safety and Financial Concerns* (13.68%), relates to perceptions of security risks associated with vacant units and comparatively minor financial considerations.

Overall, the factor structure indicates that perceptions are not isolated but organised into distinct yet interrelated dimensions, with physical condition and family suitability emerging as primary evaluative domains, alongside comparative and contextual considerations influencing residential decision-making.

Table 4: Exploratory Factor Analysis of Perceived Barriers to Residing in Teacher Quarters (All respondents, n = 6,496)

Factor	High-Loading Items (≥ 0.60)	Variance Explained (%)
Family and Design Suitability (Factor 1)	Inadequate space for family (.79); Unsuitable living environment for family members (.78); Unsuitable house type (.73); Unsuitable building type (.71); Unstrategic location of quarters (.58)	21.49
Physical and Maintenance Condition (Factor 2)	Non-conducive physical environment (.87); Poor physical condition of quarters (.87); High maintenance costs (.82)	17.74
Locational and Ownership Alternatives (Factor 3)	Better access to facilities in alternative housing (.82); Preference for housing closer to school (.80); Already own a house (.76)	14.77
Safety and Financial Concerns (Factor 4)	High proportion of vacant units (.85); Security and social concerns (.78); Lower rental cost of alternative housing (.60)	13.68
	Total Variance Explained	**67.69**

Note: *Extraction method: Principal Component Analysis; Rotation: Varimax with Kaiser Normalization. Source: Author's Calculation.*

Building on this structure, the next analysis examines whether these perception dimensions influence application behaviour.

Influence of Perception on Application Behaviour

To examine whether perception dimensions are associated with application behaviour, a logistic regression model was estimated using data from non-resident teachers (n = 3,562), focusing on activation-stage decisions among those not currently residing in quarters.

As shown in Table 5, three of the four perception dimensions are statistically significant. *Family and Design Suitability* (OR = 0.839, p < .001) and *Locational and Ownership Alternatives* (OR = 0.844, p = .002) are negatively associated with application, indicating that stronger perceptions of spatial inadequacy or preference for alternative housing reduce the likelihood of applying. In contrast, *Physical and Maintenance Condition* shows a positive association (OR = 1.268, p < .001), suggesting that more favourable evaluations of physical conditions increase the probability of application. *Safety and Financial Concerns* does not demonstrate a statistically significant relationship.

Table 5: Logistic Regression of Perception Factors on Application Behaviour (Non-Residents, n = 3,562)

Predictor	B	S.E.	Wald	Sig.	Exp(B)
Family & Design Suitability	–0.176	0.049	13.017	.000	0.839
Physical & Maintenance Condition	0.238	0.049	23.829	.000	1.268
Locational & Ownership Alternatives	–0.170	0.055	9.663	.002	0.844
Safety & Financial Concerns	–0.077	0.050	2.334	.127	0.926
Constant	–1.746	0.050	1233.109	.000	0.174

Note: Model $\chi^2(4) = 48.773$, $p < .001$; Nagelkerke $R^2 = 0.024$. *Source: Author's Calculation.*

Although the model is statistically significant ($\chi^2 = 48.773$, $p < .001$), its explanatory power is modest (Nagelkerke $R^2 = 0.024$), indicating that perception alone explains only a small proportion of variation in application behaviour. This suggests that while perceptions are associated with activation decisions, other factors beyond evaluative perception play a more substantial role in shaping application behaviour.

However, application alone does not guarantee access, making it necessary to examine outcomes at the next stage.

Application Outcomes

Table 6 presents the distribution of waiting time and application outcomes among non-residents applicants (n = 510). Waiting time varies considerably, with 40.4% receiving a response within one month, while 24.9% report waiting more than one year. In terms of outcomes, 43.3% are successfully allocated quarters, whereas 17.5% cite lack of vacancy and 17.1% report receiving no response, with the remainder rejected or unresolved.

© 2026 by MIP

Table 6: Waiting Time and Application Outcomes among Non-Residents Applicants (n=510)

Category	Items	%
Waiting Time	1–4 weeks	40.4
	1–3 months	22.0
	4–12 months	12.5
	More than 1 year	24.9
Application Outcome	Accepted	43.3
	No vacancy available	17.5
	No response	17.1
	Rejected (unspecified/other)	22.1

Source: Author's Calculation.

These findings indicate that application does not consistently translate into housing access, reflecting variability in availability and response processes. The presence of extended waiting periods and uncertain outcomes suggests that progression from application to occupancy is not guaranteed, potentially influencing willingness to apply at earlier stages.

Taken together, these findings provide a basis for synthesising the behavioural and structural dynamics shaping utilization

Moving Forward: Synthesis and Strategic Recommendations

The findings collectively indicate that utilisation of teacher quarters is fundamentally behavioural rather than purely supply-driven. Despite near-universal awareness, the substantial gap between awareness and application demonstrates that access to information does not translate into engagement, highlighting a clear activation gap at the initial stage of the utilisation process.

These findings indicate that housing utilisation is shaped by the interaction between behavioural considerations and structural constraints, where perceived suitability influences decisions but does not fully determine engagement. The presence of availability limitations and uncertain outcomes suggests that improving utilisation requires not only addressing perception-related concerns but also ensuring consistent access and reliable allocation processes

CONCLUSION

Underutilisation of teacher quarters in Malaysia persists despite continued housing provision, indicating that the issue cannot be explained by supply conditions alone. This study demonstrates that the gap lies within the behavioural process linking awareness to application, where high levels of awareness do not translate into corresponding levels of engagement.

The findings highlight a key insight: housing utilisation is not solely determined by individual perceptions or preferences, but by how behavioural

decisions interact with conditions of access and certainty. While perception-related factors influence evaluation, their explanatory power in shaping application behaviour is limited. Instead, constraints related to availability, waiting conditions, and uncertainty of outcomes play a more decisive role in determining whether individuals proceed to apply.

This study contributes to the literature by reframing underutilisation as a behavioural process rather than a purely supply-driven issue. By focusing on the transition from awareness to application, it provides an integrated perspective that links individual decision-making with access conditions, offering a more precise explanation of how utilisation gaps emerge in public housing systems.

From a practical perspective, improving utilisation requires moving beyond increasing provision or enhancing housing attributes alone. Greater emphasis should be placed on reducing uncertainty in application outcomes, improving transparency of access, and ensuring more consistent availability. Addressing these factors can strengthen behavioural engagement and support more effective utilisation of existing housing stock.

REFERENCES

Abdul Rani, M. F., Teoh, W. H., Mohd Nasir, H. U., Razi, I. H., Shahjurul Azmi, M. T. A., Nasran, M. A., & Ahmad, S. N. (2021). *Seni Bina Kuarters Kerajaan di Malaysia*.

Bramley, G. (2013). Housing market models and planning. *Town Planning Review*, *84*(1), 9–35. https://doi.org/10.3828/tpr.2013.2

Cui, T., & Osborne, S. P. (2023). Unpacking value destruction at the intersection between public and private value. *Public Administration*, *101*(4), 1207–1226. https://doi.org/10.1111/padm.12850

Dauda, S. (2019). The Use of Multinomial Logistic Regression Model to Build Housing Choice in Abuja. *International Journal of Coal, Geology and Mining Research*, *1*(1), 1–35. www.eajournals.org

Ebekozien, A., Abdul-Aziz, A. R., & Jaafar, M. (2022). Low-cost housing demand-supply gap: Government housing planners perspective on possible solutions. *International Journal of Construction Management*, *22*(9), 1736–1745. https://doi.org/10.1080/15623599.2020.1742627

Gaetano, L. (2023). Housing need and search markets. *Journal of Infrastructure, Policy and Development*, *7*(2). https://doi.org/10.24294/jipd.v7i2.2030

Głuszak, M. (2015). Multinomial Logit Model of Housing Demand in Poland. *Real Estate Management and Valuation*, *23*(1), 84–89. https://doi.org/10.1515/remav-2015-0008

Han, X. (2010). Housing demand in Shanghai: A discrete choice approach. *China Economic Review*, *21*(2), 355–376. https://doi.org/10.1016/J.CHIECO.2010.02.006

Khair, N., Mohd Aini, A., Al, Z., Zyed, S., & Aini, A. M. (2022). Public Rental Housing (PRH) Operational Policies and Housing Pathways in Kuala Lumpur. In *Journal of the Malaysian Institute of Planners VOLUME* (Vol. 20).

© 2026 by MIP

Megbolugbe, I., Marks, A., & Schwartz, M. (1991). The Economic Theory of Housing Demand: A Critical Review. *Journal of Real Estate Research*, *6*(3). https://doi.org/10.1080/10835547.1991.12090650

Moynihan, D., & Herd, P. (2023). Special issue introduction: administrative burdens as a global public management phenomenon. *Asia Pacific Journal of Public Administration*, *45*(4), 342–344. https://doi.org/10.1080/23276665.2023.2242977

Murra-Anton, Z., & Thakral, N. (2024). The Public Housing Allocation Problem. *Journal of Economic Theory*, *210*.

Newlands, G., & Lutz, C. (2020). Fairness, legitimacy and the regulation of home-sharing platforms. *International Journal of Contemporary Hospitality Management*, *32*(10), 3177–3197. https://doi.org/10.1108/IJCHM-08-2019-0733

Sissoho, A., Rabe, N. S., & Osman, M. M. (2025). Assessment of Teachers' Perception of Facilities Provision in Teachers' Quarters. *Journal of the Malaysian Institute of Planners*, *23*(2), 454–465. https://doi.org/https://doi.org/10.21837/pm.v23i36.1731

Sujith, K. M., Biju, C. A., Varma Subhash, C. R., & Dili, A. S. (2021). Need based approach: a perspective for sustainable housing. *IOP Conference Series: Materials Science and Engineering*, *1114*(1), 012042. https://doi.org/10.1088/1757-899x/1114/1/012042

Teo, J. S., Mohd Aini, A., & Zyed, Z. A. S. (2025). Exploring performance measurement practices in public housing tenancy management in Malaysia. *Property Management*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/PM-04-2024-0029/FULL/PDF

Van Ommeren, J. N., & Van der Vlist, A. J. (2016). Households' willingness to pay for public housing. *Journal of Urban Economics*, *92*, 91–105. https://doi.org/10.1016/J.JUE.2015.11.007

Yaacob, A., Mohd Noor, N. H., & Chowdhury, S. R. (2022). A Review on Housing Policy and Practices in Malaysia in Providing Access to Housing: Are they adequate? *Environment-Behaviour Proceedings Journal*, *7*(19), 257–262. https://doi.org/10.21834/EBPJ.V7I19.3216

Zulkanain, M. I., Jaafar, M., Aras, N., & Salim, A. (2021). Exploring the Adaptive Reuse Concept and Benefits in Managing Public Building Quarters in Malaysia. *MCRJ Special Issue*, *12*(1)

Received: 7th April 2025. Accepted: 8th August 2025

NOTES TO CONTRIBUTORS AND GUIDELINES FOR MANUSCRIPT SUBMISSION

INTRODUCTION

The Journal of the Malaysian Institute of Planners or PLANNING MALAYSIA is a multidisciplinary journal related to theory, experiments, research, development, applications of ICT, and practice of planning and development in Malaysia and elsewhere.

The objective of the journal is to promote the activity of town planning through dialogue and exchange of views concerning professional town planning practice. PLANNING MALAYSIA will welcome any news, feature articles, or peer reviewed (including book reviews, software review, etc.) articles for publication. All articles should be original work by the authors. **Articles, views and features will not be taken to be the official view of the Malaysian Institute of Planners (MIP) unless it carries the name of MIP as the author.** This is to encourage open discussion on diverse issues and opinion for the advancement of town planning practice. Articles and contributions will be accepted from MIP members and non-members worldwide.

In year 2010, PLANNING MALAYSIA Journal has been indexed in SCOPUS. Previous issues of PLANNING MALAYSIA Journal can be viewed on the MIP website.

SUBMISSION OF MANUSCRIPTS

Manuscript should be emailed to pmjournal@gmail.com. Manuscript should ideally be in the range of 8-10 pages long. Each manuscript should have a title page and an abstract of about 150 words. The title page should contain the title, full name(s), designation(s), organizational affiliation(s), a contact address, and an email address. All manuscripts are received on the understanding that they are not under concurrent consideration at another journal. One copy of the current Journal will be provided for each article. Additional reprints of article can be ordered, at cost, by the author(s). PDF format of the article (if available) can be obtained from the Publisher.

LAYOUT

Manuscript should be typed in single spacing (including footnotes, endnotes and references) on one side of the paper only (preferably A4) with the following margins: right and left - 4.25 cm, top - 5.5 cm and bottom - 5.2 cm (including header – 4.5 cm and footer – 4.3 cm) in 11-point Times New Roman font. Footnotes should be numbered consecutively and placed at the end of the manuscript. Footnotes should be kept to a minimum. Tables and diagrams should be provided in the text. References should follow the APA (6th Edition) referencing format. All foreign words must be typed and transliterated. The Editorial Board reserves the right to change the transliteration of all historical names, titles and non-English terminology to bring them into conformity with its own style.

© 2026 by MIP

USE OF FORMULA, FIGURES AND TABLES

Formula (mathematical formula) should be used only when necessary and the CONCLUSION derived must be explained and made intelligible to a non-mathematical reader. Wherever possible, authors are encouraged to place the mathematical parts of the article in an appendix. In cases of empirical articles, authors are expected to make readily available a complete set of data and any specialized computer programs to interested readers.

All illustrations, figures and/or tables in the manuscript must be captioned, in clear black and white (grayscale) and ready for reproduction.

REFEREEING PROCEDURE

Manuscripts will be acknowledged upon receipt. Only selected (preferred) manuscripts will be **reviewed by two (or three) referees** in addition to the editors. Editorial decision will normally be made within **two to six months**, but circumstances beyond control occasionally dictate a longer cycle. If authors are invited to prepare a revision for further consideration, the major issues to be resolved will be outlined and will be forwarded to them as quickly as possible.

ACCEPTED ARTICLES

Authors of accepted articles will be requested to provide a digital copy of the manuscript, preferably in Microsoft Word to the MIP (the Publisher) via email at pmjournal@gmail.com. MIP will not be responsible for the loss or damage of the digital copy.

COPYRIGHT

Copyright & Creative Commons Licence
eISSN: 0128-0945 © Year. The Authors. Published for Malaysia Institute of Planners.
This is an open-access article under the CC BY-NC-ND license.

The authors hold the copyright without restrictions and also retain publishing rights without restrictions.

Contact:

Editor-in-Chief
PLANNING MALAYSIA
Journal of the Malaysian Institute of Planners
B-01-02, Jalan SS7/13B, Aman Seri, Kelana Jaya,
47301, Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: +603 78770637 Fax: +603 78779636
Email: pmjournal@gmail.com
Homepage: www.planningmalaysia.org

ETHIC STATEMENT

The Journal of the Malaysia Institute of Planners or **PLANNING MALAYSIA** is a peer-reviewed journal. This statement spells out ethical behaviour of all parties involved in the act of publishing an article for this journal, i.e. the author, the peer-reviewer, the chief editor and editors, and the publisher. This statement is based on COPE's Best Practice Guidelines for Journal Editors. URL: http://publicationethics.org/files/u2 /Best_Practice.pdf

DUTIES OF AUTHORS

Reporting Standards

Authors of original research should present an accurate account of the work done as well as an objective discussion of its significance. Data of the research should be represented accurately in the article. An article should contain sufficient detail and references to permit others to replicate the work. Fraudulent or knowingly inaccurate statements constitute unethical behaviour and are unacceptable.

Data Access and Retention

Authors may be asked to provide the raw data in connection with an article submitted for editorial review, and should be prepared to provide public access to such, if practicable, and should in any event be prepared to retain such data for a reasonable time after publication.

Originality and Plagiarism

Authors should ensure that they have written entirely original works, and if the authors have used the work and/or words of others this must be appropriately cited or quoted. Such quotations and citations must be listed in the Reference at the end of the article.

Multiple Publication

An author should not in general publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behaviour and is unacceptable.

Acknowledgment of Sources

Proper acknowledgment of the work of others must always be given. Authors should cite publications that have been influential in determining the nature of the reported work.

Authorship of the Paper

Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the study, and should be listed as co-authors. Others who have participated in certain substantive aspects of the research project, they should be acknowledged or listed as contributors.

© 2026 by MIP

Corresponding author.
Corresponding author is the author responsible for communicating with the journal for publication. The corresponding author should ensure that all appropriate co-authors and no inappropriate co-authors are included on the paper. All co-authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Acknowledgment of Funding Sources
Sources of funding for the research reported in the article should be duly acknowledged at the end of the article.

Disclosure and Conflicts of Interest
All authors should disclose in their manuscript any financial or other substantive conflict of interest that might be construed to influence the results or interpretation of their manuscript.

Fundamental Errors in Published Works
When an author discovers a significant error or inaccuracy in his/her own published work, it is the author's obligation to promptly notify the journal editor or publisher and cooperate with the editor to retract or correct the paper.

DUTIES OF REVIEWERS
Contribution of Peer Review
Peer review assists the chief editor and the editorial board in making editorial decisions while editorial communications with the author may also assist the author in improving the paper.

Unqualified to Review or Promptness
Any reviewer who feels unqualified to review the assigned manuscript or unable to provide a prompt review should notify the editor and excuse himself/herself from the review process.

Confidentiality
Manuscripts received for review must be treated as confidential documents. They must not be shown to, or discussed with, others except as authorized by the chief editor. Privileged information or ideas obtained through peer review must be kept confidential and not used for personal advantage.

Standards of Objectivity
Reviews should be conducted objectively. There shall be no personal criticism of the author. Reviewers should express their views clearly with supporting arguments.

Acknowledgment of Sources
Reviewers should identify relevant published work that has not been cited by the authors. Any statement that had been previously reported elsewhere should be accompanied by the relevant citation. A reviewer should also call to the chief editor's attention any

© 2026 by MIP

substantial similarity or overlap between the manuscript under consideration and any other published paper of which they have personal knowledge.

Conflict of Interest
Reviewers should decline to review manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors.

DUTIES OF EDITORS
Decision on the Publication of Articles
The chief editor of the PLANNING MALAYSIA is responsible for deciding which of the articles submitted to the journal should be published. The chief editor may be guided by the policies of the journal's editorial board subjected to such legal requirements regarding libel, copyright infringement and plagiarism. The chief editor may confer with other editors or reviewers in making this decision.

Fair play
Manuscripts shall be evaluated solely on their intellectual merit.

Confidentiality
The chief editor/editors and any editorial staff must not disclose any information about a submitted manuscript to anyone other than the corresponding author, reviewers, potential reviewers, other editorial advisers, and the publisher.

Disclosure and Conflicts of Interest
Unpublished materials disclosed in a submitted manuscript must not be used by anyone who has a view of the manuscript while handling it in his or her own research without the express written consent of the author

© 2026 by MIP

PLANNING MALAYSIA
JOURNAL OF THE MALAYSIAN INSTITUTE OF PLANNERS

B-01-02, Jalan SS7/13B, Aman Seri, Kelana Jaya,
47301, Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: +603 78770637 Fax: +603 78779636
Email: pmjournal@gmail.com or mip@mip.org.my
Website: www.planningmalaysia.org

ISSN 16756215
9 771675 621005