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## **URBAN COMMUNITY FARMING: LESSONS FROM JAPAN'S CHOKUBAI MODEL FOR BUILDING SOCIAL ENTERPRISES**

**Nikmatul Adha Nordin<sup>1</sup>, Yong Adilah Shamsul Harumain<sup>2</sup>,  
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### **Abstract**

This study examines the feasibility of implementing community farming as a framework for community-driven social enterprises in urban Malaysia. Inspired by Japan's Chokubai model, which emphasises the direct sale of locally produced goods, this study explores its potential to improve food security, economic empowerment, and social cohesion in highly urbanised areas. A roundtable discussion with nine key stakeholders was conducted using the Net-Map tool to map actors, relationships, and influences within the community farming ecosystem. This participatory approach identified critical factors contributing to project sustainability, highlighting that while government agencies provide substantial support, the most significant determinant of success is the community's active involvement. The study also noted challenges such as inadequate infrastructure and funding, which could be addressed through targeted policy interventions. The study concludes with strategic recommendations to promote community farming projects in urban Malaysia, addressing both policy and implementation challenges.

**Keywords:** community farming, social enterprise. Net-map, sustainable community, Chokubai Model civic ecology, community garden

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## **INTRODUCTION**

Urban farming in urban areas in Malaysia has a distinct potential to tackle challenges such as food poverty, unemployment, and environmental degradation. This paper examines the feasibility of implementing urban farming as a community-based social enterprise in these regions, taking inspiration from Japan's Chokubai model. In this model, farmers directly sell their agricultural products to consumers, ensuring the freshness of the produce and fostering a stronger bond between producers and the community. Urbanisation in Malaysia, particularly in rapidly expanding cities such as Kuala Lumpur, Shah Alam, and Subang Jaya, has intensified the need for innovative strategies to address food security, economic stability, and social cohesion challenges. Local initiatives, like those under the Selangor State Government's Local Agenda 21 Action Plans, have encouraged urban agriculture and community gardening as approaches to enhance local food production and foster economic growth while simultaneously addressing environmental sustainability (Mokhtar et al., 2022).

Urban farming, as a form of social enterprise, is increasingly acknowledged for its capacity to effectively tackle many urban difficulties in a coordinated manner. Through the coordination of community members towards achieving the common objective of sustainable food production, these projects have the potential to generate economic prospects, especially for marginalised groups. Additionally, urban farming fosters a sense of ownership and pride in local food systems by enabling individuals to actively engage in cultivation, enhancing community cohesion, and creating visible contributions to sustainable living (Machado, 2020).

Recent research highlights urban farming as a response to challenges posed by neoliberal practices, such as limited access to food and environmental degradation. It reflects a shift towards localised, self-reliant food systems while navigating the tension between community-oriented goals and market-driven imperatives. For instance, it integrates entrepreneurial frameworks while fostering collective resilience in urban contexts (David & Blondet, 2023). Additionally, the rise of urban agriculture has been linked to broader neoliberal transformations that emphasise individual responsibility in food production and sustainability efforts (Harrison & Wolf, 2023). Local communities actively participate in environmental stewardship, mainly through initiatives like urban farming. It highlights how residents, who often face challenges such as limited green space, food insecurity, and environmental degradation, come together to reclaim underutilised or neglected urban areas.

Studies have also investigated the role of urban agriculture in supporting low-carbon cities and enhancing biodiversity, particularly in Malaysian urban centres (Zulkifli, M. F., & Kamaruddin, R., 2019). By converting vacant lots, rooftops, and other spaces into productive agricultural sites, these communities not only improve their immediate environment but also

promote broader ecological and social values. The grassroots efforts in urban farming contribute significantly to community resilience. Communities can diminish their reliance on external food supplies by cultivating their sustenance, a practice that becomes especially crucial during periods of economic decline or during a pandemic or interruptions in the supply chain. Additionally, these practices foster a sense of ownership and empowerment among residents as they actively participate in creating healthier and more sustainable living conditions. Integrating urban farming into Malaysian urban planning has been identified as a step towards more sustainable and inclusive city development (Rahman, N. A., & Ishak, S. Z., 2020). By integrating green spaces into urban areas, communities can mitigate some of the negative impacts of urbanisation, such as pollution and habitat loss. Urban farming encourages social interaction and cooperation, strengthening community bonds and fostering a cohesive social fabric (Mahmood et al., 2019). It facilitates collaboration among residents while promoting sustainable practices and local food production.

## **LITERATURE REVIEW**

### **The Chokubai Model: A Japanese Inspiration**

Drawing inspiration from Japan's Chokubai model, which emphasises direct sales of locally farmed produce to consumers, this article investigates how comparable approaches may be adopted and implemented in Malaysia. Chokubai, a Japanese term meaning "direct sales," refers to a system where farmers sell their agricultural products directly to consumers without intermediaries. This model, prevalent in various regions of Japan, allows for the sale of fresh, seasonal produce while also promoting transparency and trust between farmers and consumers. The Chokubai model not only supports small-scale farmers but also strengthens local economies and reduces the carbon footprint associated with food transportation. The Chokubai model has demonstrated its efficacy in Japan, not only in bolstering the livelihoods of local farmers but also in fostering social cohesion by establishing direct connections between producers and customers. The potential of this concept to improve local food security and promote economic empowerment in urban Malaysian contexts is substantial.

The development of urban farming has been driven by the need to address food insecurity, improve economic conditions, and enhance community well-being in urban areas. Studies have shown that urban farming is considered an effective way to improve food security and economic conditions in urban areas, with the potential to provide positive impacts in various aspects, including economic, social, and environmental (Dalimunthe et al., 2023).

### ***Social Enterprises and Policy Implications***

Social enterprises in urban farming are emerging as vital players in addressing the multifaceted challenges of urbanisation, including food security, community

cohesion, and environmental sustainability. According to Doherty et al. (2014), social enterprises act as hybrid organisations, balancing their social missions with the need for financial sustainability. In the context of urban farming, these enterprises often focus on local food production, providing fresh produce to underserved urban communities and creating job opportunities for marginalised groups.

Recent research highlights the role of urban agriculture as a platform for social enterprises that foster community well-being and environmental sustainability. For example, Lin et al. (2021) demonstrate how urban farming initiatives promote economic development and social inclusion, offering a model for sustainable urban livelihoods. Similarly, Adams and Pahl (2020) explore integrating social enterprise principles into urban farming, showing how these initiatives can address food insecurity while creating job opportunities for marginalised groups. In Malaysia, the potential to enhance urban farming through social enterprise frameworks remains significant, with efforts focused on community participation and resilience building (Ahmad et al., 2021). Effective social enterprises should measure their impact through indicators like food production, community engagement, environmental benefits, and economic opportunities, as suggested by recent studies (Tan & Wong, 2022).

Successful social enterprises actively involve the community in decision-making processes and operations, such as engaging residents in farm management, employing community members, or collaborating with local organisations and schools (Lin et al., 2021). Urban farming social enterprises often integrate educational initiatives to promote awareness about sustainable agriculture, nutrition, and food systems, fostering stronger community engagement and support (Adams & Pahl, 2020). Moreover, adaptability enables these enterprises to navigate changing circumstances, including market shifts, regulatory changes, and environmental challenges (Tan & Wong, 2022).

## RESEARCH METHODOLOGY

Net-Map was conducted to identify stakeholders, linkages and influences, and goals pertaining to the potential of upgrading the *kebun komuniti* using an adapted version of the Net-Map methodology described by Schiffer (2007). The Net-Map methodology involves roundtable discussion for stakeholder mapping, linking stakeholders and establishing the stakeholders' influences on achieving the desired goals (Schiffer, 2007). Stakeholder mapping refers to identifying and categorising the key stakeholders who play a role in the network. Linking stakeholders means identifying relationships that connect stakeholders who are considering domains of influence (e.g., financial support).

Nine stakeholders participated in the roundtable discussion: local authorities (MBSJ - Majlis Bandaraya Subang Jaya and DBKL - Dewan Bandaraya Kuala Lumpur), Malaysia Cooperatives Societies Commission (SKM - Suruhanjaya

Koperasi Malaysia), Federal Agricultural Marketing Authority (FAMA - Lembaga Pemasaran Pertanian Persekutuan) and *kebun komuniti* (community garden) representatives (Subang Jaya and Kuala Lumpur). During the Net-Map exercise, six more stakeholders were identified, namely the Ministry of Agriculture and Food Security (KPKM – Kementerian Pertanian dan Keterjaminan Makanan), universities, banks, Malaysian Institute of Cooperatives (IKMA - Institut Koperasi Malaysia), Malaysian Institute of Entrepreneurship (INSKEN - Institut Keusahawanan Negara), and Implementation and Coordination Unit (ICU).

During the Net-Map exercise, the participants were asked to identify stakeholders that can influence the objective of helping *kebun komuniti* commercialise their produce using the Chokubai approach. The participants were asked to identify the kinds of support and resources that these stakeholders provide. The support and resources were then categorised into three linkages: (1) technical know-how, (2) financial support and (3) basic infrastructure. Table 1 elaborates the operational definitions of the three linkages.

**Table 1:** Operational definitions of the three linkages identified in this study

<b>Linkage</b>	<b>Operational definition</b>
(i) Technical know-how	Technical know-how refers to the specific knowledge, skills, and expertise required for effectively managing both the practical and operational aspects of community farming. This includes training in gardening techniques, such as crop cultivation, soil management, pest control, and sustainable practices, as well as expertise in marketing and business operations. By acquiring this comprehensive set of skills, <i>Kebun Komuniti</i> members can operate more sustainably, attract active participation, and generate income, thus advancing their transformation into a successful social enterprise.
(ii) Financial Support	Financial support refers to the funding and monetary resources needed to help <i>Kebun Komuniti</i> develop into a social enterprise. This support can come from various sources, such as grants, donations, loans, or investments from individuals, government bodies, non-governmental organizations, or private entities. Access to adequate financial resources enables the community farms to scale up their operations, enhance productivity, and create a sustainable model for generating income, aligning with the goals of a social enterprise like Chokubai.



Linkage	Operational definition
(iii)Basic Infrastructure	Basic infrastructure refers to the essential physical facilities and services required to support the smooth functioning of <i>Kebun Komuniti</i> as a social enterprise. This includes the development and maintenance of necessary structures such as greenhouses, storage facilities, irrigation systems, composting areas, and access roads. It also involves ensuring the availability of utilities like water supply, electricity, and waste management systems. Proper infrastructure provides the foundational support needed for efficient farming operations, increases productivity, and enhances the quality of the produce.

A roundtable discussion involving key participants was conducted to explore stakeholders' roles in transforming *kebun komuniti* into Chokubai. During the discussion, participants listed relevant stakeholders, including various government offices and agencies, and wrote their names on sticky notes. The central node of the Net-Map established "*Kebun Komuniti* as Chokubai", representing the goal of the exercise. The participants were subsequently asked to position sticky notes symbolising the stakeholders' distance from the centre node according to their perceived influence on attaining the goal in question. To visually represent the level of influence, arrows were drawn between the stakeholders and the central node, with thick lines indicating high influence and thin lines indicating low influence. Throughout the mapping process, participants were reminded to consider the influence of stakeholders in three specific categories: technical know-how, financial support, and basic infrastructure. This structured approach helped to clarify the roles, relationships, and levels of influence among stakeholders, providing valuable insights into the dynamics required to support *kebun komuniti*'s transformation into a Chokubai-like social enterprise. The participants were also asked to elaborate on the stakeholders' roles based on the following categories: Control, Improvement, Combination of Control, and Improvement. Table 2 shows the operational definitions of the categories:

**Table 2:** Operational definitions of the category of roles used in this study

Category	Operational Definition
Control	Represented by the stakeholders with green-colored nodes, indicating entities that have direct authority or regulatory power in providing technical assistance or shaping the guidelines for community farming practices.
Improvement	Represented by blue-colored nodes, indicating entities focused on enhancing the skills and knowledge base of <i>Kebun Komuniti</i> .

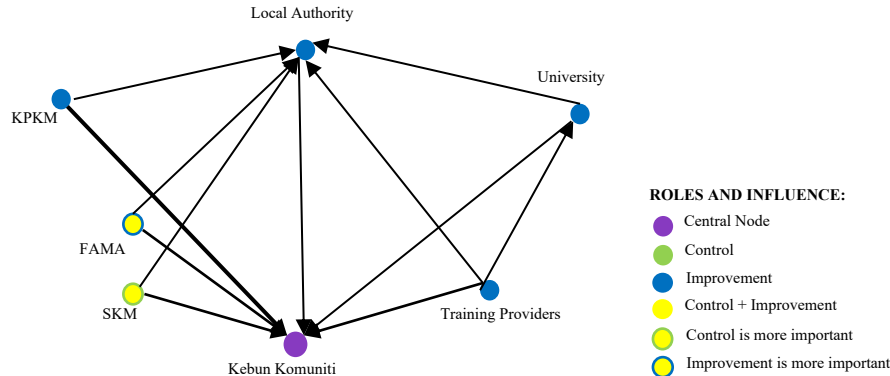
	These stakeholders are more involved in capacity-building, training, and knowledge transfer.
Combination of Control and Improvement	Stakeholders marked with both control and improvement play dual roles, contributing both regulatory oversight and efforts to enhance community farming technical skills.

The positions of stakeholders and the thickness of lines between them and the central node reflect their relative importance in guiding and supporting *kebun komuniti* toward becoming a Chokubai-like social enterprise.

## ANALYSIS AND DISCUSSION

### 1) Analysis of Stakeholders' Linkages

Fig. 1, Fig. 2 and Fig. 3 illustrate the Net-Maps of the stakeholders involved in street food safety for the three types of linkages: [A] Technical Know-How, [B] Financial Support, and [C] Basic Infrastructure. The lines and arrows between the stakeholders reflect the relationship between them, and the line's thickness denotes the strength of the relationship. The node colour represents the stakeholder's role (blue = control, green = improvement, yellow = both). If a stakeholder is involved in both roles, the coloured rim around the yellow node indicates whether control (blue) or improvement (green) is more important.

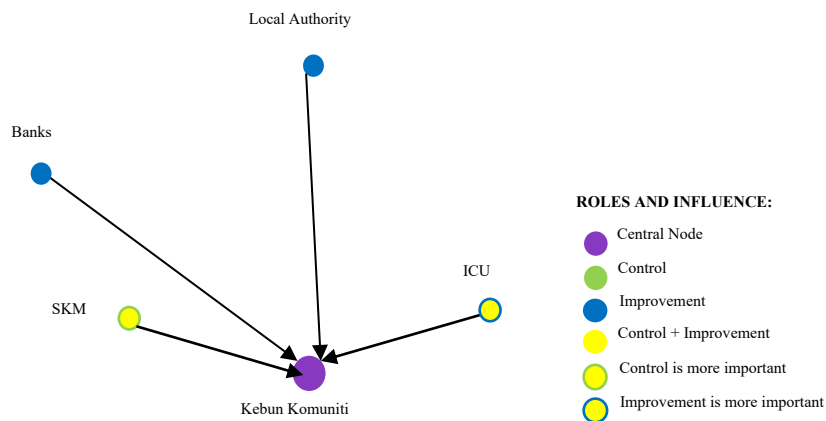


**Figure 1:** Net-Map Diagram showing interlinkages of stakeholders (Technical Know-How)

Figure 1 illustrates the network of relationships among various stakeholders involved in the training and capacity-building aspects of *kebun komuniti*. At the centre of the map, *kebun komuniti* is identified as the central node, emphasising its pivotal role in the network of interactions. Surrounding *kebun komuniti* are key stakeholders who are categorised according to their roles in control and improvement. Stakeholders such as KPKM, Local Authorities,

Universities, and Training Providers are represented as improvement nodes, indicating their focus on providing training, technical support, and capacity-building efforts to strengthen the community farming initiative.

In contrast, FAMA and SKM serve dual roles, balancing control and improvement. It suggests that they are involved in both regulatory oversight and offering supportive measures to promote sustainability. The direct and strong connections among these stakeholders signify collaborative efforts to enhance the operational and developmental capacities of *kebun komunitas*.

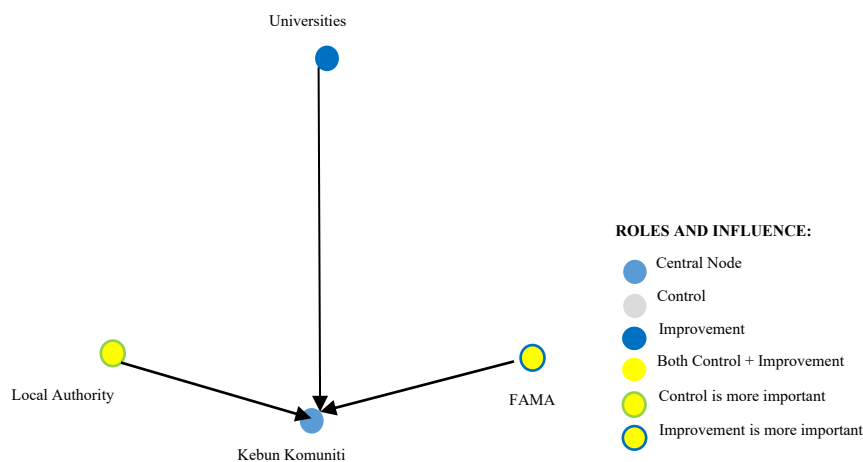


**Figure 2:** Net-Map Diagram showing interlinkages of stakeholders (Financial Support)

Figure 2 focuses on identifying stakeholders who are influential in providing financial support to facilitate the transformation of *Kebun Komuniti* into a Chokubai-like social enterprise. Positioned relatively close to the central node and connected with a moderately thick line, local authorities provide significant influence in providing financial support. This suggests that local authorities might offer grants, subsidies, or financial incentives to support community farming initiatives. Banks are positioned further from the central node with a thinner line, indicating a lower level of influence. Banks might play a role in providing loans or credit facilities, but their influence is more limited compared to public funding sources. They may also be less directly involved in grassroots community projects without structured financial plans.

Close to the central node with a medium-thickness line, reflecting moderate influence. SKM's involvement may relate to facilitating access to cooperative funds, grants, or other forms of financial assistance specifically for cooperatives and community-based enterprises. ICU (Implementation Coordination Unit) is positioned close to the central node with medium-thickness lines, indicating moderate influence. ICU likely plays a role in coordinating

government development funds or financial aid that could be directed to community projects like *Kebun Komuniti*. The diagram reveals that financial support is heavily influenced by governmental and cooperative bodies. Local authorities, SKM, and ICU are seen as the primary sources of financial support, which can be crucial for the sustainability and growth of community farming as a social enterprise. Banks' roles are less central, indicating that conventional banking institutions may not be the primary route for financial backing in this context.



**Figure 3:** Net-Map Diagram showing interlinkages of stakeholders (Basic Infrastructure)

Figure 3 illustrates the stakeholders involved in providing or facilitating access to the basic infrastructure necessary for turning *kebun komuniti* into a Chokubai-like social enterprise. Universities are positioned directly above the central node with a medium-thickness line, suggesting moderate influence. Universities are likely involved in providing infrastructure support through research facilities, demonstration plots, or technical resources that can enhance the community farming environment. Their role may include capacity-building infrastructure such as labs or spaces for training and community engagement. Local Authority is placed close to the central node with a medium-thickness line and marked in yellow, indicating a combined role in control and improvement. The local authority has moderate influence in facilitating basic infrastructure development. This could involve providing land, water access, or physical facilities like sheds or storage units for community farms, as well as ensuring access to utilities and public services. FAMA (Federal Agricultural Marketing Authority) is also positioned close to the central node with a medium-thickness

line and marked in yellow, indicating a role in control and improvement. FAMA's impact is likely associated with the development of infrastructure that facilitates market access, including collecting centres, transportation logistics, and storage facilities that align with the marketing and distribution requirements of community farms.

Figure 3 indicates that basic infrastructure development is a collaborative effort among various stakeholders, including universities, local authorities, and FAMA. Local authorities and FAMA are critical in providing or regulating the necessary physical infrastructure, while universities contribute more through research facilities and knowledge-based infrastructure. All three stakeholders play important roles, indicating that infrastructure support is both a technical and governance-related effort, requiring coordination between academic institutions and government bodies.

## 2) Proximity Factor

In analysing the identified stakeholders' influences, these three key components were analysed: Influence Scores, Role Scores, and a Proximity Factor to the central node. First, Influence Scores were assigned to each stakeholder based on the thickness of the lines connecting them to the central node, representing "*Kebun Komuniti* as Chokubai". A thick line indicates high influence (3 points), a medium line indicates moderate influence (2 points), and a thin line indicates low influence (1 point). Next, Role Scores were assigned to stakeholders based on their specific functions in the process: those with roles in "Control" or "Improvement" were given 2 points each, stakeholders with roles combining both "Control + Improvement" were given 3 points, while those where "Control is More Important" or "Improvement is More Important" received 2.5 points. These scores help capture the different ways each stakeholder contributes to the goal.

The "Proximity Factor" was calculated to reflect how close each stakeholder is to the central node, indicating their importance in transforming *kebun komunitas* into Chokubai. The Proximity Factor used a multiplier to weigh the scores: stakeholders positioned very close to the central node were assigned a factor of 1.5, those moderately close were given a factor of 1.2, and those positioned far away were assigned a factor of 1.0. This factor helps account for stakeholders' relative importance in terms of their proximity to the central objective. The Final Weighted Influence Score was then calculated by summing each stakeholder's Influence Score and Role Score and multiplying the result by the Proximity Factor. This approach allows for a comprehensive understanding of each stakeholder's overall impact, incorporating their influence level, specific role, and proximity to the goal. By quantifying these aspects, a more transparent and more strategic view of the key players and their roles in the development of *kebun komunitas* as a social enterprise is provided.



**Table 3: Weighted Influence Scores of Stakeholders**

	Technical Know-How Score	Financial Support Score	Basic Infrastructure Score	Overall Weighted Influence Score
<b>Local Authority</b>	9.0	7.5	6.0	22.5
<b>University</b>	7.5	N/A	4.8	12.3
<b>Training Providers</b>	4.8	N/A	N/A	4.8
<b>KPKM</b>	4.8	N/A	N/A	4.8
<b>SKM</b>	3.5	5.4	N/A	8.9
<b>FAMA</b>	3.5	N/A	5.4	8.9
<b>Banks</b>	N/A	3.0	N/A	3.0
<b>ICU</b>	N/A	5.4	N/A	5.4

Based on Table 3, the local authority scores the highest across all categories, showing a strong influence in technical know-how, financial support, and basic infrastructure. This high score reflects its central role in providing both regulatory oversight and practical support, making it a key stakeholder in the success of *kebun komuniti*. The quantified findings highlight that the local authority is the most influential stakeholder in all three categories: technical know-how, financial support, and basic infrastructure. Universities also play a significant role, especially in technical and infrastructure support. Other stakeholders like training providers, KPKM, SKM, FAMA, ICU and banks have more specialised roles, contributing to specific areas crucial for the sustainable development of *kebun komuniti* into a Chokubai-like social enterprise. This quantification helps in understanding where efforts should be concentrated, and which stakeholders should be prioritised for engagement.

## CONCLUSION

The transformation of *kebun komuniti* into a Chokubai-style social enterprise presents a unique opportunity to create sustainable, community-driven models that benefit urban environments. As social enterprises, these community farms can generate income, create jobs, and empower local residents, fostering social inclusion and community ownership. This shift is not just about producing fresh food but also about building social and economic resilience. By attracting diverse funding sources and forging partnerships, these farms can effectively address urban challenges like food security and local economic development.

Achieving this transformation requires close collaboration among all stakeholders—community members, local authorities, government agencies, NGOs, universities, and private sector partners. However, the sustainability of these efforts is paramount. It demands ongoing community engagement, strong leadership, and adaptable cooperative structures that can evolve with changing

needs. A sustained, collective effort is essential for ensuring that *kebun komuniti* thrives as a social enterprise, contributing to vibrant and resilient urban communities.

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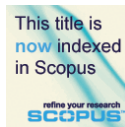
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## **EVALUATING AND ENHANCING SUSTAINABLE LIVELIHOODS OF URBAN IMPOVERISHED GROUPS IN KUALA LUMPUR, MALAYSIA**

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### **Abstract**

The sustainable livelihoods of urban impoverished 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 impoverished 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 impoverished 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 analyzed using Statistical Package for the Social Sciences (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 impoverished areas in Kuala Lumpur exhibit high well-being only in terms of environmental factors.

**Keywords:** Sustainable livelihoods; urban impoverished groups; Kuala Lumpur

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## **INTRODUCTION**

Urban poverty continues to be a significant issue for cities globally, including Kuala Lumpur. Recent urbanization has exacerbated the socioeconomic divide, with several urban poor confronting difficulties in housing, employment, and essential services (Kamal et al., 2020; Hassan et al., 2021). Sustainable and resilient living for these communities entails addressing immediate necessities such as food, shelter, and healthcare while establishing avenues 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 vital for empowering communities and enabling them to adapt to economic shocks or disruptions, which are increasingly prevalent due to global crises and climate change (World Bank, 2020). Resilience is essential, as it allows communities to recuperate and flourish in the face of challenges. Researchers indicate that urban impoverished populations with access to education, skill enhancement, and support networks are more adept at confronting economic difficulties and enhancing their quality of life over time (Mokhtar & Rahman, 2022). Initiatives to promote sustainable and resilient living for Kuala Lumpur's urban impoverished groups must adopt a comprehensive strategy encompassing financial aid, skill development, healthcare, and housing assistance to achieve enduring transformation and improved welfare (UN-Habitat, 2020). This introduction establishes the framework for examining effective methods and policies to attain sustainable and resilient urban living for low-income residents of Kuala Lumpur.

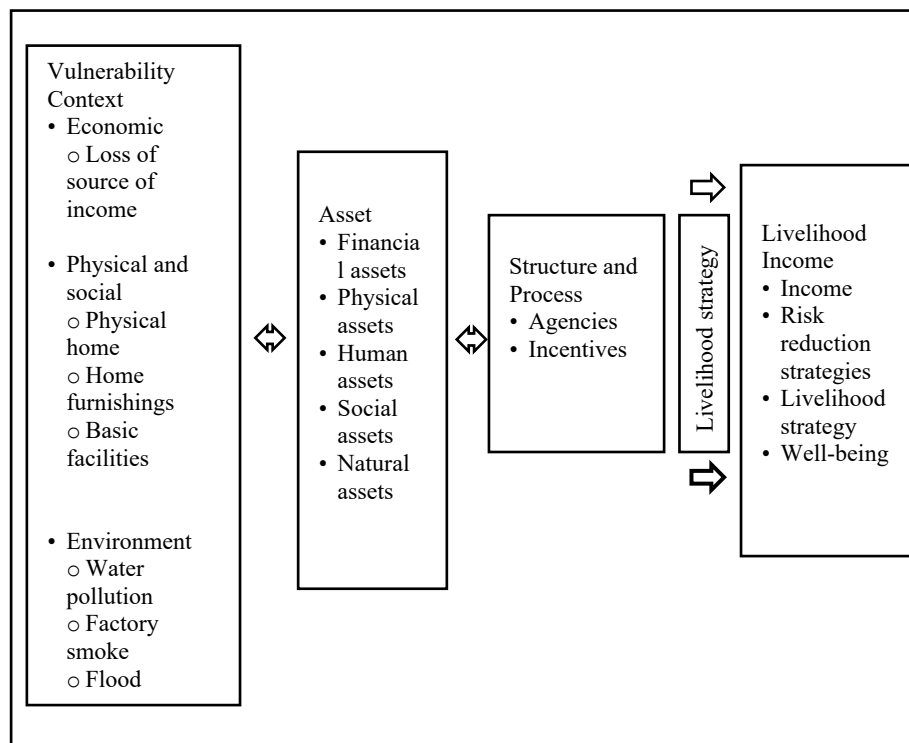
Furthermore, current research indicates a lack of empirical studies about the sustainable and resilient living conditions of urban impoverished groups in Kuala Lumpur. Despite extensive studies on global urban poverty and resilience, studies concentrating on sustainable and resilient living among the poor urban in Kuala Lumpur are limited. Current research frequently focuses on overarching concerns such as urban poverty, affordability, and access to basic needs. However, it is deficient in empirical studies that investigate holistic frameworks for sustainable and resilient living specifically adapted to the distinct socioeconomic context of Kuala Lumpur (Zainal et al., 2019; Ariffin & Yusof, 2021). This gap constrains our comprehension of how these communities address economic and environmental issues and the prospective impact of governmental interventions on bolstering their resilience. This project assesses and improves the sustainable livelihoods of impoverished urban neighbourhoods in Kuala Lumpur.

## **CONCEPTUAL FRAMEWORK OF THE STUDY**

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, physical, and 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.



**Figure 1:** Conceptual Framework of the Study: Sustainable Livelihood Framework of the urban poor communities in Kuala Lumpur  
*Source: Modified from DFID (1999)*

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 identified multiple organizations directly associated with

the respondents, indicating that agencies tied to rural communities either assist or provide services to urban communities and the impoverished.

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 employs a quantitative research design focusing on urban impoverished neighbourhoods in Kuala Lumpur. This study employed a purposive sampling method. Purposive sampling is an optimal method for this study, facilitating the deliberate selection of participants who are directly engaged with or impacted by matters concerning sustainable and resilient living in the urban impoverished neighbourhoods of Kuala Lumpur. This sampling strategy is appropriate for research investigating certain social phenomena among specific groups and necessitates insights from persons with distinctive, pertinent knowledge or experience (Patton, 2015). After establishing the sampling technique, the following study ascertains the requisite sample size for the investigation. The Department of Statistics Malaysia (DOSM) indicates that around 0.2% of households in Kuala Lumpur are classified as experiencing deep poverty, impacting around 18,445 homes in this study, with a total sample size (n) of 394. According to Krejcie and Morgan (1970), if the population exceeds 15,000, the required sample size is 377.

To obtain precise results, the survey included 394 respondents. The questionnaire used in the study consisted of open-ended and closed-ended questions, with a five-point Likert scale for perception inquiries. Data analysis was conducted using several software tools, including Statistical Package for the Social Sciences (SPSS) Version 25. This study employed a vulnerability score and an asset ownership index to assess the sustainable and resilient living conditions of impoverished urban neighbourhoods in Kuala Lumpur.

### ***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) to create this index. The construction of the Vulnerability Index employs a uniform weighting value for each vulnerability category and its corresponding indication. This weighting factor is derived from Sullivan et al. (2002), wherein each indication contributes equally to each vulnerability category. 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 percentage and transformed into an index value utilizing the 92-conversion process employed in the Human Development Index, which considers 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 SLF by DFID (1999), tailored to the context of this study. Only standardized asset indicators are utilized to compute 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) and Ismail et al. (2025), constructing the Asset Ownership Index should employ a comprehensible procedure with uniform weights as a recommended approach. 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 (Ismail et al., 2019). This study exclusively considers uniform asset indicators when constructing 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 considers 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 for urban impoverished communities in Kuala Lumpur. The index reveals that economic risks represent the greatest vulnerability, with a value of 0.600. Although social, physical, and environmental hazards exist, their index values are comparatively lower at 0.187 and 0.352, respectively. This indicates that prioritizing economic concerns is essential to reduce overall vulnerability in these areas.

**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
Loss of the primary source of income/job	0.600	Economic	0.600
Physical condition of the house (cramped/bad house)	0.2	Social and Physical	0.187
Lack of home furnishings	0.133		
Lack of basic facilities (prayer, kindergarten, shop lot)	0.044		
There is a polluted river/source of water	0.089	Environment	0.352
Floods that damage crops and property	0.044		
Factory smoke	0.933		

*Source: Field Study (2022)*

Table 2 depicts the Asset Ownership Index of impoverished communities in Kuala Lumpur, indicating a reasonable level for human and physical assets. The analysis suggests minimal ownership of social, natural, and financial assets. This demonstrates that asset ownership among individuals in the urban impoverished communities of Kuala Lumpur is comparatively restricted, highlighting difficulties in establishing financial stability and enduring prosperity.

**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
Respondent's highest education	0.334	Human assets	0.606
Current work experience	0.267		
Health	0.778		
Knowledge get help	0.378		

Water source	0.532	Physical assets	0.543
Toilet	0.632		
Home conditions	0.321		
Homeownership	0.121		
Vehicle ownership	0.6		
Association position	0.289	Social assets	0.242
Parent-Teacher Associations (PTA)	0.411		
Society	0.600		
Cooperative	0		
Land ownership	0.144	Natural assets	0.466
Income	0.666	Financial assets	0.430
Acceptance of financial aid	0.800		
Loan	0.144		
Savings	0.111		
Overall			0.590

Source: Field Study (2022)

### ***Sustainable Livelihood Results***

#### ***Increased Income***

Table 3 depicts the income distribution within impoverished areas in Kuala Lumpur for 2022. The predominant share (64.4%) earns between RM501 and RM1000, while 11.1% earns RM500 or less, signifying acute poverty. A lesser proportion (17.8%) earn between RM1001 and RM1500, and merely 4.4% reside within the RM1501–RM2589 bracket. Individuals earning above RM2589 represent merely 2.2%, indicating that even those with higher incomes in this category may still face difficulties owing to elevated living expenses. The data suggests that 75.5% of the impoverished earn RM1000 or less, highlighting the necessity for focused measures to mitigate low-income inequities.

**Table 3:** Income of poor communities in Kuala Lumpur in 2022

Income	Percentage (%)
RM500 and below	11.1
RM501-RM1000	64.4
RM1001 – RM1500	17.8
RM1501 – RM2589	4.4
RM2589 and above	2.2

Source: Field Study (2022)

### ***Vulnerability Reduction***

Vulnerability reduction analysis pertains to the resilience tactics employed by impoverished communities in Kuala Lumpur to combat vulnerability. It refers to the resilience methods used by the study participants in economic, social, physical, and environmental aspects.

#### ***Economic vulnerability***

Table 4 illustrates the reduction or resilience strategy addressing the economic vulnerability encountered by impoverished groups in Kuala Lumpur. Meanwhile, economic vulnerability denotes the deprivation of the primary source of income. The strategy of undertaking a side job is the most effective risk reduction approach in the event of losing their primary source of income or employment.

**Table 4.** The reduction strategy or resilience strategy against economic vulnerability

<b>Type of Vulnerability</b>	<b>Strategy for reducing vulnerability</b>	<b>Percentage (%)</b>
Loss of primary income/source of employment	Seeking new employment	37.8
	Taking on side jobs	38.9
	Borrowing money	13.3

*Source: Field Study (2022)*

#### ***Vulnerability to social and physical threats***

Examining measures for reducing social and physical vulnerability encompasses resilience approaches to address the susceptibility of housing conditions, insufficient furnishings, and inadequate essential services. In response to the precarious physical condition of the dwelling, impoverished populations in Kuala Lumpur employ numerous resilience methods. Note that home remodeling is a resilience strategy selected by 13.3% of impoverished populations in Kuala Lumpur (Table 5). To address the lack of house furnishings, individuals from underprivileged communities in Kuala Lumpur predominantly purchase furnishings independently. The absence of essential infrastructure constitutes a minimal threat encountered by responders.

**Table 5.** Comparison of social and physical vulnerability reduction strategies

Types of vulnerability	Vulnerability reduction strategies	Percentage (%)
Physical condition of the house (cramped/bad house)	Self-improvement of the house	13.3
	Repair the house yourself	4.4
	Apply for home help from the responsible party	2.2
Lack of home furnishings	Buy your home furnishings	11.1
	Ask for help from the responsible party	2.2
Lack of basic facilities (prayer, kindergarten, shop lot)	Make reports and complaints to relevant agencies	4.4
	Ask for help from the responsible party	0

Source: Field Study (2022)

#### *Ease of environmental threats*

The prevalence of environmental risks necessitates various resilience methods for impoverished people in Kuala Lumpur. The analysis suggests two resilience options for mitigating the flooding hazard: upgrading homes and obtaining assistance or compensation from relevant institutions (Table 6). The 4.4% of participants from impoverished communities in Kuala Lumpur renovated their residences. Hence, the mitigation method for storm damage to crops and property solely engages people from impoverished neighbourhoods in Kuala Lumpur. It focuses on damage restoration, procurement of new equipment, and obtaining assistance or reimbursement from relevant organizations.

**Table 6.** The resilience strategies to ease environmental threats

Types of vulnerability	Vulnerability reduction strategies	Percentage (%)
There is a river or source of polluted water	Do not engage in polluting activities	6.7
	Implementation of awareness programs	0
	Actions from responsible parties	2.2
There is an open burning from factory activities	Implementation of awareness programs	2.2
	Actions from responsible parties	4.4
Floods that damage property	Renovating the house	4.4
	Getting help/compensation from related agencies	40.0
	Build drainage / deepen ditches and drains	0

Source: Field Study (2022)

### *Well-being*

Table 7 examines the welfare of participants from impoverished communities in Kuala Lumpur across economic, social, physical, and environmental dimensions. This well-being analysis employs a Likert scale ranging from 1 to 5. Moreover, mean analysis indicates that impoverished areas in Kuala Lumpur exhibit high well-being solely due to environmental factors.

**Table 7. Well-being Analysis**

Dimensions	Score
Economic	2.203
Social and physical	3.603
Environment	3.839

Scale: 1 = Strongly disagree; 2 = Disagree; 3 = Medium; 4 = Agree; 5 = Strongly agree

Scale: \*Score: 1.00 – 2.39: Low; 2.40 – 3.79: Medium; 3.80 – 5.00: High

*Source: Field Study (2022)*

## **STRATEGIES FOR ENHANCING SUSTAINABLE LIVELIHOODS IN KUALA LUMPUR'S URBAN POOR COMMUNITIES**

Essential techniques for improving sustainable living in Kuala Lumpur's impoverished urban neighbourhoods include prioritizing cheap housing, ensuring access to fundamental services, and creating economic opportunities within urban design. Creating affordable, high-quality housing will mitigate overpopulation and enhance living circumstances (Sohaimi et al., 2018). Furthermore, augmenting and improving the public transportation network will enhance mobility, facilitating greater access to employment, healthcare, and education. Urban planning must also establish areas for local enterprises and vocational education, promoting employment generation and skills enhancement. Guaranteeing dependable access to clean water, sanitation, energy, and healthcare can enhance general well-being and mitigate health concerns within these communities.

Moreover, sustainable urban development must prioritize community engagement, green areas, and catastrophe risk mitigation. Involving impoverished urban areas in the planning process ensures that their needs and interests are included (Azmi et al., 2023). Incorporating green spaces and sustainable architecture will boost environmental sustainability and offer recreational areas that promote residents' physical and emotional well-being. Other than that, efforts for disaster risk mitigation are crucial, particularly in regions susceptible to flooding or other natural calamities. Enhancing social



safety nets and welfare programs will assist the most vulnerable individuals in these communities, ensuring enduring sustainability and resilience.

## SUMMARY

This study contributes to knowledge of sustainable and resilient living among impoverished urban populations. The results demonstrate that governmental actions significantly contribute to improving the sustainable livelihoods of urban residents in Kuala Lumpur. Mean analysis indicates that impoverished areas in Kuala Lumpur exhibit high well-being only in terms of environmental factors. The vulnerability index for impoverished urban populations in Kuala Lumpur indicates the necessity of prioritizing economic concerns to mitigate overall vulnerability. Therefore, sustainable urban development must prioritize community engagement, green spaces, and disaster risk mitigation. Involving impoverished urban areas in the planning process guarantees that their needs and interests are included.

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## **ANALYSIS OF FARMERS' INCOME AND WILLINGNESS TO PAY FOR UPSTREAM WATERSHED IMPROVEMENT IN KRUENG KLUET ACEH INDONESIA**

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### **Abstract**

Krueng Kluet Aceh Watershed is one of the largest watersheds in the Aceh Province of Indonesia. Over the past three years, forest destruction in the upper part of the Krueng Kluet Aceh Watershed has resulted in the loss of 424.15 hectares of forest. This destruction has led to flooding during the rainy season, adversely affecting paddy fields. Farmers have incurred significant losses due to reduced production levels caused by flooding. The gap in this research lies in the analysis of farmers' income during flood events compared to non-flood situations, serving as a basis for assessing the extent of farmers' willingness to pay for environmental improvements—an approach that has not been undertaken previously. This research aims to compare farmers' income during the period of flooding versus period without flooding, as well as to assess farmers' willingness to pay for environmental improvement services in the upper Krueng Kluet Aceh Watershed. The findings of this study indicate that the average income of farmers during flooding periods is IDR 5,529,000 per hectare per planting season, equivalent to USD 354. In contrast, when flooding does not occur, farmers' income rises to IDR 26,027,000 per hectare per planting season, or USD 1,668. This means that farmers experience an income loss of IDR 21,020,000, which is USD 1,347, during flooding events. Notably, 71% of farmers expressed their willingness to pay for environmental improvements in the upper Krueng Kluet Aceh Watershed, with a total willingness to pay valued at IDR 1,078,500 per growing season, leading to an average of IDR 9,297 per farmer per growing season. The study also found that income variables, formal education, and land area positively influence farmers' willingness to pay for environmental improvements in the upstream areas of the Krueng Kluet Aceh Watershed. Furthermore, the formal education variable and the number of family dependents significantly affect farmers' willingness to pay for these environmental improvements.

**Keywords:** High-rise Residential, Strata Residential, Commissioner of Building, Strata Management Body

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## **INTRODUCTION**

In the past three years, 424.15 hectares of protected areas in the upper Krueng Kluet Aceh Watershed have experienced deforestation. This deforestation has resulted in flooding of paddy fields (Pirngadi & Rahmawaty, 2022). Prior to the flooding, the total production of paddy rice in 21 villages within the North Kluet Sub-district was 9,827 tonnes, spanning approximately 1,627.34 hectares, yielding a productivity rate of 6.03 tonnes per hectare. However, during flooding events, paddy rice production decreased to 2,827 tonnes, with a productivity rate of 1.73 tonnes per hectare. This decline in production due to flooding has had a significant negative impact on farmers (Pirngadi et al., 2024). Losses for farmers in the Krueng Kluet Aceh Watershed due to flooding reached IDR 9,052,640,500, affecting an area of 1,391 hectares of paddy fields.

The objectives of this paper are (i) to analyze the income of wet-rice farmers during flooding events compared to periods without flooding, and (ii) to calculate the Willingness to Pay (WTP) of farmers for improvements in the upstream watershed of Krueng Kluet Aceh, as well as to analyze the factors that influence this willingness. The contribution of this research to the development of new knowledge lies in understanding the behaviors of wet-rice farmers regarding financial contributions for the improvement of the upstream area of the Krueng Kluet Aceh Watershed. Notably, the WTP of farmers for these improvements is not solely determined by the extent of their losses in rice production due to flooding; other factors also play a significant role in shaping their willingness to pay for enhancements to the watershed.

## **LITERATURE REVIEW**

### **Flooding from Forest Deforestation**

The presence of forests, characterized by trees and woody vegetation, facilitates the gradual release of rainwater through springs and rivers, thereby mitigating the occurrence of flooding. When forest areas are damaged, their capacity to absorb rainwater during periods of heavy rainfall diminishes, resulting in increased runoff that leads to river overflow in low-lying areas. In the Janeberang Watershed in South Sulawesi, Indonesia, flooding is attributed to deforestation and degradation in the upstream forest areas, with a loss of 36.67 hectares due to deforestation and 770.14 hectares due to degradation. This flooding has significant adverse effects on the economic well-being of the local community. Effective flood mitigation strategies must focus on the restoration of forest areas and the enforcement of legal measures within the forestry sector (Widodo et al., 2021)

### **Effects of Flooding on Paddy Farming**

The impact of flooding on rice fields can lead to reduced production due to crop failure. Research on the effects of flooding on food production has been conducted in Central Java Province, Indonesia (Pratiwi et al., 2020). The intensity of flooding in agricultural land in Central Java, which steadily increased from 2014 to 2018, adversely affected rice production. In 2014, 33,792 hectares of rice fields experienced crop failure, resulting in a production loss of 505,197 tons, which constituted approximately 5.24% of the total rice production in Central Java (Pirngadi & Rahmawaty, 2022). Additionally, 7,000 tons of rice production in the North Kluet Sub-district were lost due to flooding in the Krueng Kluet Aceh Watershed. This significant loss in production has substantially impacted the income of rice farmers in the North Kluet Sub-district.

### **The Impact of Flooding on Farmers' Production and Income**

Before the flood, the total production of paddy rice across 21 villages in the North Kluet Sub-district was 9,827 tonnes, with a total land area of approximately 1,627.34 hectares, yielding a productivity rate of 6.03 tonnes per hectare. During the flood, paddy rice production decreased to 2,827 tonnes, with a productivity value of 1.73 tonnes per hectare. This decline in production due to flooding has been significantly detrimental to farmers (Pirngadi & Rahmawaty, 2022).

The estimated total losses incurred by wet-rice farmers during flooding in the Krueng Kluet Aceh Watershed reached USD 580,297, affecting 1,391 hectares of wet-rice land. The North Kluet Sub-district suffered the greatest losses, amounting to IDR 6,201,539,500, followed by the East Kluet Sub-district with losses of USD 180,142, and the South Kluet Sub-district with losses of USD 2,620 (Pirngadi et al., 2024).

Brémond & Grelot (2013) reviewed 42 studies on the economic evaluation of flood damage to agricultural land, concluding that flood losses result in decreased production and reduced farmers' income. Furthermore, Alamgir et al. (2021) noted that climate change has intensified flooding in paddy fields, leading to yield losses. The substantial reduction in rice production has contributed to an increase in the number of impoverished farmers in the Jamalpur and Netrokona Districts of Bangladesh.

### **Willingness to Pay (WTP)**

Contingent Valuation Method (CVM) is a method for collecting information on preferences or WTP through direct questioning techniques. WTP can be defined as the maximum price an individual is willing to pay for a good or service (Haab & McConnell, 2002). Preference values are obtained through structured interviews. Supported by Christoph (2005) who defines willingness to pay as the highest amount a person is prepared to pay for goods and services. While WTP

is a robust method for measuring an individual's preferences regarding the payment for goods and services, it is not without weaknesses; biases may arise, as highlighted by Hanley & Spash (1993). These biases include strategic bias, design bias, respondent mood bias, and hypothetical market error bias. Despite its limitations, the willingness to pay method also possesses strengths, as noted by Breidert et al. (2006) the strength of this method lies in its methodological rigor in estimating the value of structured goods and services; while allowing respondents the freedom to provide a price they are willing to pay for the evaluated goods and services. In such conditions, models can be estimated using simple linear regression or multiple linear regression models.

This research employs a willingness to pay approach, drawing from previous studies related to the valuation of environmental services, such as in the work of Hanley & Spash (1993). Willingness to pay reflects an individual's readiness to invest in improving or preserving environmental conditions and natural resources, thereby enhancing environmental quality. The measure of WTP is based on how much individuals or communities are willing to contribute financially to mitigate the negative impacts of environmental degradation in line with their preferred standards (Pearce & Turner, 1991).

Farmers' attitudes and education are critical factors influencing their willingness to pay for environmental services, particularly in contexts like the Peruvian Amazon. These farmers are often willing to pay more, anticipating that they will benefit from environmental improvements. Typically, as environmental damage increases, so does the willingness of farmers to invest in environmental services (Smith et al., 1997). For instance, flooding in Sempayang Village, North Kalimantan, Indonesia, resulted from land degradation covering 541.08 hectares, adversely impacting agricultural land (Pratiwi et al., 2018). In this context, farmers expressed a willingness to pay between IDR 21,296 and IDR 50,000 per production period to enhance the condition of degraded lands. Additionally, using the willingness to pay approach, visitors to the CMC Tiga Warna area in Malang, Indonesia, have expressed support for conservation activities, with an average contribution of IDR 12,829 per individual for mangrove forest conservation initiatives (Zimo et al., 2023).

## **RESEARCH METHOD**

This research was conducted in the Krueng Kluet Aceh Watershed, Aceh Province, Indonesia. Within this watershed, three sub-districts—North Kluet, East Kluet, and South Kluet—are particularly prone to flooding of rice fields. To represent these three sub-districts, one village was purposively selected from each for the study. The sample size was determined using the Slovin formula, with a 10% margin of error. The total population of wet-rice farmers in the three selected villages was 513. Research data was collected using questionnaires given in

structured interviews with farmers. The questions were systematically organized to effectively address the research issues. The design of the questionnaire began with the identification of the farmers, including their name, age, education, number of dependents, and the area of rice land owned. Subsequently, a series of questions were posed to analyze the income of rice farmers during flood events and under normal conditions, focusing on aspects such as rice production, selling price, variable costs, and fixed costs incurred. Following this, additional questions were included to assess the extent of farmers' willingness to pay for the improvement of the upper catchment area of the Krueng Kluet River in Aceh, with the expectation of minimizing flood intensity on rice land in the future.

Additionally, this research categorizes the level of flood vulnerability of paddy fields in each village within the Krueng Kluet Aceh Watershed based on an assessment of flood categories, which are determined by the percentage of paddy fields affected by flooding:

- Very High Category: 80% - 100% of paddy fields affected
- High Category: 61% - 79% of paddy fields affected
- Medium Category: 30% - 60% of paddy fields affected
- Low Prone Category: 1% - 29% of paddy fields affected

Data analysis in this study was conducted in two stages:

1. Analysis of the income of wet-rice farmers when flooding occurs and when flooding does not occur using the following equation:

$$\pi = TR - TC$$

with:

$\pi$ : Income  
 TR: Total Revenue (IDR)  
 TC: Total Cost (IDR)

with:  $TR = P.Q$   
 $TC = FC + VC$

description:

P = Price (IDR)  
 Q = Production (Kg)  
 TC = Total biaya (IDR)  
 FC = Fixed Cost (IDR)  
 VC = Variabel Cost (IDR)

2. Contingent Valuation Method (CVM) using WTP approach and Multiple Regression equation model to see factors that influence farmers in paying for environmental improvements in the upper Krueng Kluet Aceh Watershed with the following model specifications:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu$$

with:

$\beta_0$  = Constant

$\beta_0, \dots, \beta_5$  = The value of each variable

Y = nilai WTP petani (IDR/ Planting season)

$X_1$  = Age (Year)

$X_2$  = Income (IDR/ Month)

$X_3$  = Number of family dependents (People)

$X_4$  = Of education (Year)

$X_5$  = Land area (Hectares)

$\mu$  = error term

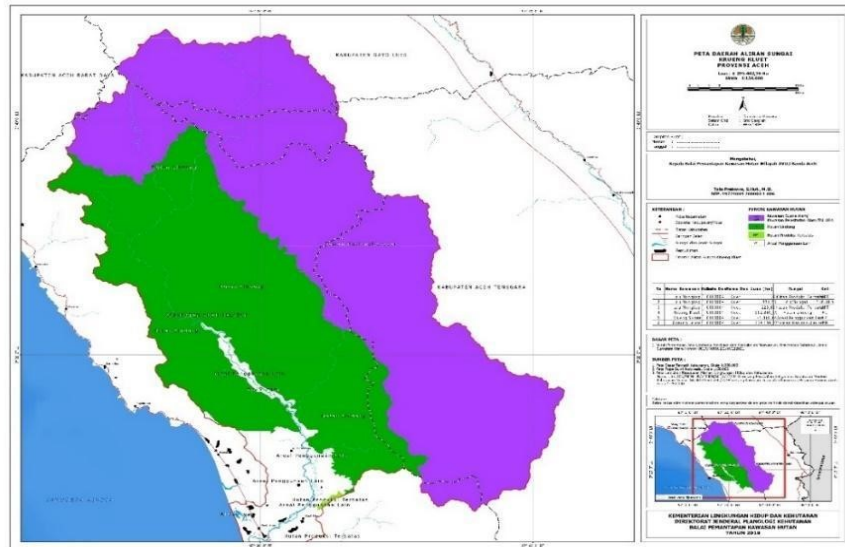
The data on farmers' income was obtained from all responses to the questionnaire and compiled to calculate the average rice production, average selling price of rice, and total average costs incurred during a single planting season.

## ANALYSIS AND DISCUSSION

The Krueng Kluet Aceh Watershed encompasses an area of 232,600 hectares. The upstream region includes Gunung Leuser National Park, the Leuser Ecosystem Area, and other designated use areas. The map of the Krueng Kluet Aceh Watershed is presented in Figure 1.

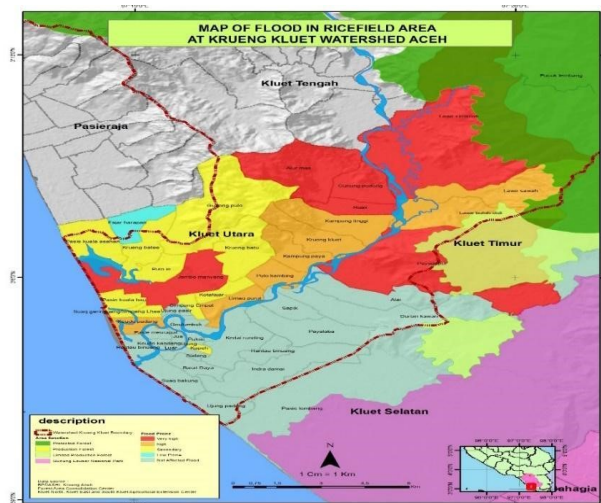


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**Figure 1:** Watershed of Krueng Kluet Aceh

During the rainy season, flooding frequently occurs due to the overflow of the Krueng Kluet Aceh Watershed, which the river systems are unable to accommodate. This flooding has a detrimental impact on agriculture, particularly on paddy rice production. Currently, 1,319 hectares of paddy fields in the Krueng Kluet Aceh Watershed are affected by flooding. The locations of these affected paddy fields are illustrated in Figure 2.



**Figure 2:** Map of flood-prone rice paddy fields in the Krueng Kluet Aceh Watershed

From the map in Figure 2, four categories of paddy fields with varying levels of flood vulnerability can be identified: areas coloured red indicate very high flood vulnerability, orange represents high flood vulnerability, yellow denotes medium flood vulnerability, and blue signifies low flood vulnerability.

Overall, 26 villages across three sub-districts have paddy fields affected by flooding in the Krueng Kluet Aceh Watershed. The extent of paddy fields impacted by flooding in this watershed is detailed in Table 1.

**Table 1:** The area of paddy fields affected by flooding within the Krueng Kluet Aceh Watershed 2022.

District	Village	Flood Vulnerability Level	Rice Paddy Area (Ha)	Area of Rice Paddy Fields Affected by Flood (Ha)
North Kluet	Gunung Pudung	Very High	85	68
	Ruak	Very High	135	115
	Alur Mas	Very High	112	95
	Jambo Manyang	Very High	112	90
	Kampung Tinggi	High	31	22
	Krueng Kluet	High	60	45
	Kampung Paya	High	118	77
	Pulo Kambing	High	66	49
	Limau Purut	High	35	26
	Kedai Padang	High	45	32
	Krueng Batu	Medium	185	111
	Pulo Ie	Medium	155	70
	Krueng Batee	Medium	34	15
	Pasie Kuala Asahan	Medium	51	15
	Pasie Kuala Ba'u	Medium	58	32
	Simpang Empat	Medium	84	37
	Simpang Lhee	Medium	35	18
	Suaq Geuringgeng	Medium	29	12
	Gunung Pulo	Medium	130	59
	Kota Fajar	Medium	31	14
	Fajar Harapan	Low Prone	54	8
East Kluet	Lawe Cimanok	Very High	122	103
	Paya Dapur	Very High	174	147
	Lawe Sawah	High	144	108
	Lawe Buloh Didi	High	17	12
South Kluet	Kapeh	Medium	28	11
<b>Total Area of Rice Paddy Fields Affected by Floods</b>				<b>1391</b>

Table 1 indicates four categories of flood vulnerability levels for rice fields in the Krueng Kluet Aceh Watershed: very high, high, medium, and low vulnerability categories (Ata et al., 2023). To anticipate future floods, flood simulation using hydraulic technology is one potential alternative for mitigating the impact of flooding, as demonstrated in the Junjung Watershed (Said et al.,

2024). Effective flood mitigation through risk management is essential, necessitating the involvement of institutions responsible for flood control to minimize future flood-related risks.

### Income Analysis of Rice Paddy Farmers during the Flood of Krueng Kluet Aceh Watershed

Farmers' income was analysed by subtracting the total costs of rice production from total revenue for one growing season. The income of wet-rice farmers during flooding in the Krueng Kluet Aceh Watershed is presented in Table 2.

**Table 2:** Analysis of the Average Income of Rice Paddy Farmers during Floods in the Krueng Kluet Aceh Watershed

No	Description	Average value (IDR)
	Income (TR) = P.Q	
1	a. Production (Q) (Kg/Ha)	2,300
	b. Production price (P) (Kg)	6,000
	<b>Total Revenue</b>	<b>13,800,000</b>
	A. Variabel Cost (VC)	
	Fertilisers and Other Materials:	
	- Urea	840,000
	- Phonska	840,000
	- Pestisida	800,000
2	Labour	1,400,000
	Tractor Rental Land Cultivation	2,200,000
	Harvest Equipment Rental (CHB)	1,058,000
	Seeds (Inpari 32)	675,000
	Sacks	138,000
	<b>Total Variabel Costs</b>	<b>7,951,000</b>
	B. Total Fixed Costs (FC)	
	Tool Depreciation Cost	
	- Hoe	80,000
	- Hand Sprayer	240,000
	<b>Total Fixed Costs</b>	<b>320,000</b>
	Total Cost (TC)	
3	a. Variabel Cost (VC)	7,951,000
	b. Fixed Cost (FC)	320,000
	<b>Income = TR – TC</b>	<b>5,529,000</b>

As Table 2 shows, the average income of wet-rice farmers affected by flooding in the Krueng Kluet Aceh Watershed is IDR 5,529,000 per hectare per planting season, which is equivalent to USD 354.

### Analysis of Rice Paddy Farmers in the Non-Flooding Period of Krueng Kluet Aceh Watershed

The results of income analysis of wet-rice farmers in the Krueng Kluet Aceh Watershed area when there is no flood are presented in Table 3.

**Table 3:** Analysis of the average income of rice paddy farmers when there is no flood in the Krueng Kluet Aceh Watershed

No	Description	Average Value (IDR)
	Income (TR) = P.Q	
1	c. Production (Q) (Kg/Ha)	6,000
	d. Production price (P) (Kg)	6,000
	<b>Total Revenue</b>	<b>36,000,000</b>
	C. Variable Cost (VC)	
	Fertilisers and Other Materials:	
	- Urea	840,000
	- Phonska	840,000
2	- Pestisida	800,000
	Labour	1,400,000
	Tractor Rental Land Cultivation	2,200,000
	Harvest Equipment Rental (CHB)	2,760,000
	Seeds (Inpari 32)	675,000
	Sacks	138,000
	<b>Total Variable Costs</b>	<b>9,653,000</b>
	D. Total Fixed Costs (FC)	
	Tool Depreciation Cost	
	- Hoe	80,000
	- Hand Sprayer	240,000
	<b>Total Fixed Costs</b>	<b>320,000</b>
	Total Cost (TC)	
3	c. Variable Cost (VC)	9,653,000
	d. Fixed Cost (FC)	320,000
	<b>Income = TR – TC</b>	<b>26,027,000</b>

Table 3 indicates that the income of wet-rice farmers in the Krueng Kluet Aceh Watershed, when there is no flooding, is IDR 26,027,000, equivalent to USD 1,668. The analysis reveals that the income disparity between farmers during flooding and in the absence of flooding amounts to IDR 20,498,000, or USD 1,313. In other words, farmers' income increased by 270% when there was no flooding.

### **Farmers' Willingness to Pay for Improvements to the Upper Krueng Kluet Aceh Watershed**

There are three categories of farmer perceptions regarding the willingness of paddy farmers to pay for services aimed at improving the upstream watershed of Krueng Kluet Aceh: (1). Farmers who are unwilling to pay for environmental improvements in the Krueng Kluet Aceh Watershed; (2). Farmers who are willing to pay moderate amounts for environmental improvement services in the upstream Krueng Kluet Aceh Watershed; and (3). Category not specified; please provide additional information to complete this section.

The first category consists of farmers who express no desire to pay for environmental improvement services in the upstream Krueng Kluet Aceh

Watershed area. In the second category, farmers are willing to pay moderate amounts for environmental improvements in the upstream Krueng Kluet Aceh Watershed, specifically between IDR 2,000 and IDR 10,000. These farmers understand both the direct and indirect values of forests in the upper watershed. In-depth interviews with farmers in this category revealed that they believe the responsibility for improving the upstream area of the Krueng Kluet Aceh Watershed should not rest solely on farmers but should be shared by all communities that utilize the watershed. In the third category, farmers are willing to pay higher amounts for environmental improvement services, ranging from IDR 10,000 to IDR 20,000. The results of in-depth interviews with farmers in this category indicate that they view the damage to the upstream region as a collective responsibility of all communities living in the Krueng Kluet Aceh Watershed, particularly those affected by flooding.

Farmers believe that the greater the financial contribution they make, the more likely it is to minimize future flooding in their paddy fields. The total willingness to pay for environmental improvement services in the upper Krueng Kluet Aceh Watershed from all respondents was IDR 1,078,500, equivalent to USD 69 per growing season, with an average contribution of IDR 9,297, or USD 0.60 per farmer per growing season.

Analysis of the field data indicates that 71% of paddy field farmers are willing to pay for environmental improvements, while 29% are not. The analysis will further explore the value of regression coefficients as specified in the following model:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu$$

$$Y = -7172.011 - 32.997 X_1 + 0.001 X_2 - 601.701 X_3 + 1407.052 X_4 + 2264.169 X_5 + \mu$$

Farmers' willingness to pay for environmental improvement in the upper Krueng Kluet Aceh Watershed = - 7172.01 - 32.997 Age + 0.001 Income - 601.701 Number of Family Dependents + 1407.052 Formal Education + 2264.169 Land Area +  $\mu$ .

From this model specification, it can be concluded that three variables significantly affect farmers' willingness to pay for environmental improvements in the Krueng Kluet Aceh Watershed: income, education, and land area. Specifically, an increase in income of 1 rupiah is associated with an increase in willingness to pay of 0.001 rupiah. Additionally, a one-year increase in formal education results in an increase in willingness to pay by IDR 1,407.052, while an increase in land area of 1 hectare leads to an increase in willingness to pay by IDR 2,264.169.

A study conducted in the canal irrigation area of Rahim Yar Khan, Punjab, Pakistan, found that higher levels of education among farmers, along with increased income and greater concern about climate change, were directly proportional to their willingness to pay for climate change programs that impact agricultural production and mitigate frequent natural disasters (Ahmed et al., 2015). This literature strongly supports the findings of our research, indicating that as farmers' education increases, so does their willingness to pay for environmental improvement services. This correlation is confirmed by both joint (F-test) and partial (T-test) analyses, where education emerged as a significant variable influencing the willingness to pay for services aimed at improving the upstream area of the Krueng Kluet Aceh Watershed.

Additional studies further substantiate these findings. For instance, Prasmatiwi et al. (2011) identified factors such as farmer education, income, knowledge of forest functions, land area, land productivity, and family labour as contributors to increased willingness to pay for environmental improvements in West Lampung District. Similarly, Pirngadi (2019) demonstrated that formal education and age positively influence farmers' willingness to pay for environmental services in the Sarap sub-watershed. Furthermore, Tao et al. (2012) found that 61.8% of farmers were willing to pay for environmental improvement services in the upper Heshui Watershed, with education, age, income, and family size as key influencing factors.

#### ***Results of the Coefficient of Determination ( $R^2$ )***

The coefficient of determination ( $R^2$ ) measures the extent to which the independent variables explain the variation in the dependent variable. The results of the data processing are presented in Table 4.

**Table 4:** Coefficient of determination ( $R^2$ ) test results

Model	R Square
1 Regression	0.711

Table 4 indicates that the  $R^2$  value is 0.711. This means that 71.1% of farmers' willingness to pay for environmental improvements in the upper Krueng Kluet Aceh Watershed can be explained by the variables of age, income, number of family dependents, formal education, and land area. The remaining 28.9% is attributed to other variables not included in the model.

#### ***F-test results***

The F-test is used to determine whether the independent variables simultaneously affect the dependent variable. The results of the data processing are presented in Table 5.

**Table 5:** F-test results

Model	F	Signifikansi	( $\alpha$ )
1 Regression	77.676	0.000	0.05

Table 5 indicates that the variables of age, rice paddy farming income, number of family dependents, formal education, and land area have a significant simultaneous effect on farmers' willingness to pay for environmental improvements in the upper Krueng Kluet Aceh Watershed.

#### **Partial Test Results (t-test)**

The t-test is used to assess whether each independent variable individually affects the dependent variable. The results of the data processing are presented in Table 6.

**Table 6:** T-test results

Model	B	T	Signifikansi	( $\alpha$ )
(Constant)	- 7172.011	-3.220	0.002	0.05
Age	-32.997	-1.053	0.294	0.05
Rice Paddy Farming Income	0.001	1.490	0.138	0.05
Number of Family Dependents	-601.701	-2.343	0.020	0.05
Education	1407.052	16.937	0.000	0.05
Land Area	2264.169	1.756	0.081	0.05

Table 6 indicates that the variables of formal education and the number of family dependents have significance values less than  $\alpha$  ( $0.000 < 0.05$ ), indicating that these variables have a significant effect when considered individually. Higher levels of formal education among farmers are associated with a greater willingness to pay for environmental improvement services, while fewer family dependents correspond to an increased willingness to pay within the Krueng Kluet Aceh Watershed.

Additionally, Xiong et al. (2018) found that education, type of work, and location of residence significantly influence individuals' willingness to pay for ecological improvements in the Ganjiang River basin, with 75.03% of respondents expressing a willingness to pay an average of USD 47.62 per year.

## **CONCLUSION**

The income of rice farmers during floods was IDR 5,529,000, while in the absence of floods, the income increased to IDR 26,027,000. A total of 71% of farmers expressed a willingness to pay for environmental improvements in the upper Krueng Kluet Aceh Watershed, with an overall contribution amounting to IDR 1,078,500 per growing season and an average of IDR 9,297 per farmer per growing season. The willingness of farmers to pay for improvements in the upstream Krueng Kluet Aceh Watershed was influenced by income, formal education, and land area in the simultaneous test. In the partial test, formal

education and the number of family dependents were found to have a significant effect. A limitation of this research is that it only analyses farmers' incomes during floods and in drought conditions, assessing their willingness to pay and the factors influencing that willingness for watershed improvements. It is recommended that further research should identify all factors contributing to flooding in rice fields and develop strategies for flood mitigation in these areas.

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## **URBAN AGRICULTURE: A PATHWAY TO SUSTAINABLE URBAN DEVELOPMENT**

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### **Abstract**

This study explores the stakeholders' perspectives in urban agriculture (UA) toward sustainable urban development, expanding the discussion on the social, economic, and environmental potential and its challenges, thereby proposing a framework of action plans to support UA. Grounded on stakeholder theory, this study employed a qualitative approach using semi-structured interviews. A total of 15 stakeholders were selected from different authority levels in Malaysia consisting of the Department of Agriculture Malaysia and PLANMalaysia (federal level), Department of Agriculture Perak (state level), Subang Jaya City Council (local level), private property managers (real estate practitioners) and academicians (university). These stakeholders were top management, practitioners, and officers with the related background, knowledge, and experience in urban agriculture, urban planning, and real estate. The findings illustrate a framework of actionable plans centred on social, economic, environmental, policy, and technological innovation to highlight the importance of strategic initiatives in UA toward sustainable urban development. This framework contributes to the existing knowledge by proposing action plans based on sustainability pillars to advance UA as a pathway toward sustainable urban development. This study provides helpful strategies for policymakers and urban planners and guides them in making effective action plans for UA.

**Keywords:** Sustainable development, Stakeholder Perspective, Urban Agriculture

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## **INTRODUCTION**

Rapid urbanisation strains food supply, quality of life, and the urban environment, escalating living costs and impacting community well-being (Marzuki and Jais, 2020; Ramaloo et al., 2018). Addressing these pressing issues requires effective urban planning strategies to enhance sustainability. UA emerges as a crucial tool to tackle these challenges, fostering community networks and aiding individual recovery while bolstering cities' adaptive capacity. By incorporating sustainability principles, UA offers numerous benefits, such as creating green spaces, reducing carbon emissions, enhancing food security, promoting social interactions, facilitating education and skill development, and improving aesthetics (Lin et al., 2017; Ayoni et al., 2022). However, widespread implementation of UA seems insufficient due to inadequate cooperative efforts and strategic planning.

Malaysia has great potential to support sustainability through UA, but a clear development plan is lacking. This situation is mainly due to limited space, resources, and inadequate education about UA (Islam and Chamhuri, 2012). Ishak et al. (2022) also point out that land scarcity is a major barrier to UA, particularly in Kuala Lumpur.

Integrating UA practices into urban planning strategies can stimulate sustainable city development. Yet, UA frequently operates independently, lacks integration into planning and policy frameworks (Lovelley, 2010), and poses complex challenges due to conflicting stakeholder goals (Huang et al., 2015). UA practices vary based on context, influenced by climate, culture, and the urban environment. Thus, local authorities may need to approach UA strategies differently, tailoring them to the local community. Although numerous studies have examined UA's socio-economic factors, food security, and sustainability, there remains a need for further research to enhance UA strategies.

This study aims to explore stakeholders' views on UA concerning sustainable urban development. It expands the discussion by exploring UA's social, economic, and environmental opportunities and challenges and proposes a framework of action plans to support its implementation.

## **RESEARCH BACKGROUND**

### **Definition of UA**

Generally, UA refers to activities related to cultivating, processing, and marketing food and non-food products within urban and peri-urban settings. (Smit et al., 1996; Gallaher and Njenga, 2019).

### **Benefits and Challenges of UA**

Since the 1980s, UA has served as a crucial survival strategy for feeding the urban poor in Tanzania (Briggs, J., 1991). Beyond food security, UA has gained recognition in West Africa as a solution to food shortages caused by economic

difficulties and climate challenges (Levasseur et al., 2007). However, Martellozzo et al. (2014) found that UA struggles to ensure vegetable self-sufficiency for urban residents, especially under economic pressures. Zhou et al. (2023) noted that campus UA can generate an income of TWD 200 weekly and be self-sufficient for small family needs. Numerous studies highlight the benefits of UA, including creating green spaces, reducing carbon emissions, enhancing food security, fostering social interactions, and promoting education and skill development (Lin et al., 2017; Ayoni et al., 2022). While UA is less economically efficient for food production in Taipei, it emphasises sociocultural impacts (Zhou et al., 2023). Although urban greening has attracted wealthier individuals to UA, it is primarily more appealing to lower-income groups. For instance, 70% of urban farmers in Kenya are low-income individuals who have intensified their efforts to cope with various challenges (Omondi et al., 2017). Research by Crush et al. (2017) indicates that even elite individuals engage in UA, reflecting its broad appeal across income levels. While UA is generally well-received in Malaysia, community participation remains low and uncertain due to negative attitudes and socio-economic barriers, especially among low-income groups. Additionally, the widespread adoption of UA practices faces several challenges, summarised in Table 1.

**Table 1: Challenges of UA**

Authors	UA Challenges
Gunasiri et al. (2021), Huang et al. (2015)	Difficulty integrating into urban planning policies
Simon (2023), Lovell (2010), Kaufman (2007)	Disconnected and isolated initiatives
Ishak et al. (2022), Ali and Srivastava (2017)	Huge cost
Ishak et al. (2022), Gunasiri et al. (2021), Low (2019)	Land issues & limited land space
Gunasiri et al. (2021), Chenarides et al. (2020)	Human-related & poor community engagement
Ishak et al. (2022), Rahim (2014)	Climate change
Ishak et al. (2022), Rahim (2014)	Risks in pests, diseases
Pourjavid et al. (2013)	Lack of education and awareness
Veenhuizen. V and Danso (2007)	Challenges in access to water

*Source: Authors (2024)*

Governance challenges often obstruct the integration of UA into urban planning policies (Gunasiri et al., 2021; Huang et al., 2015). In the U.S., there is no comprehensive analysis of the various UA policies across cities (Halvey et al., 2021). In Malaysia, while the Urban Community Garden Policy aims to promote UA, its implementation remains non-mandatory, relying primarily on community

initiatives. The practice of UA has historically been fragmented and isolated, leading to conflicts among stakeholders due to differing values and interests (Simon, 2023; Lovell, 2010; Kaufman, 2007). This disconnect emphasises the need for understanding stakeholder roles and governance procedures to enhance participatory urban planning. High costs also present significant barriers to community engagement in UA, particularly regarding irrigation expenses (Ishak et al., 2022). Limited financial, technological, and institutional support hinders large-scale UA in countries like India (Ali and Srivastava, 2017). In Singapore, space shortages and a complex regulatory framework further complicate access to land for urban farmers (Low, 2019; Ishak et al., 2022; Gunasiri et al., 2021). Comparatively, Malaysia's UA efforts remain community-driven and non-mandatory. A potential solution is to incorporate UA into formal policies, similar to Cape Town, which has a dedicated UA policy that supports resource provision, land access, and training (City of Cape Town, 2007). Promoting partnerships between private landowners and the government could also enhance UA initiatives by allowing land leasing for farming purposes. Significant human-related challenges persist in developing countries, where economic concerns often take precedence. Communities typically lack information on cultivation, marketing, and market demand, highlighting the urgent need for training and foundational knowledge in UA. Collaborative efforts among stakeholders are essential to integrate UA into community culture, as practices may vary based on unique local conditions and environments.

### **Sustainable Development Goal (SDG 11): Sustainable Cities and Communities**

As urban populations grow, SDG 11 aims to ensure that urban areas are able to cater to this expansion while improving living conditions and reducing the environmental impact of cities. Thus, making cities inclusive, safe, resilient, and sustainable. UA directly contributes to SDG 11 by promoting sustainable cities through green spaces, improving food security, and supporting community resilience and urban sustainability. By integrating UA into urban planning, cities can enhance their adaptive capacities, reduce their carbon footprints, and build healthier, more inclusive environments.

### **UA Development in Malaysia**

Malaysia has significant potential for sustainability through UA, but the lack of an integrated development approach carries challenges, including limited space, resources, and education (Islam and Chamhuri, 2012). Ishak et al. (2022) identified land scarcity in Kuala Lumpur, along with unpredictable weather and financial issues, as major obstacles.

### Strategic Efforts of UA: Experienced in Other Countries

Exploring strategies for UA by considering insights from successful practices in other countries is essential. The following Table shows the strategy efforts of UA carried out based on various countries:

**Table 2:** Strategic Efforts of UA based on various countries

Authors	Merkle (2023)	Merkle (2023), Butturini and Marcelis (2019)	Merkle (2023), Junqian (2011)	Silbiger et al. (2022)	Silbiger et al. (2022)
UA Strategies	Germany Hugo Biomass Park Belvedere Park	France City of Paris Sports Hall Vignoles	China Shanghai	Canada City of Mississauga	US City of Boston
Education & training	✓	✓		✓	
Roles of stakeholders	✓			✓	
Technology advancement	✓	✓	✓		
Engagement multiple stakeholders	✓				
Rejuvenate areas	✓				
Prioritise environmentally- friendly cultivation method		✓	✓		
Rooftop garden	✓	✓	✓		
Promote, support, and enable inclusive, culturally relevant	✓	✓	✓	✓	
Support individuals, communities, and local businesses in developing creative ideas to expand local food initiatives	✓	✓	✓	✓	
Proactive planning & implementation	✓	✓	✓	✓	✓

*Source: Authors (2024)*

### Sustainability Matrix in UA

As Table 3 shows, social, economic, environmental, policy, and innovative factors are essential to urban sustainability to ensure UA's long-term sustainability and viability in creating sustainable cities.

**Table 3:** Sustainability Matrix in UA

UA based on Sustainability Pillars	Authors				Azunre et al. (2019)	Mengual et al. (2019)
	Kafle, Hopeward and Myer (2023)	Yoshida et al. (2019)	Clerino & Lelievre (2020)	Ding et al. (2020)		
<b>Social</b>						
▪ Human health benefits		•				
▪ Community development		•				
▪ Educational benefit		•	•			

UA based on Sustainability Pillars	Authors				Azunre et al. (2019)	Mengual et al. (2019)
	Kafle, Hopeward and Myer (2023)	Yoshida et al. (2019)	Clerino & Lelievre (2020)	Ding et al. (2020)		
<ul style="list-style-type: none"> <li>Providing local foods</li> <li>Employment</li> <li>Social capital</li> </ul>		•	•	•		
<b>Economic</b> <ul style="list-style-type: none"> <li>Business strategy</li> <li>Offer low transportation cost</li> </ul>	•	•				
<b>Environmental</b> <ul style="list-style-type: none"> <li>Greening</li> <li>Boosting biodiversity</li> <li>Improving natural resource</li> </ul>		• • •		•		
<b>Policy</b> <ul style="list-style-type: none"> <li>Land use planning and zoning</li> </ul>					•	
<b>Innovation and Technology</b> <ul style="list-style-type: none"> <li>Innovative technique of UA</li> </ul>						•

Source: Authors (2024)

### Stakeholder Theory

Freeman's Stakeholder Theory (2015) emphasises that organisations should consider the interests of all stakeholders, not just their own. In this study, key stakeholders in Malaysia include the Department of Agriculture, PLANMalaysia, local councils, private property managers, and academicians, all contributing their expertise in urban agriculture and planning. Government agencies focus on policy-making and resource allocation, private property managers engage the community, and academicians provide education. Effective collaboration among these stakeholders is essential for advancing urban agriculture and sustainable urban development.

## RESEARCH METHODOLOGY

This study was exploratory in nature. Thus, considering the lack of empirical research in this field, a qualitative approach was employed to explore experts' views, experiences, and insights on UA toward sustainable urban development.

### Research Context

Given the importance and potential of UA in Malaysia, this study aims to explore the perspectives of 15 stakeholders across federal, state, and local levels (agricultural directors and officers, urban planners), property managers, and academicians focusing on key aspects of UA, including its various benefits and challenges. The study identifies strategic actions needed to address these gaps and enhance UA's contribution to sustainable city development.

### Sample

This study engaged 15 stakeholders, including agricultural directors and officers at federal, state, and local levels, urban planners, private property managers, and academicians. Informants were selected through purposive sampling, focusing on those with over three years of experience in UA. Expert interviews, deemed effective for exploratory research (Bogner, Littig, & Menz, 2009), were conducted via email, phone, and in-person from February 2 to March 18, 2024. The interview demographic comprised two property managers, six agricultural stakeholders, one local authority representative, three urban planners, and three academicians. Details of the informant criteria are provided in Table 4.

**Table 4: Basic Data of Informants**

Level	Organisation	Type of Informant	Numbers of Informants	Background	Inclusion criteria
Federal	Department of Agriculture Malaysia	Agricultural Directors, Assistant Directors	5 (R1, R2, R3, R4, R5)	Agricultural Officer, 3- 15 years experience	These stakeholders were top management, practitioners, and officers with related backgrounds, knowledge, and experience in urban agriculture, urban planning, real estate, and green campus committees.
	PLANMalaysia	Urban Planners	3 (R6, R7, R8)	Urban Planner, 3- 15 years experience	
State	Department of Agriculture Perak	Agricultural Officer	1 (R9)	Agricultural Officer, 17 years experience	
Local	Subang Jaya City Council	Senior Assistant Director Town and Country Planning Department	1 (R10)	Senior Assistant Director Town and Country Planning Department; 23 years experience	
Practitioner (Real Estate)	Private Property Managers	Property Managers	2 (R11, R12)	Property Manager and Registered Property Manager; 10 years experience	
Academicians	Universiti Teknologi MARA Perak Branch	Lecturer	3 (R13, R14, R15)	PhD Qualification, 18-24 years experience, Green University Campus Committee	

*Source: Authors (2024)*

### Data Analysis

The transcripts were prepared for thematic analysis to identify the data's patterns, themes, and categories. This step involved familiarising with the data, generating codes, searching for themes, reviewing and naming them, and producing a report. The researcher manually analysed the data using inductive and deductive methods to uncover new themes. Triangulation of data from different authority



levels ensured reliable insights into UA's potential for sustainable urban development.

## **ANALYSIS AND DISCUSSION**

### **UA Issues and Challenges**

The research findings align with prior studies highlighting that UA faces various challenges, including planning policy issues, unclear initiatives, high operating costs, limited land, and community engagement obstacles (Gunasiri et al., 2021; Huang et al., 2015; Simon, 2023; Lovell, 2010; Kaufman, 2007; Ishak et al., 2022; Pourjavid et al., 2013). Informants identified the most significant challenges as the costs of operating UA and the level of community commitment and participation. Mindset and time constraints within the community also play critical roles. Collaboration between stakeholders, especially government agencies and organisations, is crucial for addressing these high-cost issues. Informants emphasized the need for affordable technological innovations and grants to support suitable innovations. Additionally, community leaders should foster commitment and organise regular programs to enhance participation in UA. Some agricultural sector informants and urban planners pointed out that policy challenges, such as the lack of a dedicated act and limited land, significantly affect UA. Overcoming these challenges requires collaboration among government and relevant agencies, introducing incentives, promoting strong community commitment, and enacting supportive legislation to advance inclusive and sustainable UA.

### **UA Benefits**

During the interview process, most stakeholders recognised that UA provides multiple advantages and diverse opinions. Informant R13 mentioned that implementing UA provides many benefits to the local community. If there is support from all parties, the implementation of UA can be used as a side income, health the body, and strengthen the relationship between local communities. Informant R9 stated that UA can reduce house-living expenses while producing safe-to-eat crops that can be sold to the local community. Based on their practical experience, households can plant and sell their cultivation in the market, reducing living costs significantly. Informant R14 added that UA is acknowledged for fostering social bonds among community members and acting as an approach to increasing local community involvement. This opinion also aligns with informant R11 who mentioned that UA can be used as a group activity and sharing the crops.

### **Proposing Strategic efforts to implement UA toward sustainable urban development**

This study analyses and incorporates recommendations from informants into frameworks using NVIVO version 14, as illustrated in Figure 1. These proposed

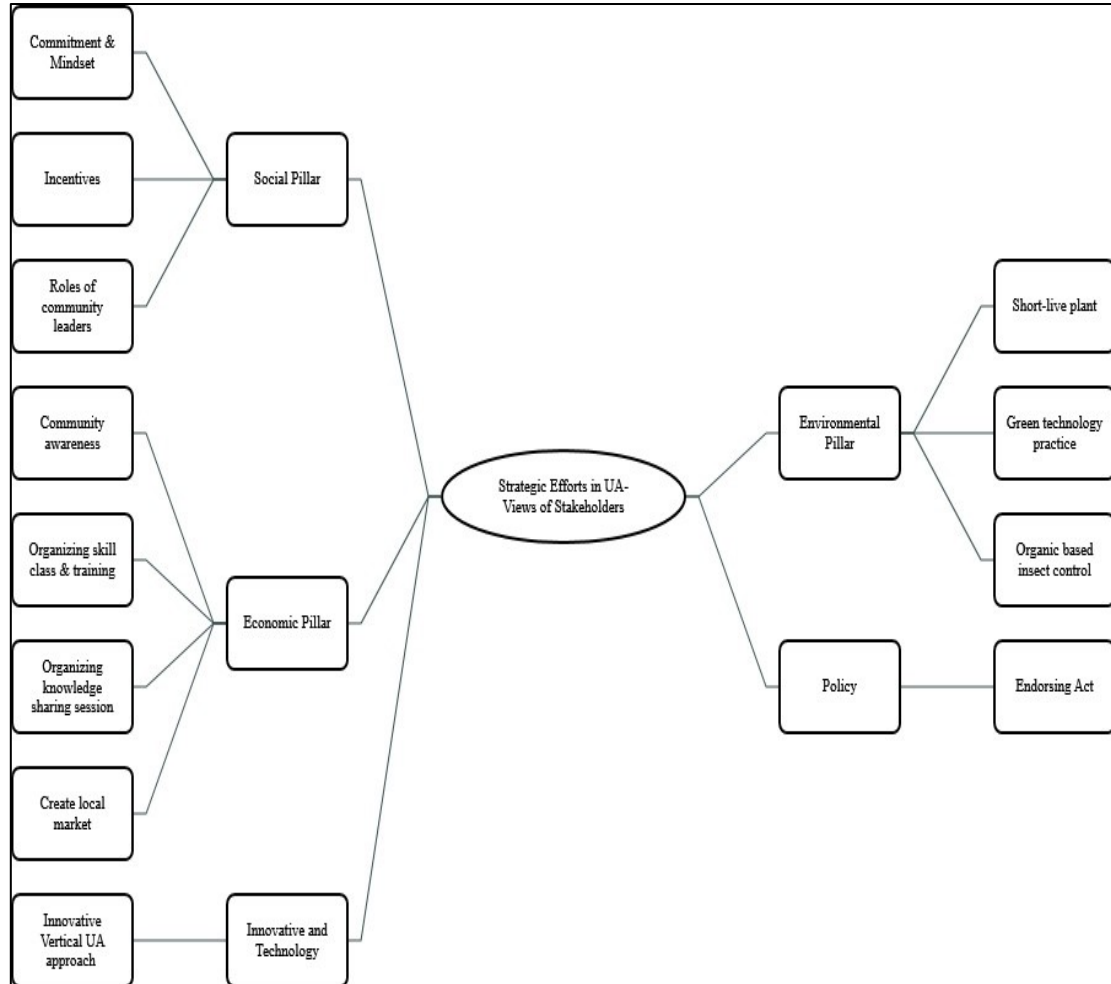
frameworks are designed to be practical and adaptable for policymakers, potentially employing a phased implementation approach. The initial phase may concentrate on immediate actions like stakeholder engagement, followed by program development in the next phase, and concluding with evaluation in subsequent stages.

### **Economic**

In the economic pillar, community awareness and understanding of the benefits of UA and its significance as a business opportunity platform are significant strategic efforts suggested by informants R10 and R13 points of view. Other strategic efforts can include organising classes, training sessions, and coaching by successful participants in UA. Providing marketing skills courses is another viable initiative stated by R11. Additionally, effective use of digital and media platforms can increase awareness and interest in UA, thereby expanding the market effectively. To establish UA as a viable business opportunity platform, the role of community leaders and government agencies is crucial in delivering comprehensive information about UA and ensuring community awareness.

*“Local market centres could be created through UA, offering various products at affordable prices to generate profound interest in UA as a business opportunity.” (R9)*

This initiative aims to enlighten and engage the community. A study by Islam and Chamhuri (2012) also highlighted that interactive and participatory approaches at the community level should be implemented to foster a sense of ownership among community members. This should be reinforced through the coordination roles by various stakeholders, ensuring collective support and engagement in the process. Sharing success stories of urban gardening, both within and outside the country, through knowledge-sharing sessions can also be beneficial, as suggested by R13. As we know, urban land use is highly competitive with various development activities. Therefore, strategic efforts to overcome limited land availability, including implementing knowledge sharing in vertical farming, hydroponic cultivation, and expanding land use for UA, are helpful.



**Figure 1:** Framework of stakeholders' viewpoints on strategic efforts that could be implemented in UA.

Source: Authors (2024)

### Social

On the social aspect, community participation and commitment are crucial in implementing and ensuring UA's success, thus contributing towards sustainable cities.

*“Commitment and mindset are essential to ensure continuous involvement in UA.” (R1, R2, R9, R10, R11, R12, R13, R14, R15)*

All in all, commitment and mindset are important aspects of ensuring participation and involvement in UA. Without these, UA cannot be sustained. Therefore, most stakeholders agreed that establishing activities and awareness of UA is essential. In fact, community leaders also play a significant role in holding a regular program to encourage collective community involvement in UA activities. Through this, continuous UA activities could be established, incentivising informants to quickly garner interest and commitment from the community in engaging in UA (R14).

### **Environmental**

In terms of environmental aspects, UA faces challenges with unpredictable climate conditions and environments. Securing clean water sources also becomes a matter of concern. Therefore, realising urban sustainability through UA implementation poses significant challenges. Hence, R9 and R13 proposed several aspects to address this issue. To cope with uncertain climates, prioritising the selection of short-lived plants and choosing suitable locations is essential. Additionally, the use of greenhouses and green technology practices was suggested the most by stakeholders (R3, R9). Insect control is also crucial to ensure a safe environment and food sources. Informants R2 and R9 also recommend the use of organic-based insect control.

### **Policy**

Regarding policies to further encourage UA, informants have proposed several recommendations. For example, R10 from the local authority recommended formulating a specific federal, state, and local policy regarding the necessity of UA. This aligns with Prové (2018) findings, which indicated that a well-designed multi-level governance system would boost local actors' involvement in UA policymaking and help establish UA as a distinct policy entity across different governance levels. Other informants mentioned this:

*“Government needs to study this policy and local authority suggested needs to work hard in realising UA.” (R13)*

*“Attractive programs in UA should be implemented to attract community interest through establishing cooperation or model UA/successful UA to be exposed to the communities.” (R9)*

By interpreting this, it is found that endorsing Acts is crucial to fostering and realising the growth of UA. In Madison, US, UA has implemented a zoning ordinance on its land use plan to encourage community gardens in the city. Besides that, Taiwan has established successful policies such as Taipei Beautiful

and Taipei Garden City (Zhou et al, 2023). As a result, many small and vacant lots were converted into edible gardens and gained great popularity.

### **Innovation & Technology**

Incorporating innovative methods is essential for improving UA's overall sustainability. Therefore, among strategic efforts suggested by informants to overcome limited land availability include implementing hydroponics, terraced planting technology, hydroponics, and expanding land use for UA (R1, R2, R3, R4, R5, R6, R9). The use of technology and innovation at minimal costs in UA activities is also an important aspect of encouraging the development of UA (R14). However, informant R11 suggested replacing existing trees that the developer planted with trees, fruits, and vegetables. According to informant R9, the agricultural department has offered UA many technologies and tools. However, it sometimes involves high cost. Therefore, collaboration in financial assistance from government agencies and related organisations is crucial to addressing high-cost issues, as suggested by R14. Grants from the relevant parties for developing suitable innovations are also encouraged (R14). Nevertheless, informant R13 underscored the importance of exposure to the community through briefing and training in technology and innovation skills from experts should be conducted to impart the latest advancements. As we know, urban land use is highly competitive with various development activities.

### **CONCLUSION**

This study explores UA's challenges and benefits in contributing to sustainable development by considering the stakeholders' perspectives, thereby proposing action plans or strategic efforts to fill the gap and support UA for sustainable urban development. The objective is to propose actionable plans to support UA's progress, bridging knowledge gaps by developing a framework that emphasises social, economic, and environmental factors and other key factors such as innovation, technology, and policy. In terms of the theoretical implications, the findings of this study are consistent with previous research that highlights the importance of participation by all stakeholders to ensure a successful and sustainable UA. As for the practical implication, the findings of this qualitative study are to guide policymakers, industry practitioners, and educators in formulating effective policies and sustainable planning strategies that support the progress and growth of UA in sustainable development. The implications of this study also offer valuable insights for government authorities and urban planners in line with the pursuit of Sustainable Development Goals, Sustainable Cities and Communities (SDGs 11). This study is generally a pre-study conducted in the context of sustainable development and limited to the informants; further research could be carried out to explore strategies and interventions to the specific real estate and sustainable cities field that can promote collaborative synergies within

real estate planning development. While UA offers potential economic and social benefits, these are often unevenly distributed, with low-income areas facing more significant barriers to implementing UA. Future studies could explore the economic models that ensure the long-term viability of UA initiatives, examining funding mechanisms, market accessibility, and profitability in different urban environments. Additionally, researchers could focus on strategies to make UA more inclusive and accessible to marginalised groups, addressing issues like land tenure, resource access, and financial support.

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## **AGILE URBAN DYNAMICS: EXAMINING HOUSING CHARACTERISTICS IN THE SLUMS OF BELAWAN BAHARI, MEDAN-INDONESIA**

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### **Abstract**

Rapid urbanisation in Medan, particularly in the Belawan Bahari district, has catalysed the emergence of slum settlements, requiring an in-depth exploration of housing dynamics. This research employs qualitative methods, including site observations, interviews, and community engagement, to examine the structural, infrastructural, and social factors shaping housing conditions in the slum residences of Belawan Bahari. It analyses construction practices, materials, and structural integrity alongside essential amenities such as water, sanitation, and electricity. Additionally, it investigates community structures, social interactions, and shared spaces, providing a comprehensive view of the area's social fabric. This agile approach aims to inform targeted interventions, enhancing residents' quality of life. Expected outcomes include a detailed understanding of housing characteristics, offering insights for urban planners, policymakers, and community organisations. Findings are intended to guide adaptive interventions that address local challenges and utilise existing strengths, contributing to a resilient urban environment in Belawan Bahari, Medan, Indonesia.

**Keywords:** Agile Urban Dynamics, Housing Characteristics, Slum Residences, Medan-Indonesia

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## **INTRODUCTION**

Rapid urbanisation is transforming cities globally, and Medan, Indonesia, particularly in the Belawan Bahari district, is no exception (Hana & Pujiati, 2023). This swift growth has spurred the development of slum settlements characterised by substandard housing, limited access to essential services, and precarious living conditions, presenting challenges and opportunities for urban planners and policymakers (UN HABITAT, 2020). In response, "agile urban development" emerges as a critical approach, advocating for flexibility, responsiveness, and iterative adjustments to meet urbanization's dynamic and unpredictable nature (Munro, 2015). This model enables planners to implement solutions iteratively, continually integrating stakeholder feedback and adapting strategies to evolving needs. This is particularly pertinent in rapidly growing slum areas like Belawan Bahari, where socio-economic conditions, housing needs, and infrastructure demands shift rapidly (Eren, 2017).

The Belawan Bahari district exemplifies the complexities of informal settlements growth amidst rapid population increases (Rahmad et al., 2017). Its proximity to port and industrial zones has attracted a large migrant population, leading to the spontaneous formation of slums with limited infrastructure such as clean water, sanitation, and electricity, exacerbating social and economic inequalities (Bagheri, 2013). Yet, these communities exhibit a notable capacity for self-organisation, adapting to socio-economic pressures through dynamic, bottom-up processes. As Zappulla et al. (2014) note, slums are "unstable systems in continuous transformation," forming complex spatial arrangements that reflect adaptive survival strategies. In Belawan Bahari, dense housing and resourceful adaptations reveal the community's resilience, underscoring the need for inclusive strategies that both address residents' needs and leverage their inherent adaptability.

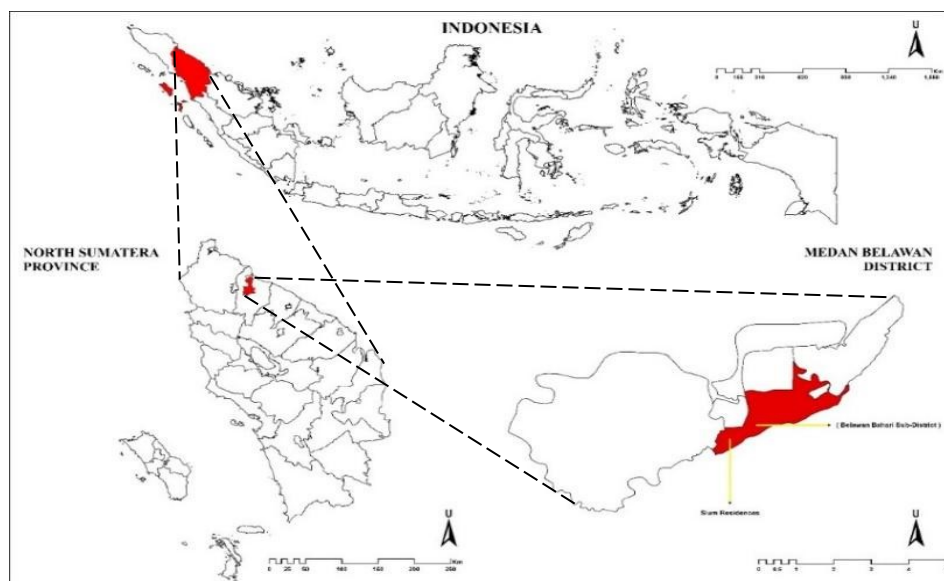
This study is grounded in agile urban development principles that stress flexibility, adaptability, and responsiveness to urban challenges, especially within slum settlements (World Economic Forum, 2016). Inspired by agile project management, these principles encourage stakeholder collaboration and continuous feedback to tackle complex urban issues (Daraojimba et al., 2024). As Russell (2011) highlights in *The Agile City*, agility in urban planning enables cities to swiftly modify infrastructure, buildings, and community layouts to reduce carbon emissions and boost resilience. Such an approach is particularly relevant in slum contexts, where residents face diverse and evolving challenges that demand responsive, co-created solutions (World Bank, 2021). Resilience has become increasingly integral to urban planning. A bibliometric analysis by Zuraidi et al. (2021, 2022) reveals that themes such as climate change, sustainability, and spatial planning are central to resilience research and critical in addressing vulnerabilities. By integrating agile and resilience-focused

strategies, urban planners can revitalise outdated housing, transport, and resource management systems through participatory approaches, fostering sustainable growth, socio-economic opportunities, and enhanced adaptability for vulnerable communities.

Building on this foundation, this study examines housing characteristics in Belawan Bahari's slum residences, focusing on structural, infrastructural, and social dynamics. Through observations, interviews, and community engagement, it investigates construction techniques, material quality, structural integrity, and access to essential amenities such as water, sanitation, and electricity. The study also explores community structures and shared spaces to understand the local social fabric. By applying agile principles, it aims to inform targeted interventions and policies that improve living conditions, enhance resilience, and guide future urban development efforts.

## RESEARCH METHODOLOGY

This study focuses on Belawan Bahari Village in Medan Belawan District, Indonesia, a rapidly urbanising area of 230 hectares where slum settlements are emerging (Figure 1).



**Figure 1:** Study Location: Belawan Bahari Sub-district, Medan, Indonesia

Selected for its representative urban growth and informal settlement patterns, the village, home to 13,373 people across 3,069 families in 13 neighbourhoods ("Lingkungan") (Bureau of Statistic of Medan City, 2024),

serves as a case study of housing dynamics. The research concentrates on Lingkungan VIII to examine structural, infrastructural, and social dimensions of slum housing. Structural aspects, such as construction methods and materials, affect safety and resilience yet remain constrained by limited resources (Killemsetty, 2021). Infrastructural issues, including inconsistent access to water, sanitation, and electricity, further intensify socio-economic inequalities (Oskam et al., 2021). Social dynamics, including neighbourhood ties and collective action, enhance resilience through resource-sharing networks (Aldrich & Meyer, 2015). Data collection involved site visits, interviews with residents and leaders, and participatory mapping to document local knowledge and priorities (Table 1). Employing purposive sampling and thematic analysis, the study identified recurring patterns that provide a strong foundation for agile, targeted interventions (Nowell et al., 2017). Agile principles underpin this process, allowing iterative data collection, real-time adjustments to research priorities, and adaptability to evolving insights (Andriyani et al., 2024).

Table 1 presents a sample of 45 individuals, predominantly male (67%) with females comprising 33%. The average age is 47.3 years, ranging from 23 to 74, indicating a predominantly mature demographic. Educational attainment is modest: 56% have completed middle school, 42% primary school, and only 2% have a high school education. Fishing is the primary occupation, involving 67% of individuals and underscoring its economic significance within the community. Additionally, 13% work in dried fish processing, while 9% are housewives. A smaller segment is economically dependent on family support, with 7% relying on children, 2% on parents, and 2% employed in sales. This profile reflects a community with limited educational advancement, a strong reliance on fishing, and a socio-economic structure sustained by artisanal work and family-based economic support.

**Table 1: Respondent Profile**

No.	Gender	Age	Education	Occupation
Respondent 1	M	69	Primary School	Fisherman
Respondent 2	M	46	Middle School	Fisherman
Respondent 3	M	60	Primary School	Fisherman
Respondent 4	M	57	Middle School	Fisherman
Respondent 5	M	37	Middle School	Fisherman
Respondent 6	M	45	Primary School	Fisherman
Respondent 7	M	53	Middle School	Fisherman
Respondent 8	F	40	Middle School	Housewife
Respondent 9	F	32	Middle School	Housewife
Respondent 10	F	49	Middle School	Dried Fish Artisan
Respondent 11	M	50	Primary School	Fisherman
Respondent 12	M	47	Middle School	Fisherman
Respondent 13	M	32	High School	Fisherman
Respondent 14	F	68	Primary School	Dependent on child

No.	Gender	Age	Education	Occupation
Respondent 15	F	46	Middle School	Dried Fish Artisan
Respondent 16	M	57	Middle School	Fisherman
Respondent 17	M	66	Primary School	Fisherman
Respondent 18	F	70	Primary School	Dependent on child
Respondent 19	F	74	Primary School	Dependent on child
Respondent 20	M	49	Middle School	Fisherman
Respondent 21	F	48	Middle School	Housewife
Respondent 22	F	37	Middle School	Housewife
Respondent 23	F	50	Primary School	Dried Fish Artisan
Respondent 24	M	52	Middle School	Fisherman
Respondent 25	M	48	Middle School	Fisherman
Respondent 26	M	53	Primary School	Fisherman
Respondent 27	F	23	Middle School	Dependent on parents
Respondent 28	F	54	Primary School	Dried Fish Artisan
Respondent 29	M	66	Primary School	Fisherman
Respondent 30	M	44	Middle School	Fisherman
Respondent 31	M	66	Primary School	Fisherman
Respondent 32	F	45	Primary School	Sales
Respondent 33	M	30	Middle School	Fisherman
Respondent 34	F	43	Middle School	Dried Fish Artisan
Respondent 35	M	57	Primary School	Fisherman
Respondent 36	M	28	Middle School	Fisherman
Respondent 37	M	34	Middle School	Fisherman
Respondent 38	M	45	Middle School	Fisherman
Respondent 39	M	34	Middle School	Fisherman
Respondent 40	M	43	Middle School	Fisherman
Respondent 41	M	59	Primary School	Fisherman
Respondent 42	M	24	Middle School	Fisherman
Respondent 43	F	26	Primary School	Dried Fish Artisan
Respondent 44	M	44	Primary School	Fisherman
Respondent 45	M	27	Primary School	Fisherman

## ANALYSIS AND DISCUSSION

This section discusses the general profile of slum residences in the study area, followed by a detailed examination of the structural, infrastructural, and social dynamics that shape housing conditions in these settlements. It also explores the implications of these findings for urban development and policymaking (Table 2).

### Housing Profile of Slum Residences

The housing profile in Belawan Bahari's slum residences highlights critical aspects of the built environment, spatial organisation, and socio-economic dynamics (Table 2).

**Table 2:** Housing Profile of Slum Residences in Belawan Bahari, Medan

Items	Descriptions
House Type	Stilt houses with plank floors are designed to prevent waterlogging from frequent tidal flooding.
House layout	Consists of one bedroom, a multipurpose common room, and a small bathroom.
House Size	60% of respondents reside in houses measuring between 60 m <sup>2</sup> - 100 m <sup>2</sup> , while the remaining 30% occupy homes ranging from 10 m <sup>2</sup> - 50 m <sup>2</sup> .
Residents in 1 house	4 to 6 people
Land Ownership	property rights and use rights.
Spatial structure of neighbourhood	The lack of institutionalised spatial planning has led to unregulated housing construction, resulting in densely packed homes that heighten the risk of fire hazards.
Buildings Distance	The building density and designation are very high (0.5m – 2 m) apart.
Settlement pattern	The settlement follows a linear pattern, with dense housing flanking both sides of the road.
Shared space	Residents utilise the available space to dry sea products, such as salted fish, with limited land preventing the creation of green open spaces.

Most homes are stilt houses with plank floors, designed to mitigate flooding during high tides. These structures range from 10 m<sup>2</sup> to 100 m<sup>2</sup> and typically house 4 to 6 residents (Figure 2a). The homes are compact, typically consisting of a single bedroom, a multipurpose common room, and a small bathroom. The absence of formal spatial planning has resulted in densely packed housing, with gaps as narrow as 0.5m to 2m, increasing fire risks and limiting emergency access. A resident recounted, *"When a fire broke out, it spread so quickly that no one could help. The spaces are just too tight."* Land ownership is diverse, with some residents holding formal property rights, providing a degree of stability, while others rely on informal use rights, facing ongoing uncertainty and vulnerability. One resident shared, *"We live here because my grandfather used this land for years, but without papers, there's always fear."* Informal land transactions are based largely on trust and personal relationships, as a community leader remarked, *"Without documents, it's all about knowing who to talk to and building trust."* These dynamics underscore the significant challenges of ensuring tenure security and promoting long-term settlement stability.



**Figure 2:** Housing Environment (a. Stilts house with plank floor; b. House Structure; c. Road Condition; d. Shared space)

### **Structural Dynamics of Slum Residences**

Through site observations, interviews, and community engagement, a nuanced understanding of the structural dynamics within the slum settlements of Belawan Bahari emerged. These dynamics of slum residences encompass several key aspects vital to understanding the built environment of these informal settlements. This section explores three critical components: construction methods and techniques, materials used in slum housing, and an assessment of structural integrity (Figure 2a dan 2b).

#### ***Construction Methods and Techniques***

In Belawan Bahari, construction methods reflect the informal nature of the settlements, with most homes built using salvaged materials, wood, and corrugated metal sheets. These ad-hoc techniques, including bricklaying, timber framing, and metal sheet roofing, result in semi-permanent structures that often lack durability (Table 2). Observations of brittle, poorly maintained walls and makeshift roof reinforcements highlight significant structural vulnerabilities, particularly in high-risk environments such as flood-prone areas (Killemssetty, 2021). These findings align with studies from Kibera, Nairobi, and Dharavi, Mumbai, where informal construction relies heavily on locally available materials and labour (UN HABITAT, 2017). However, unlike Kibera, where mud-based walls and tin roofing dominate, Belawan Bahari's reliance on timber framing and metal sheets reflects adaptation to coastal conditions and the need for mobility in case of relocation. This underscores the site-specific responses to environmental constraints, illustrating the diverse construction strategies employed in slums worldwide.

#### ***Materials Used in Slum Housing***

The materials used in Belawan Bahari reflect a trade-off between affordability and structural resilience (Table 2). Common materials, such as corrugated metal

sheets, salvaged wood, boards, plywood, and plaster, offer cost-effectiveness but raise concerns about long-term durability. For example, wooden frames with zinc sheet roofing provide basic shelter but lack robustness against natural disasters like high tides or strong winds. Similar trends are observed in informal settlements in Phnom Penh, Cambodia, where cost-effective materials dominate due to financial constraints (Alshubiri & Al Ani, 2024).

**Table 3:** Observation Checklist for Housing Dynamics in Slum Residences

Observation Aspects	Field Notes
<b>Structural Dynamics</b>	
Construction methods and techniques of housing	Semi-permanent buildings with walls that have become brittle due to age and lack of maintenance.
Materials used in slum housing	The roof structure consists of a simple wooden frame with a zinc sheet covering, while the walls are constructed using boards, plywood, and plaster
The structural integrity of the housing	Many buildings in the settlement show signs of structural instability, including corroded foundations, porous roofs, water leaks, wall cracks, and sagging roofs, indicating widespread structural weaknesses.
<b>Infrastructural Dynamics</b>	
Water supply	Clean water networks are not yet available to all homes.
Sanitation facilities	Available for every home
Electricity	The electrical network is available but suffers from an unreliable supply, high costs, and safety risks due to makeshift wiring.
Waste management system	There are no trash facilities available, leading to indiscriminate disposal of waste.
Road network	The road network is accessible but is partially damaged due to frequent tidal flooding.
<b>Social Dynamics</b>	
Community structure and organisation	Neighbourhood committees
Interpersonal relationships and social networks	In these communities, social ties often extend beyond immediate family members to include neighbours, friends, and acquaintances.

### ***Structural Integrity***

The examination of structural integrity in Belawan Bahari's slum settlements revealed a range of housing conditions, from well-maintained buildings with reinforced foundations to deteriorating structures showing signs of instability (Figure 2b). While some homes were built with solid roofing and reinforced foundations to reduce disaster risks, many exhibited signs of decay, including rusted materials, water leaks, wall cracks, and sagging roofs, highlighting significant structural weaknesses. Additionally, residents expressed concerns about the safety of their homes, particularly during natural disasters when



structural damage heightens their vulnerability. Community engagement activities, such as participatory mapping, facilitated discussions on potential solutions to address these vulnerabilities, emphasising the importance of community-led initiatives and stakeholder collaboration to reinforce housing structures and enhance disaster resilience (Zuraidi et al., 2023).

### **Infrastructural Dynamics**

The quality of housing in slum settlements is profoundly impacted by the availability and accessibility of essential amenities. This section examines how infrastructure, particularly water supply, sanitation facilities, electricity, waste management, and the road network, affects housing conditions within the context of Belawan Bahari's informal settlements (Figure 3).

#### ***Water Supply***

In Belawan Bahari, residents face disparities in water access, characterised by irregular supply, poor water quality, and the financial burden of purchasing water. These challenges mirror findings in Lagos, Nigeria, where slum residents rely on vendors due to the inadequacy of public water systems (Oskam et al., 2021). A unique feature of Belawan Bahari is the use of participatory mapping exercises, which revealed collective concerns and calls for action. This highlights an emerging trend in community-driven approaches to addressing water scarcity, aligning with the objectives of Sustainable Development Goal 6.



**Figure 3:** The infrastructure dynamics (water supply, sanitation facilities, electricity, waste management system, road network)

#### ***Sanitation Facilities***

Sanitation in Belawan Bahari shows a positive aspect in the availability of toilet, a notable improvement compared to settlements in Sub-Saharan Africa, where open defecation remains common due to a lack of facilities (Aladelokun & Ayiti,

2023). However, challenges related to functionality, maintenance, and hygiene persist, reflecting issues reported in settlements in Jakarta, Indonesia, where poorly maintained toilets pose significant public health risks (Ferianto & Widodo, 2024). A distinguishing feature in Belawan Bahari is the presence of basic sanitation infrastructure, though it lacks effective community-led management systems. This highlights the potential for targeted investment and community-driven maintenance programs to improve hygiene standards.

### ***Electricity***

While Belawan Bahari benefits from a functioning electricity network, challenges such as unreliable supply, high costs, and safety hazards from makeshift wiring are prevalent in informal settlements globally (Table 2). Similar issues are reported in Cape Town, South Africa, where illegal connections result in frequent outages and safety risks (Jefferson, 2015). Unlike settlements like Kibera, Nairobi, where access to electricity remains a significant barrier, Belawan Bahari has better electricity infrastructure but still suffers from inefficiencies. A unique opportunity exists in fostering community-led sustainable energy initiatives, which could help address concerns related to affordability and reliability.

### ***Waste Management System***

The absence of waste management infrastructure in Belawan Bahari results in indiscriminate disposal, posing significant environmental and health risks (Figure 2c). This mirrors findings from Addis Ababa, Ethiopia, where inadequate waste management in slums exacerbates pollution and disease outbreaks (Eshete et al., 2024). However, Belawan Bahari's reliance on ad-hoc disposal methods is less structured compared to waste-picking systems in settlements like Rocinha, Brazil, where informal recycling networks help reduce waste (Arcidiacono et al., 2017). The findings emphasise the urgency for designated waste disposal systems and awareness campaigns, in line with best practices from other settlements that integrate informal waste collectors into formal systems.

### ***Road network***

The road network in Belawan Bahari, while present, is vulnerable to frequent tidal floods, which compromise mobility and access (Figure 4). This issue is consistent with studies in Jakarta, where slum roads are regularly affected by flooding, hindering transportation and economic activity (Gomez-Cunya et al., 2020). However, unlike settlements in Dhaka, Bangladesh, where road quality varies based on proximity to formal neighbourhoods, the road conditions in Belawan Bahari are uniformly poor, with tidal floods being the primary environmental stressor (Martín et al., 2021). Investment in flood-resilient road

infrastructure, such as raised and reinforced pathways, would improve mobility and reduce the environmental impacts.

### **Social Dynamics**

Understanding the social dynamics within slum residences is essential for gaining insight into the community fabric and interpersonal relationships that shape daily life in informal settlements. This section explores three key aspects: community structures and organisations, interpersonal relationships and social networks, and the analysis of shared spaces.

#### ***Community Structures and Organizations***

Site visits revealed the presence of various community structures and organisations in Belawan Bahari, including informal leadership and neighbourhood committees, which play crucial roles in fostering social cohesion and collective action. Informal leaders, often referred to as *"tokoh masyarakat"* (community figures), are influential in coordinating initiatives and advocating for better living conditions. One resident stated, *"Pak Ali always organises us when there's a need—whether for cleaning the drains or addressing our concerns to the local government."* This mirrors findings from studies in Kibera, Nairobi, where informal leaders and grassroots organisations play a significant role in community development and conflict resolution (UN HABITAT, 2020).

#### ***Interpersonal relationships and social networks***

Semi-structured interviews with residents revealed the deep interpersonal relationships and social networks that underpin daily life in Belawan Bahari. Residents emphasised the importance of community support, which extends beyond family to include neighbours and friends. As one resident explained, *"When we face challenges, it's not just our family we turn to. Our neighbours are like family here."* These networks provide critical support in the absence of formal infrastructure, enabling residents to access resources and services while fostering resilience (Aldrich & Meyer, 2015). Belawan Bahari's reliance on extended social networks for support during crises mirrors a common trend in slum settlements worldwide. For example, in favelas in Rio de Janeiro, Brazil, Perlman (2010) found that residents depend heavily on informal social networks for access to resources and emotional support. What distinguishes Belawan Bahari, however, is that mutual assistance often extends to shared physical labour, such as collaborative roof-building or drainage cleaning, as well as the sharing of food or childcare responsibilities. This cooperation reinforces social bonds and helps residents cope with socio-economic constraints. As one respondent shared, *"When I needed help building a roof, my neighbours came without hesitation. We always help each other."*

### ***Shared spaces***

Participatory mapping activities highlighted the importance of shared spaces in Belawan Bahari (Table 2). Communal areas, such as courtyards, serve multiple functions - providing spaces for drying sea products like salted fish (Figure 2d) and hosting various community gatherings. This aligns with findings from studies on Kampung settlements in Yogyakarta, Indonesia, where community spaces play a central role in daily life (Ferianto & Widodo, 2024). However, the absence of green spaces limits recreational opportunities for residents. Residents expressed a deep connection to these communal spaces, seeing them as essential for fostering social cohesion and community interaction. As one participant shared, *"This courtyard is not just for work; it's where we meet, talk, and support each other."* The engagement process also revealed aspirations for improving shared spaces, fostering collaboration, and encouraging a sense of ownership over community initiatives (Zuraiddi et al., 2023). By voicing their concerns and ideas, residents demonstrated a strong desire to enhance communal areas to better support their needs and interactions.

### **Integration of Agile Principles**

Integrating agile principles provides a flexible and adaptive framework to address the complex challenges in slum settlements like Belawan Bahari. Agile methodologies, with their focus on collaboration, iterative problem-solving, and real-time responsiveness, align well with the shifting dynamics of informal settlements. Studies indicate that participatory approaches can build trust and ensure that solutions are tailored to local contexts. Practical strategies include upgrading essential infrastructure, such as improving drainage, waste management, and fire safety, with participatory planning to capture residents' priorities. Modular housing designs, inspired by Turner's (1972) incremental housing model, allow for phased construction, enabling families to expand and adapt their homes as needed. Social empowerment initiatives, such as skill centers and cooperatives, further reduce dependency and foster self-reliance (Malta, 2023). Formalising land tenure policies is also critical, as social tenure encourages residents to invest in home improvements without the risk of displacement, supporting sustainable urban development (Killemsetty, 2021). By integrating structural, infrastructural, and social interventions, these agile strategies support a responsive and resilient development pathway for Belawan Bahari.

## **CONCLUSION**

Research conducted in Belawan Bahari's slum settlements offers critical insights into the complex interplay between housing characteristics, infrastructure, and social dynamics in informal urban environments. Key findings reveal how these

interconnected elements shape housing conditions and underscore the need for agile methodologies to address their inherent challenges. Through qualitative approaches such as site observations, interviews, and participatory community engagement, the study uncovers these interdependencies, establishing a foundation for informed, targeted interventions aimed at improving resilience and quality of life. The results highlight the limitations of traditional urban development approaches in addressing the distinct needs of slum communities, suggesting that more flexible, context-specific methods are essential. Agile strategies, particularly those that integrate community involvement, are well-suited to the dynamic nature of informal settlements, supporting efforts to enhance access to essential services, infrastructure, livelihood opportunities, and social inclusion. Moving forward, these findings advocate for collaborative partnerships between government bodies, civil society, and local communities, co-developing sustainable and resilient development strategies that can drive meaningful, long-term transformation.

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## **REDUCING THE PREVALENCE OF SMOKING AMONG STREET CHILDREN TO MAINTAIN THE SUSTAINABILITY OF A HEALTHY CITY IN THE URBAN AREA OF JAKARTA, INDONESIA**

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### **Abstract**

Street children in urban community need protection against several risk factors easily affecting them, one of which is smoking habit. Interventions targeting their smoking habits will improve public health and healthy social life to maintain the sustainability of a healthy city. This study aims to provide an overview and evidence of street children's condition as a driving force for more comprehensive government policies to reduce the smoking prevalence among street children. This qualitative study was conducted through focused group discussions with 38 street children in Jakarta and greater areas. Availability of affordable, cheaper and accessible cigarettes at points of sale, also ineffective education on smoking are factors making the street children difficult to stop smoking. The government needs to implement policies to address these challenges, such as raising cigarette prices and strictly banning cigarette sales to children. Therefore, it is crucial to strengthen policies supporting the tobacco control while also supporting the implementation of sustainable healthy city policy. An integrated intervention program involving all stakeholders is essential. This study lays the foundation for comprehensive policies addressing the child smoking prevalence and maintaining the sustainability of a healthy city.

**Keywords:** Street Children Smoker, The Sustainability, Healthy City, Urban Area, Jakarta

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## **INTRODUCTION**

Addressing challenges faced by vulnerable groups, including street children, is pivotal to achieve the sustainability of healthy city development. Street children in urban areas require special protection due to higher exposure to risk factors (Raj & Jayanth, 2023). Conditions surrounding street children, such as emotional problems and peers, can influence them to engage in risky behaviour (Sulaiman et al., 2023). Although street child protection programs exist, they remain vulnerable to risky behaviours, such as taking drugs and drinking alcohol, which often begin with the habit of smoking (Dejman et al., 2015; Islam et al., 2014). Cigarette is a substance first used by most street children (Amiruddin et al., 2015).

Furthermore, efforts to reduce the prevalence of smoking among street children can be in line with the vision of sustainable healthy city by creating a supportive environment for people to have a healthy lifestyle (Kaufman et al., 2010). For urban areas aiming for sustainable healthy city development, focusing on the health of street children is crucial (Abro et al., 2013; Thapa et al., 2009). While, empirical problems in the field have found that many street children are still found smoking due to inadequate parental supervision and the promiscuity. In this regard, a holistic approach should be applied, which not only focuses on solving health problems, but also considers social and economic aspects (Gupta, 2012).

The Joint Regulation of the Indonesian Minister of Home Affairs and Minister of Health No. 34 of 2005 on the Implementation of Healthy Districts/Cities emphasises that the concept of a healthy city encompasses efforts to create an urban environment that supports the health and well-being of citizens. A criterion to be met is none of family members smoking. In the context of the prevalence of child smokers, a healthy city strives to reduce the number of children falling into the habit of smoking, since the impacts are not only limited to individuals, but also the quality of life and sustainability of the city as a whole, including the street child population. Preventing smoking among street children should be a priority in a healthy city initiative.

Therefore, this study aims to analyse the issue of affordable cigarette products among street children in urban areas of Indonesia and challenges that need to be addressed, also provide sustainable policy solutions to safeguard the health and future prospects of street children. Not only does a healthy city aim to improve individual health, but also to reduce the prevalence of child smokers and create an environment that supports a healthy lifestyle for all the residents.

## **METHODOLOGY**

This qualitative study used a case study approach, which aimed to provide an overview and evidence of the street children's conditions as a driving force for

more comprehensive government policies to reduce the prevalence of smoking among street children. Data was collected through focus group discussions (FGDs) in Jakarta and greater areas: Depok, Tangerang, and Bekasi cities, which were selected due to the increasing number of street children.

The informants were street children selected by applying two methods: 1) a purposive approach to determine street children living in shelters, 2) snowball sampling technique to collect data from street children who did not have shelters. The inclusion criteria for this study were street children spending at least 4 hours earning a living on the street or in public places in the past month, aged 10-17 years, being active smokers, and willing to be informants.

The main instrument of this study was a semi-structured questionnaire to conduct FGDs with street children. The questionnaire was developed based on variables and literature studies that support the problem of this study. Aspects of the questionnaire included demographic, social, economic, and educational factors, also the street children's perspectives, the government or NGO support, and potential positive and negative impacts of smoking behaviour. The question instrument was developed and tested on 15 street children in Jakarta to ensure street child informants could understand each question item. Data from FGDs with informants was transcribed verbatim.

Data analysis was carried out with thematic content by comparing excerpts of informants' answers. Content analysis was used to answer orientation methodologically. Furthermore, the results of FGDs in the field were reviewed and compared with government policies relevant to the factors asked in the FGDs, and analysed the problem gaps. The main output of this study was to prove the causes and impacts of affordable cigarette products among street children, requiring more comprehensive policies to contribute to maintain the sustainable healthy city. This study could observe the street children's perspectives, including their reasons they started smoking and their smoking behaviour. This qualitative data analysis was carried out using the Atlas-TI application.

## RESULTS

Table 1 shows that most street child informants are male (33 children); while, five female informants are active smokers. Characteristics based on the street jobs indicate that the informants are mostly busker, scavenger, and umbrella rental. In contrast, other informants are parking attendant, tissue seller, '*ondel-ondel*' (a large puppet figure featured in the Betawi folk performance in Jakarta) busker, and beggar with a silver-painted body.

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**Table 1:** Characteristics of Street Child Informants

IF	Sex	Age (Year)	Most Frequent Job	The Last Level of Education
1	Male	17	Busker	Senior High School
2	Male	17	Busker	Senior High School
3	Male	17	Umbrella rental	Senior High School
4	Male	17	Parking attendant	Not Going to School
5	Male	15	Parking attendant	Junior High School
6	Male	17	Parking attendant	Senior High School
7	Male	17	'Ondel-ondel' busker	Senior High School
8	Male	17	Busker	Senior High School
9	Male	16	Parking attendant	Senior High School
10	Male	16	Busker	Senior High School
11	Male	13	Umbrella rental	Junior High School
12	Male	17	Parking attendant	Senior High School
13	Male	17	Parking attendant	Senior High School
14	Male	15	Parking assistant	Junior High School
15	Male	17	'Ondel-ondel' busker	Senior High School
16	Male	17	Parking attendant	Senior High School
17	Female	17	Busker	Senior High School
18	Female	16	Busker	Senior High School
19	Male	17	Silver beggar	Elementary School
20	Male	13	Silver beggar	Dropped Out in the 5 <sup>th</sup> Grade of Elementary School
21	Female	12	Busker	Not Going to School
22	Male	16	Parking attendant	Junior High School
23	Male	17	Parking attendant	Senior High School
24	Male	16	Busker	Dropped Out in the 2 <sup>nd</sup> Grade of Junior High School
25	Female	16	Busker	Dropped Out in the 3 <sup>rd</sup> Grade of Junior High School
26	Male	11	Busker	Not Going to School
27	Male	17	Scavenger	Senior High School
28	Male	17	Scavenger	Senior High School
29	Male	13	Tissue seller	Junior High School
30	Female	13	Used bottle scavenger	Junior High School
31	Female	14	Scavenger	Junior High School
32	Male	16	Tissue seller	Junior High School
33	Male	12	Scavenger	Junior High School
34	Male	13	Scavenger	Junior High School
35	Male	13	Scavenger	Junior High School
36	Male	12	Tissue seller	Elementary School
37	Male	16	Scavenger	Junior High school
38	Male	12	Scavenger	Junior High School

*Source: Author's Analysis*

Most of the street child informants were still students, but their families were poor; therefore, they had got to do their jobs on the streets to help support their families or just to earn extra pocket money.

*"I have become a busker since dropping out of school because I want to help my parents to support the family income." (IF 25)*  
*"[I] just spend my free time with friends, so I can get extra pocket money." (IF 20)*  
*"After school, I follow my mother to scavenge [used bottles] on the streets." (IF 30)*

The street children earned money ranging from IDR50,000/\$3.30 to IDR300,000/\$19.77 per day and set aside some of their income to give some to their parents at home. They also said that they spent money on food, cigarettes, other necessities, and entertainment. The following is statements of some street child informants.

*"My daily income ranges from IDR 200,000/\$13.03 to IDR 300,000/\$19.55 with various types of job like guarding the parking lot to being a field coordinator at the market." (IF 15)*  
*"I usually earn IDR90,000/\$58.65 each day from the job of guarding the parking lot and taking children to school." (IF 12)*  
*"The amount of my daily income depends on the [length of] time on the street. Usually, I earn IDR50,000/\$3.30 to IDR100,000/\$6.5." (IF 19)*

The number of cigarettes purchased varied, ranging from only three cigarettes to one and a half packs daily.

*"I usually smoke three cigarettes. Last year, I could smoke three cigarettes for only IDR5,000, but at the [same] price, now I only get two cigarettes." (IF 2)*  
*"I also experienced the same thing. I used to buy half a pack of cigarettes because the price per stick was only IDR 1,500/\$0.1 before, but it costs IDR2,000/\$0.13 to IDR25,000/\$16.29 per stick now" (IF 6)*  
*"I usually finish one and a half packs [of cigarettes] or as many as 18 cigarettes each day." (IF 1)*

One reason is that cigarette is sold in one stick, making it easier for children to buy cigarette products. The following describes that almost all street child informants secretly bought more cigarettes

*"I buy more cigarettes by the stick since the packaged price has started to rise." (IF 6)*  
*"I sometimes buy cigarettes by the stick and sometimes buy cigarettes in packs, but I often buy cigarettes by the stick more." (IF 1)*  
*We buy cigarettes more on sticks than in packs (IF 2, 4, and 6)*

*If I have more income, I usually buy cigarettes per pack, but I buy more cigarettes on sticks because it is only IDR 2,000/\$0.13 (IF 24)*

Table 2 shows that 16 street child informants still remember the first time they started smoking at an early age. On the other hand, other answers are forgetting, not knowing, and remaining silent when asked about the early age of starting smoking. Most street informants start smoking in elementary school, with the earliest age start from the 3<sup>rd</sup> grade of elementary school.

**Table 2:** Street Child Informants Remembering the Age of First Smoking

Age (Years)	School Age	N	Percent
9	Elementary School Grade 3	3	18.75 %
10	Elementary School Grade 4	3	18.75 %
11	Elementary School Grade 5	2	12.50 %
12	Elementary School Grade 6	2	12.50 %
13	Junior High School Grade 1	2	12.50 %
14	Junior High School Grade 2	2	12.50 %
15	Junior High School Grade 3	2	12.50 %
<b>TOTAL (N and Percent)</b>		<b>16</b>	<b>100 %</b>

*Source: Author's Analysis*

Some children have been smokers since they became street children at elementary school age. In addition, some of them began to smoke in secret. The following is the statement of the street child informant.

*"I started smoking when I was a street child, at [the age of] around 9 or 10 years." (IF 6)*

*"I smoked since the 5th grade [of elementary school] and started smoking in secret." (IF 22)*

The curiosity of minors arises from often buying cigarettes for a family member, or seeing their father, grandfather, and brother smoking, thus affecting them to try it. The following is an excerpt from an interview the author conducted with the informant.

*"I smoke since I see my father smoking." (IF 1,2)*

*"I saw my brother smoking, so I wanted to try smoking." (IF 3, 13)*

*"I smoke because I imitate my grandfather smoking." (IF 8)*

The price of cigarettes has raised in Indonesia, but still feels cheap to some street children. There were street children saying that the raise in the price of cigarette was only IDR1,000/\$0.07, then they had no difficulty buying

cigarettes. The price of cigarettes in Indonesia is still relatively lower than in developed countries. Here is the informant's full statement.

*"The price of cigarettes is still low, there has been an increase, but the increase is only IDR1,000/\$0.07. Previously, half a pack cost IDR10,000/\$0.67, now it is IDR11,000/\$0.73; so, it is not difficult [to buy cigarettes] if [the price] only increases by a thousand." (IF 32)*

Most street children preferred to stop buying cigarettes if the price was expensive. The following is statements of informants who intend to stop smoking if the price of cigarettes gets more expensive:

*"If the price of a cigarette raises from IDR2,000/\$0.13 to IDR10,000/\$0.65, I will not buy cigarettes because the money is better spent on buying food." (IF 24)*  
*"I will stop [smoking], [I do] not need to buy cigarettes anymore." (IF 37)*

Several informants had other ways if the price of cigarettes was higher: buying cigarettes per stick, switching to cheaper products, or smoking cigarette less often. The following is the informants' full statements.

*"There are cigarettes with cheap and expensive prices in Indonesia, but if it is expensive, we can buy them per stick." (IF 29)*  
*"I will switch to a cheaper cigarette product." (IF 15)*  
*"Even though the price of cigarettes is rising, we can still switch to [cheaper] brands." (IF 37)*

This study found that most street child smokers were addict, making it difficult for them to break free from the influence of cigarettes. They felt dizzy if they did not smoke cigarettes. Here is what they said:

*"I feel empty when I do not smoke, and my mouth tastes sour." (IF 6)*  
*"I want to try to stop smoking when I am sick, but it is challenging." (IF 21)*  
*"If I do not smoke for a day, I would feel dizzy." (IF 27)*

Furthermore, they disclosed short-term economic impacts caused by their smoking behaviour, such as waste, less income, and simply doing an activity of 'burning money'. The following is the informants' explanation.

*"I realize that buying cigarettes is wasteful, but I get sleepy quickly when I do not smoke." (IF 4)*  
*"My daily income decreased because I bought cigarettes." (IF 22)*  
*"My money is gone because I buy cigarettes." (IF 37)*

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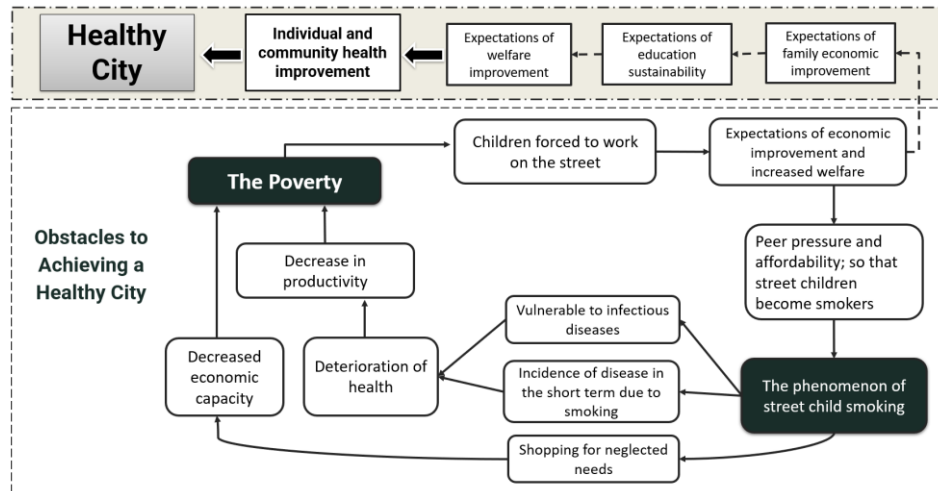
In the short term, the effect of worsening health conditions felt by most street child informants was frequent coughing. This condition was also seen during a 1-hour 30-minute observation in Bekasi City where a street child was found coughing after smoking. In addition, a two-hour observation in Kota Tua, Jakarta, also found the smallest street child coughing without phlegm.

*"I feel my throat getting dry." (IF 35)*  
*"My throat is itchy and I have a cough." (IF 12)*

Another finding, from the one-hour observation at the Depok Baru Bus Terminal in Depok City, was the condition of the surrounding environment where many tissues and cigarette butts scattered around the area where street children smoked. These cigarette butts certainly pollute public places so that they look dirty. This is confirmed by the informant's explanation that thick cigarette smoke could be detrimental to the surrounding environment.

*"The smoke is thick for others." (IF 34)*

Further analysis revealed that street children were trapped in poverty due to the low price of cigarettes. Figure 1 shows the lane gap impoverished effects of smoking behaviour on street children. The impact of poverty can be seen from reduced spending on basic needs due to buying cigarettes and the emergence of diseases that several street child informants began to feel. In addition, smoking behaviour results in decreased productivity for life-threatening and costly disease. This cycle will interrupt the actualisation of a better quality of life, such as the family economic improvement, continuity of education, and improved welfare, in individuals and communities, which can have an impact on achieving a healthy city.



**Figure 1: Poverty Gap and Obstacles to Achieving a Healthy City Due to the Smoking Behaviour of Street Children**

Source: Author's Analysis

## DISCUSSION

According to the Joint Regulation of the Indonesian Minister of Home Affairs and Minister of Health No. 34 of 2005 on the Implementation of Healthy Districts/Cities, a criterion to achieve by the cities/districts is independent and healthy community life (Indonesian Minister of Home Affairs and Minister of Health, 2005). The seventh variable indicates the components of family health, one indicator of which is none of family members smoking. Unfortunately, street children often found themselves living in environments with high social, economic, and emotional pressures, increasing their risk of engaging in smoking behaviour.

This ongoing issue reflects the complex and persistent socio-economic challenges the street children face as a vulnerable group. A major challenge is that cigarettes are easily accessible to the street children in individual and at a cheap price of IDR1,500/\$0.10 per stick (Hartono et al., 2023). The low earnings of street children from their jobs and the cheap price of cigarettes facilitate them to smoke. This is in line with the FGD results showing that most street children bought some cigarettes retail per stick and are not aware that their purchases could reach one pack with repeat purchases.

This problem also occurs due to inadequate regulation and less strict supervision of cigarette purchases by children. A concrete step to take is through a firm policy banning the sale of individual cigarettes and significantly increasing cigarette prices so that cigarettes are not easily accessible to street children.



Mullins et al. (2018) has found that high cigarette prices are a major reason for participants to stop or want to stop smoking. Raising cigarette prices can make them unaffordable for children with financial constraints. Similarly, informants in the FGDs said that when the price of cigarettes was raised fivefold, they did not want to buy cigarettes anymore.

Informants also complained about health problems they experienced as smokers, such as itchy throat and cough. If these problems are not immediately addressed, they can generate various adverse effects, starting with critical health impacts later on. This is relevant to the study by Chowdhury et al. (2017), reporting that most of the street children respondents felt that they were suffering from various illnesses, particularly respiratory and stomach disorders. These health problems are also associated and worsened with longer period of smoking. It becomes a concern because many street child informants admitted to having smoked since elementary school. A study in Europe stated that individuals who started smoking before the age of 16 years were more likely to find it difficult to stop more than those starting at older ages (Pesce et al., 2019). Given many street children are still too young, it could potentially turn them into loyal consumers of cigarette products, contributing to an increase in the number of child smokers in Indonesia and a decreased productivity due to the worsening health conditions in the future.

Another impact of cigarette use is its environmental impact. Smoking does not only worsen individual health, but it also has an impact on the air, soil, and water quality, disrupting ecosystem balance (Nitschke et al., 2023; Pahari, 2022). Harmful substances in cigarettes contribute to the environmental damage. Given the extent of environmental damage, ecosystem and human health will continue to be threatened. Therefore, it is pivotal for the government to create the long-term planning strategy for a healthy city development by prioritizing health elements (Hashim Lim et al., 2023).

Creating cities with long-term health improvements within human and ecological systems is part of sustainable urban development efforts (Wheeler, 1996). Not only does a healthy city aim for health outcomes, but it also focuses on improving human resources by promoting healthy environmental conditions, including physical, social, environmental, economic, cultural, and behavioural aspects that support health (Darmajanti et al., 2019; Notoatmodjo, 2008). Optimal and coordinated endeavours to reduce the prevalence of smoking among the street children are essential both from a public health perspective and in the context of child protection and welfare (Woan et al., 2013).

## **CONCLUSION**

Reducing the prevalence of smoking among the street children faces several challenges to address, which are affordability of cigarettes, imitation of parental or family habit, widespread availability of cigarettes in retail outlets, exacerbated by socio-economic constraints and weak regulatory oversight. To protect street children and promote a sustainable healthy city, comprehensive policies are needed, both fiscal and non-fiscal. The policies should include a raise in cigarette prices through excise taxes, banning the sale of cigarettes per stick to children, intensifying social support programs, providing Smoking Cessation Clinic services, and enforcing local Smoke-Free Area regulations. Integrating these strategies will support governments in protecting the street children from the harms of tobacco, improving their well-being, and advancing the sustainability of healthy cities. It is fundamental to ensure that street children, as part of the urban population, grow into healthy and productive individuals who contribute to the sustainability of healthy cities by avoiding exposure to addictive substances.

## **ACKNOWLEDGEMENT**

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## **ETHICAL STATEMENT**

This research has received Ethical Clearance Approval issued by the Research Ethics Commission of Atma Jaya Catholic University with Number 0006U/III/PPPE.PM.10.05/07/2022. This research has also obtained approval from the respondents (informed consent) before starting the interviews, including data confidentiality through anonymity and the use of information for research publication purposes.

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## **SUSTAINABLE STRATEGIES BASED ON COMMUNITY PERCEPTION AND PARTICIPATION IN ECOTOURISM DEVELOPMENT PLANNING IN INDONESIA**

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### **Abstract**

The Forest Management Unit of Region IV of Balige has a working area within Toba Regency, one of the regencies in North Sumatra Province which is rich in ecotourism potential. SWOT analysis was used in this study to analyze community perception and participation in ecotourism development planning and establish sustainable strategies for ecotourism development within the study area. Data were collected through focus group discussions, in-depth interviews, and a questionnaire survey with 114 respondents. The data were then analyzed using participatory analysis, involving a variety of community groups. Community members generally had a positive attitude toward the ecotourism development plan. The average community participation indicating a medium level of community engagement in ecotourism development. The positioning of strategies for ecotourism development within Quadrant I of the SWOT diagram, where strengths and opportunities are high, is an ideal scenario. To ensure long-term success, the strategies for the Forest Management Unit of Region IV of Balige should leverage positive community perceptions, address gaps in participation, and align with sustainable development goals, benefiting both the community and the environment. This study makes a unique contribution to ecotourism planning by integrating local knowledge and community involvement in ecotourism management strategy development.

**Keywords:** Economy, environment, management, social, SWOT

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## **INTRODUCTION**

Ecotourism should focus on responsible travel, conserving the environment while benefiting local communities. It should offer economic advantages while promoting environmental protection and respecting cultural values. However, its success hinges on the active involvement and positive perceptions of local communities, whose participation is essential for developing strategies that balance conservation goals with community needs. Therefore, understanding local communities' perceptions of ecotourism and their willingness to participate is vital for sustainable development. This is also true for Toba Regency. Community support often depends on perceived benefits and involvement in decision-making, but challenges like limited engagement, insufficient training, and inadequate infrastructure can hinder progress. The Forest Management Unit of Region IV of Balige (FMU Balige), works to balance conservation and socio-economic benefits in its working area, which lies within Toba Regency. Ecotourism planning in this area is aimed at minimizing environmental impacts, involving local communities in decision-making and focusing on benefit-sharing, which is essential for fostering positive perceptions, participation, and the long-term success of various ecotourism projects.

Toba Regency, renowned for Lake Toba and a range of other beautiful landscapes, is a prime location for ecotourism. Developing a sustainable ecotourism strategy in this region will require integrating community perceptions and participation, ensuring that the plan addresses local needs, minimizes negative impacts, and maximizes benefits for both the community and the environment. As local authorities and stakeholders seek to harness the potential for ecotourism in this region, understanding and involving the community is essential for the successful development and implementation of various ecotourism initiatives. With the growth in sustainable travel demands, it becomes crucial to integrate community aspirations and knowledge into tourism planning, while focusing on carefully balancing economic growth, natural resources conservation, and respect for cultural values. This research attempts to elucidate on how Toba Regency residents perceived ecotourism development, particularly in balancing conservation efforts and preserving local wisdom. Engaging the local community in this process will foster ownership, empowerment, and sustainability, ensuring long-term benefits for both the community and the environment. The indigenous knowledge, traditions, and customs of the community serve as invaluable assets that should be respected and integrated into ecotourism development (Sahureka et al., 2016; Seipalla et al., 2020; Aynalem & Kaur, 2020; Lelloltery et al., 2018; Assaye et al., 2023; Tufa et al., 2022; Abdullah et al., 2025). By incorporating local wisdom, the tourism experience becomes more authentic, immersive, and meaningful for both visitors and locals, fostering a sense of pride and appreciation for their cultural heritage.

With its ecological and cultural uniqueness, Toba Regency is deemed a suitable location for planning studies on sustainable ecotourism development. Lake Toba, the main attraction of this location, boosts a rich ecosystem and biodiversity, which can be a major nature-based ecotourism asset. Involving the Batak people, an indigenous community in the region, along with their traditional nature-related values, will provide great opportunities for sustainable, community-based ecotourism management. However, FMU Balige, one of the forest management units in charge of this region, faces challenges in developing ecotourism sustainably, including challenges from limited infrastructure that supports natural tourism. In managing ecotourism, it is crucial that FMU Balige balance economic development and environmental conservation, striving to improve sustainable resources management while dealing with threats from forest degradation.

Community perceptions are beneficial for several reasons: they can boost tourist interest and local economic development, influence government and stakeholder decisions, guide targeted planning based on community preferences, and identify potential challenges in ecotourism development. Overall, community perceptions are key to the successful and sustainable development of ecotourism in Toba Regency, as was asserted in previous studies (Sahureka et al., 2016; Seipalla et al., 2020; Lelloltery et al., 2018; Assaye et al., 2023; Tufa et al., 2022; Rahmawaty et al., 2024a,b; Roslinda et al., 2024).

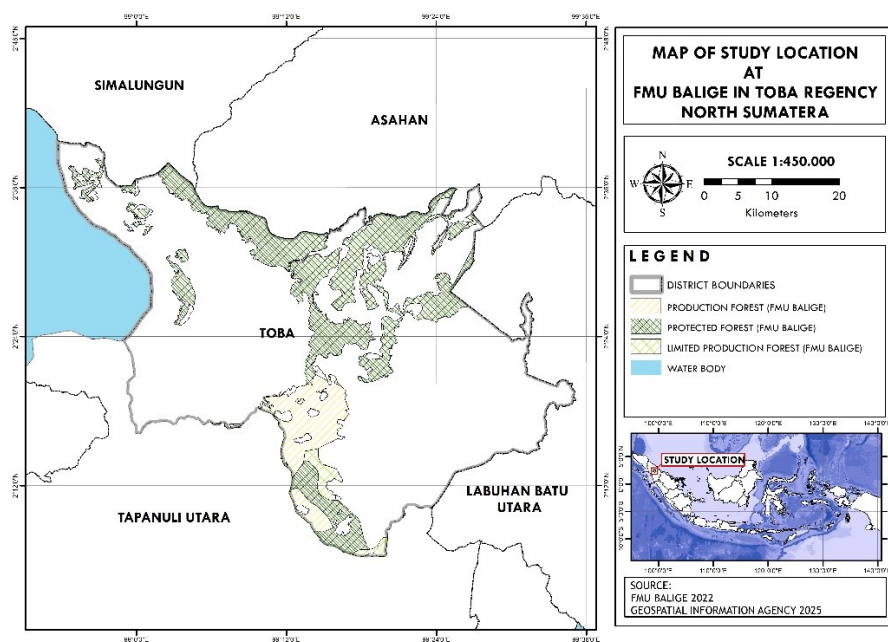
However, none of previous studies on ecotourism drew a link between ecotourism and sustainable planning strategies (Sahureka et al., 2016; Seipalla et al., 2020; Lelloltery et al., 2018; Assaye et al., 2023; Tufa et al., 2022). To make it worse, there is a lack of studies focusing on community perception and participation in ecotourism development in relation to sustainable planning strategies. Here is where this study comes into play, emphasizing the importance of community participation in planning, particularly under the oversight of FMU Balige, to ensure that ecotourism initiatives are environmentally sound, socially inclusive, economically beneficial, culturally respectful, and aligned with sustainable development. This study provides policymakers, tourism planners, and local communities in Toba Regency with insights and recommendations for developing sustainable ecotourism strategies. By integrating conservation principles and local wisdom, a balance between economic development, cultural preservation, and environmental protection may be achieved in Toba Regency.

## **MATERIALS AND METHODS**

### **Research Location**

This research was conducted in the working area of FMU Balige in Toba Regency, North Sumatra (Figure 1), Toba Regency, home to Lake Toba which is rich in natural resources and cultural heritage, served as an ideal case for the

investigation into the balance between conservation and sustainable tourism. With its unique characteristics, Toba Regency was considered a suitable location for exploring how community perceptions influenced sustainable ecotourism development, integrating conservation and local wisdom. This research attempted to elicit the perspectives of local community members, indigenous leaders, tourism stakeholders, and conservation experts on ecotourism using in-depth interview, survey, and observation methods.



**Figure 1:** Map of Study Location at FMU Balige in Toba Regency, North Sumatra

### Data Collection

This study mixed qualitative and quantitative methods, integrating SWOT (strengths, weaknesses, opportunities, and threats) analysis and community perception and participation data, to develop sustainable ecotourism strategies for Toba Regency. A structured questionnaire with a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used to assess community perception and participation in ecotourism development. This questionnaire was distributed to 114 respondents, who were members of forest farmer groups under the supervision of FMU Balige. These respondents were selected in such a way to ensure representation of the forest farmer groups that were assisted by FMU Balige, with the number reflecting diversity within the group and involvement within forest management activities. In-depth insights into strengths, weaknesses,



opportunities, and threats pertaining to ecotourism were gathered through focus group discussions and interviews with key informants. These data collection methods were adopted from Rahmawaty et al. (2024a,b); Ramadhani et al. (2022), Sitanggang et al. (2021a,b), Saraan et al. (2020), Lubis et al. (2021).

### Data Analysis

Data from interviews, survey, and observations were summarized and computed using Microsoft Excel, and the results are presented in the form of tables and graphs to make data analysis easier (Table 1). Direct observations in the study area were needed to help provide an explanation of the criteria for the results of the questionnaire survey and interviews. These results were used for subsequent descriptive analysis. The interval and score range for these results were determined following the equations below:

- Interval = score range/criteria number (1)
- Score range = maximum score – minimum score (2)
- Maximum score = the highest value on the Likert scale x number of questions (3)
- Minimum score = the lowest value on the Likert scale x number of questions (4)

Scores were calculated based on the equations above, while criteria were categorized based on a Likert scale. Using the equations above, the interval for perception and participation was calculated as 19. The score range and criteria for community perception and participation were, therefore, as presented in Table 1 and Table 2.

**Table 1:** Score Range and Criteria for Community Perception

Score	Criteria	Explanation
77–95	Very good	Scores in this range indicate that the community perception was highly positive, likely reflecting strong satisfaction and approval across various aspects.
58–76	Good	Scores in this range suggest that the community perception was generally positive, indicating satisfaction and favorable opinions in general.
39–57	Moderate	Scores in this range suggest a neutral to moderately positive perception, with a room for improvement in certain areas.
20–38	Low	Scores in this range indicate a negative perception, with significant areas of dissatisfaction or concern among the community.
1–19	Very low	Scores in this range reflect a highly negative perception, with widespread dissatisfaction and significant issues requiring immediate attention and improvement.

**Table 2:** Score Range and Criteria for Community Participation Level

Score	Criteria	Explanation
77–95	Very high	Scores in this range indicate highly active and enthusiastic participation among the community across various activities and initiatives. There was strong engagement and involvement.
58–76	Hight	Scores in this category suggest active participation and engagement among the community, with consistent involvement in some activities and initiatives.
39–57	Moderate	Scores in this range suggest a moderate level of participation. The community shows some interest and engagement, but there may be opportunities to increase involvement and participation
20–38	Low	Scores in this range indicate limited participation among the community. There may be challenges in engaging the community effectively or motivating the community to participate.
1–19	Very low	Scores in this range reflect minimal to no participation among the community, indicating significant barriers to or disinterest in engaging with activities or initiatives.

To create strategies in planning ecotourism development in the working area of FMU Balige, SWOT analysis was carried out (Khairi et al., 2022; Pandita et al., 2024; Rahmawaty et al., 2025). It is a strategic planning tool used to evaluate the strengths, weaknesses, opportunities, and threats involved in a project or business venture. This analysis was conducted by defining the objective or topic under analysis, gathering information relevant to each SWOT category, identifying strengths and weaknesses by analyzing the internal factors contributing to FMU Balige's success or hindering its progress, identifying opportunities and threats by looking outward to understand the factors that positively or negatively impacted FMU Balige, interpreting the findings to consider how the strengths could be leveraged to pursue opportunities and how the weaknesses that might exacerbate threats could be mitigated, and developing strategies that could capitalize on strengths, minimize weaknesses, seize opportunities, and defend against threats.

## RESULTS AND DISCUSSION

### Respondent Characteristics

Survey results showed that the majority of respondents were male, aged 41–60 years (61%), with a high school education (63%), and predominantly Protestant Christian (95%). Most respondents were farmers with a monthly income below five million rupiah (91%). This demographic profile is crucial for interpreting survey findings, as it influenced respondents' perspectives and priorities, particularly in agriculture and land use. Understanding these demographics helps tailor policies and interventions to address the specific needs of and challenges faced by the community, ensuring that initiatives are relevant and effective in supporting community development and policy formulation.

### Community perception of the development of ecotourism

A summary of community perception of the development of ecotourism in the working area of FMU Balige is presented in Table 3.

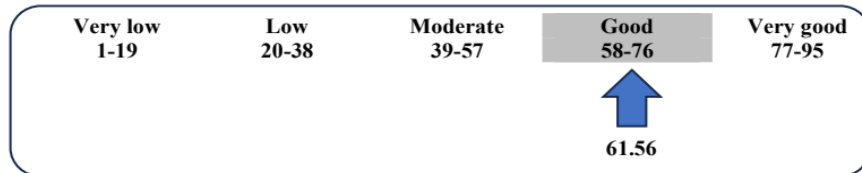
**Table 3:** A Summary of Community Perception in the Working Area of FMU Balige

Question Number	Answer									
	SA		A		DF		DA		SD	
	n	%	n	%	n	%	n	%	n	%
1	5	4.42	94	83.19	9	7.96	5	4.42	0	0
2	4	3.54	102	90.27	4	3.54	3	2.65	0	0
3	3	2.65	66	58.41	15	13.27	29	25.66	0	0
4	5	4.42	55	48.67	4	3.54	49	43.36	0	0
5	3	2.65	69	61.06	11	9.73	30	26.55	0	0
6	2	1.77	40	35.40	10	8.85	61	53.98	0	0
7	6	5.31	36	31.86	8	7.08	63	55.75	0	0
8	5	4.42	91	80.53	10	8.85	7	6.19	0	0
9	11	9.73	96	84.96	4	3.54	2	1.77	0	0
10	8	7.08	94	83.19	6	5.31	5	4.42	0	0
11	3	2.65	50	44.25	8	7.08	52	46.02	0	0
12	6	5.31	68	60.18	5	4.42	34	30.09	0	0
13	6	5.31	49	43.36	8	7.08	50	44.25	0	0
14	7	6.19	47	41.59	11	9.73	48	42.48	0	0
15	8	7.08	77	68.14	7	6.19	21	18.58	0	0
16	7	6.19	67	59.29	6	5.31	33	29.20	0	0
17	15	13.27	79	69.91	4	3.54	15	13.27	0	0
18	13	11.50	87	76.99	3	2.65	10	8.85	0	0
19	7	6.19	76	67.26	14	12.39	16	14.16	0	0
20	14	12.39	77	68.14	4	3.54	18	15.93	0	0
21	7	6.19	72	63.72	0	0	34	30.09	0	0
22	12	10.62	96	84.96	0	0	5	4.42	0	0
23	14	12.39	92	81.42	2	1.77	5	4.42	0	0
24	15	13.27	59	52.21	1	0.88	38	33.63	0	0
<b>Total score</b>	<b>930</b>		<b>6.956</b>		<b>462</b>		<b>1.266</b>			
<b>Average</b>	<b>8.23</b>	<b>6.86</b>	<b>61.56</b>	<b>64.12</b>	<b>4.09</b>	<b>5.68</b>	<b>11.20</b>	<b>23.34</b>		

Note: n = Number of respondents who answered questions.

SA: Strongly Agree; A: Agree; DF: Doubtful; DA: Disagree; SD: Strongly Disagree.

Based on Table 3, the highest average score for community perception was 61.56. According to Table 1, this score, falling within the range of 58–76, was categorized as “Good” (Figure 2).



**Figure 2:** Score Range and Criteria for Community Perception

This score suggests that the community generally held a positive view and perception. This positive perception has profound implications for policy-making: it validates current strategies, encourages stakeholder engagement, improves compliance, provides a foundation for future policy adjustments, enhances communication and trust, and establishes a basis for measuring impact. By leveraging this positive perception, policymakers can further enhance the effectiveness of their initiatives, fostering a more sustainable and participatory approach to forest management. However, specific strengths and weaknesses within this range would need further exploration to understand where improvements can be made or where strengths can be leveraged further. This type of analysis is valuable for organizations or communities in gauging public opinion and strategically planning interventions or improvements based on the identified perceptions.

### **Community Participation in the Development of Ecotourism**

A summary of community participation in the development of ecotourism in the working area of FMU Balige is presented in Table 4.

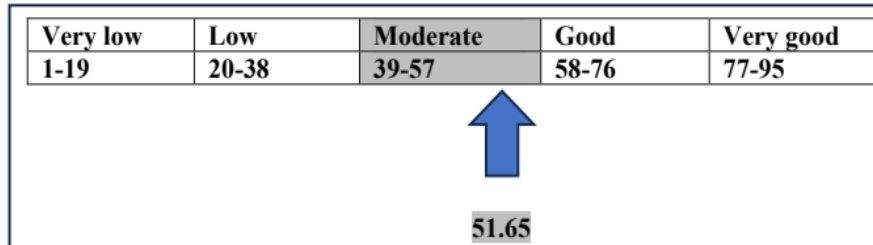
**Table 4:** A Summary of Community Participation in the Working Area of FMU Balige

Question Number	Answer									
	SA		A		DF		DA		SD	
	n	%	n	%	n	%	n	%	n	%
1	5	4.42	62	54.87	2	1.77	44	38.94	0	0
2	0	0.00	54	47.79	32	28.32	27	23.89	0	0
3	3	2.65	73	64.60	6	5.31	31	27.43	0	0
4	1	0.88	100	88.50	7	6.19	5	4.42	0	0
5	3	2.65	73	64.60	23	20.35	14	12.39	0	0
6	38	33.63	12	10.62	63	55.75	0	0	0	0
7	2	1.77	98	86.73	5	4.42	8	7.08	0	0
8	6	5.31	69	61.06	7	6.19	31	27.43	0	0
9	9	7.96	72	63.72	3	2.65	29	25.66	0	0
10	7	6.19	54	47.79	6	5.31	46	40.71	0	0
11	17	15.04	90	79.65	1	0.88	5	4.42	0	0
12	8	7.08	41	36.28	22	19.47	42	37.17	0	0
13	16	14.16	50	44.25	5	4.42	42	37.17	0	0
14	5	4.42	65	57.52	7	6.19	36	31.86	0	0
15	6	5.31	67	59.29	7	6.19	33	29.20	0	0
16	3	2.65	39	34.51	29	25.66	41	36.28	1	0.88
17	3	2.65	35	30.97	17	15.04	57	50.44	1	0.88
18	5	4.42	31	27.43	17	15.04	60	53.10	0	0
19	5	4.42	31	27.43	15	13.27	61	53.98	1	0.88
20	8	7.08	56	49.56	28	24.78	21	18.58	0	0
21	11	9.73	78	69.03	5	4.42	19	16.81	0	0
22	9	7.96	62	54.87	8	7.08	34	30.09	0	0
23	4	3.54	71	62.83	5	4.42	33	29.20	0	0
24	7	6.19	76	67.26	8	7.08	22	19.47	0	0
Total score	905		5836		984		1482		3	
Average	8.01	3.34	51.65	26.90	8.71	6.05	13.12	13.66	0.03	0.06

Note: n= Number of respondents who answered questions.

SA : Strongly Agree. A : Agreed. Df : Doubtful. Da : Disagree. SD : Strongly Disagree

The average score for community participation was 51.65. As it fell within the range of 39–57, according to the criteria provided in Table 1, the community participation was categorized as “Moderate” (Figure 3). This suggests that the community showed a reasonable level of participation. In other words, while there was reasonable engagement among the community in FMU Balige's activities, several barriers still limited the achievement of higher levels of participation. There might still be some opportunities to enhance and encourage more active involvement in community activities and initiatives.



**Figure 3: Score Range and Criteria for Community Participation**

Addressing community participation through education, resources support, improved communication, and inclusive practices could foster a more participatory environment, ultimately enhancing the effectiveness of forest management initiatives and ensuring that community voices are heard and valued. For organizations aiming to improve participation levels, understanding where they fall within this spectrum of participation can guide strategies to increase engagement, foster community involvement, and strengthen relationships between the community and the initiatives or programs being offered.

#### **Strategies for the Development of Ecotourism in Toba Regency**

The internal strategic factors (IFAS) and external strategic factors (EFAS) of the development of ecotourism in Toba Regency are presented in Table 5 and Table 6, and the final IFAS and EFAS scores are presented in Table 7. As for the matrix position of the ecotourism development planning strategies, it is provided in Figure 4.

**Table 5: Internal Strategic Factors (IFAS)**

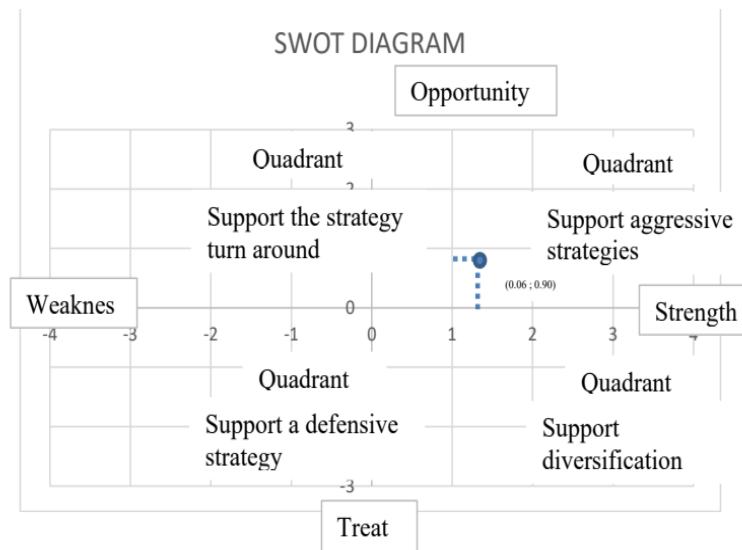
No	Internal Strategic Factors	Weight	Rating	Score
	<b>Strength</b>			
1	Diverse potential for nature tourism	0,02	4	0,08
2	High community interest in managing nature tourism	0,04	4	0,16
3	Local wisdom in managing nature tourism, especially religious tourism	0,08	4	0,32
4	Existence of nature tourism management organizations (Village Forest institutions, community forests, and youth organizations)	0,06	4	0,24
5	Existence of tourism awareness groups officially recognized by the regent	0,06	4	0,24
	Total	0,26		1,04
	Totality			1,30
	<b>Weakness</b>			
1	Suboptimal management of nature tourism areas	0,06	1	0,06
2	Lack of promotional ability from the managers	0,13	2	0,25
3	Insufficient human resources for managing nature tourism	0,08	2	0,17
4	Insufficient funding for managing nature tourism	0,02	1	0,02
5	Insufficient facilities and infrastructure in FMU 4	0,04	2	0,08
6	Low accessibility to nature tourism objects	0,08	1	0,08
7	Lack of creativity in managing similar nature tourism objects	0,17	1	0,17
8	Lack of services in managing similar nature tourism objects	0,15	1	0,15
	Total	0,73		0,98
	Totality	1.00		1,72

**Table 6: External Strategic Factors (EFAS)**

No	External Strategic Factors	Weight	Rating	Score
	<b>Opportunity</b>			
1	Inclusion of Toba regency as a national strategic area	0,03	4	0,11
2	Regulation as a super priority national tourism destination area	0,14	3	0,41
3	Existence of tourism association networks	0,16	3	0,49
4	Very good accessibility to national strategic area (NSA)	0,05	3	0,16
5	Advances in communication technology can be utilized for nature tourism promotion	0,08	4	0,33
6	Tradition of returning home to develop the area, including nature tourism	0,08	3	0,24
	Total	0,54		1,74
	Totality			2,29
	<b>Threat</b>			
1	High potential for forest fires	0,04	1	0,04
2	High pressure from other sector developments on forest areas	0,08	2	0,16
3	Low community income levels	0,08	2	0,16
4	Damage to local culture due to incoming tourists	0,10	2	0,20
5	Damage to ecosystems due to visitors	0,12	2	0,24
6	Floods and landslides in nature tourism locations	0,03	1	0,03
	Total	0,46		0,84
	Totality	1.00		1,30

**Table 7: Final IFAS and EFAS Scores**

IFAS		EFAS	
Category	Total Score	Category	Total Score
S	1.04	O	1.74
W	0.98	T	0.84
Total (S-W)	0.06	Total (O-T)	0.90



**Figure 4: Matrix Position of the Ecotourism Development Planning Strategies**

The SWOT quadrant scheme established based on analysis can be explained as follows:

1. The Strengths-Opportunities (S-O) quadrant is designated for strategies that utilize internal strengths to take advantage of external opportunities.
2. The Weaknesses-Opportunities (W-O) quadrant is designated for strategies that overcome internal weaknesses to take advantage of external opportunities.
3. The Strengths-Threats (S-T) quadrant is designated for strategies that utilize strengths to overcome external threats.
4. The Weaknesses-Threats (W-T) quadrant is designated for defensive strategies that aim to reduce the impact of internal weaknesses and external threats.

Based on Figure 4, the ecotourism development strategies are positioned within Quadrant I of the SWOT diagram, which means strengths and opportunities are high, while weaknesses and threats are low. The strategies



established were based on the researchers' considerations and data, aiming to achieve sustainable ecotourism development planning in the working area of FMU Balige in Toba Regency.

The SWOT matrix of the ecotourism development planning strategies for FMU Balige is presented in Table 8.

**Table 8:** SWOT Matrix for the Ecotourism Development Planning Strategies

<div> <div>Internal</div> <div>External</div> </div>	Strengths (S)	Weaknesses (W)
	<ol style="list-style-type: none"> <li>1. Diverse potential for nature tourism</li> <li>2. High community interest in managing nature tourism</li> <li>3. Local wisdom in managing nature tourism, especially religious tourism</li> <li>4. Existence of nature tourism management organizations</li> <li>5. Existence of tourism awareness groups officially recognized by the regent</li> </ol>	<ol style="list-style-type: none"> <li>1. Suboptimal management of nature tourism areas</li> <li>2. Lack of promotional ability from the managers</li> <li>3. Insufficient human resources for managing nature tourism</li> <li>4. Insufficient funding for managing nature tourism</li> <li>5. Insufficient facilities and infrastructure in FMU 4</li> <li>6. Low accessibility to nature tourism objects</li> <li>7. Lack of creativity in managing similar nature tourism objects</li> <li>8. Lack of services in managing similar nature tourism objects</li> </ol>
Opportunities (O)	Strategy S-O	Strategy W-O
<ol style="list-style-type: none"> <li>1. Inclusion of Toba regency as a national strategic area</li> <li>2. Regulation as a super priority national tourism destination area</li> <li>3. Existence of tourism association networks</li> <li>4. Very good accessibility to NSA areas</li> <li>5. Advances in communication technology can be utilized for nature tourism promotion</li> <li>6. Tradition of returning home to develop the area, including nature tourism</li> </ol>	<ol style="list-style-type: none"> <li>1. Develop and Promote Diverse Tourism Packages</li> <li>2. Empower Communities with Digital Tools</li> <li>3. Integrate Cultural and Religious Elements</li> <li>4. Enhance Organizational Capacity</li> <li>5. Amplify Awareness Efforts Digitally</li> </ol>	<ol style="list-style-type: none"> <li>1. Enhance Management Practices through Partnerships and Training:</li> <li>2. Boost Promotional Abilities Using Digital Tools and Networks:</li> <li>3. Attract and Train Human Resources:</li> <li>4. Secure Funding through National Programs and Private Partnerships:</li> <li>5. Develop Infrastructure Using National Funding and Good Accessibility:</li> <li>6. Improve Access and Virtual Visibility:</li> <li>7. Foster Creativity and Innovation:</li> <li>8. Enhance Service Quality through Training and Standards</li> </ol>
Treats (T)	Strategy S-T	Strategy W-T
<ol style="list-style-type: none"> <li>1. High potential for forest fires</li> <li>2. High pressure from other sector developments on forest areas</li> <li>3. Low community income levels</li> <li>4. Damage to local culture due to incoming tourists</li> <li>5. Damage to ecosystems due to visitors</li> <li>6. Floods and landslides in nature tourism locations</li> </ol>	<ol style="list-style-type: none"> <li>1. Diversify Tourism to Mitigate Ecological Risks</li> <li>2. Engage Community in Income-Generating and Culture-Preserving Tourism:</li> <li>3. Apply Local Wisdom in Tourism Management and Advocacy:</li> <li>4. Enhance Disaster Preparedness through Management Organizations:</li> <li>5. Promote Responsible Tourism through Awareness Groups:</li> </ol>	<ol style="list-style-type: none"> <li>1. Enhance Management through Risk Training and Systems:</li> <li>2. Promote Responsible Tourism and Joint Promotions:</li> <li>3. Bolster Human Resources through Volunteer and Cross-Training Programs:</li> <li>4. Secure Funding for Resilient Infrastructure and Conservation:</li> <li>5. Develop and Maintain Resilient Infrastructure:</li> <li>6. Improve Access with Safe Routes and Adaptive Transportation:</li> <li>7. Innovate and Rotate Tourism Practices: Enforce Service Standards and Eco-Friendly Solutions</li> </ol>

The strategies above outline comprehensive approaches to developing sustainable ecotourism practices based on community involvement, digital innovation, cultural integration, and proactive risk management. By leveraging strengths, addressing weaknesses, seizing opportunities, and mitigating threats, FMU Balige can enhance its tourism offerings while ensuring environmental conservation, community empowerment, and economic benefits. Implementing these strategies requires collaboration among stakeholders, adherence to best practices, and continuous monitoring to achieve long-term sustainability in ecotourism development. To achieve sustainable ecotourism goals, careful planning must involve local communities, strengthen infrastructure, and implement policies that align economic growth with nature conservation. A collaborative approach and pentahelix partnership (government, community, academics, business actors, and media) are key to facing this challenge and maximizing the potential of Toba Regency as an environmentally friendly and community-based ecotourism destination.

## **CONCLUSION**

The community had a generally positive perception of the ecotourism development plan, as shown by a perception score of 61.56, which fell within the "Good" category. This suggests a strong foundation, with some room for improvement. Meanwhile, community participation was in the "Moderate" category, with a score of 51.65, indicating both interest in and potential for greater engagement. Strategies to increase involvement include improving communication and offering more participation opportunities. The ecotourism development plan's being positioned in Quadrant I of the SWOT diagram suggests that it has strengths that can be leveraged to capitalize on available opportunities, promoting sustainable and beneficial ecotourism development.

Based on the results of this study, it is suggested that local authorities and stakeholders should strengthen community engagement in the ecotourism development planning, leveraging the existing positive perceptions while addressing the factors contributing to moderate participation. This collaborative approach will not only promote sustainable ecotourism development but also enhance the overall well-being of the community, ensuring that ecotourism benefits are widely shared and effectively realized.

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## **INVESTIGATING THE IMPACT OF LONG AND SHORT-TERM NATURAL RESOURCE RENTS ON ECOLOGICAL FOOTPRINTS: EVIDENCE FROM INDONESIA**

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### **Abstract**

This study examines the relationship between economic growth and environmental sustainability in Indonesia, focusing on the validity of the Environmental Kuznets Curve (EKC) hypothesis and the impact of various factors on a country's ecological footprint. Although extensive research has explored the connection between carbon emissions and economic growth, the specific roles of economic growth, mineral rent, forest rent, and human capital in determining the ecological footprint in Indonesia remain understudied. This study aimed to investigate two primary aspects. First, it examines the EKC hypothesis in Indonesia using a cubic representation of economic growth, which offers a more nuanced understanding of the relationship between environmental degradation and economic expansion than the traditional inverted U-shaped EKC curve. Second, it analyses the long-term and short-term effects of mineral rent, forest rent, and human capital on the ecological footprint using an Autoregressive Distributed Lag (ARDL) model. Data for the study variables were collected from Indonesia for the period 1991Q1-2021Q4. The ARDL findings revealed that human capital and forest rent contribute to improving Indonesia's ecological footprint. Conversely, mineral rents demonstrate the potential for reducing environmental impacts over time. The results indicate an N-shaped Environmental Kuznets Curve, illustrating the relationship between the ecological footprint and economic growth. This research has significant policy implications for Indonesian decision makers, emphasising the need for efficient transformation of non-renewable resources into a sustainable, eco-friendly environment. Additionally, this study highlights the importance of continuously enhancing environmental awareness and implementing educational reforms to achieve long-term sustainability benefits.

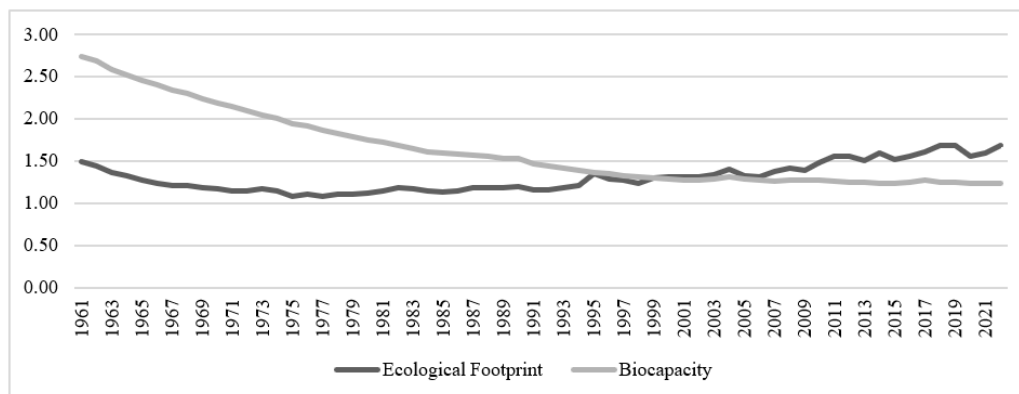
**Keywords:** Ecological footprint, Environmental Kuznets curve, Mineral rent, Forest rent, Human capital.

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## INTRODUCTION

Indonesia has adopted the Sustainable Development Goals (SDGs) framework, aiming for achievement by 2030, making sustainable development crucial. This concept balances socio-economic growth and environmental preservation, though economic priorities often overshadow environmental concerns, leading to increased production, consumption, and environmental degradation (Shahbaz et al., 2019). The Environmental Kuznets Curve (EKC) theory, first proposed by Grossman & Krueger (1991), suggests an inverted U-shaped relationship between economic growth and environmental quality. Initially, economic expansion worsens environmental conditions, but over time, technological advancements and awareness reduce ecological strain (Aytun et al., 2024).

Many studies explore environmental quality determinants, often using CO<sub>2</sub> emissions as a pollution measure (Adebayo, 2020; Idroes et al., 2024). Others analyse sulfur dioxide (SO<sub>2</sub>) (Sinha & Bhattacharya, 2017) and nitrogen dioxide (NO<sub>2</sub>) (Alola et al., 2023). This study utilises the ecological footprint, a comprehensive measure of environmental impact, to validate the EKC hypothesis. The ecological footprint assesses human demand for natural resources and is widely recognised in empirical research (Balsalobre-Lorente et al., 2024). Given its significance, numerous studies have examined its determinants (Bello et al., 2018; Ozcan et al., 2019; Ragmoun, 2023), reinforcing its role as a crucial indicator of environmental degradation.



**Figure 1:** Ecological footprint in Indonesia (Global hectares per person). Source: Global Footprint Network

The ecological footprint reflects human dependence on natural resources to meet needs. These resources significantly contribute to Indonesia's economic growth. However, Indonesia faces an ecological deficit due to importing biocapacity, liquidating national ecological assets, or emitting more carbon dioxide than its ecosystems can absorb. Despite Law No. 32/2009

mandating sustainable economic growth, implementation remains challenging. Natural resource rents drive excessive resource use and production, expanding the ecological footprint. While resource rents provide short-term economic gains, they can hinder long-term growth and sustainability (Hoang et al., 2023; Tabash et al., 2022). Mineral and forest rents, key sustainability concepts, must balance resource extraction with environmental and social interests (Wang & Wang, 2024). Minerals are vital for construction, manufacturing, energy, and agriculture (Nassani et al., 2021), but depletion leads to economic instability and ecosystem degradation. Similarly, rising forest rents cause deforestation, biodiversity loss, and climate change (Usman et al., 2023; Suriani et al., 2023, 2024).

The impact of human capital on the environment remains debated. Traditional human capital theory (Danish et al., 2019) links it to skills, education, and productivity. Education fosters awareness of sustainable technologies and renewable energy, influencing behaviours that enhance energy efficiency and resource conservation (Bano et al., 2018; Zallé, 2019). Thus, human capital plays a crucial role in mitigating environmental degradation. This study advances prior research by analysing environmental degradation and economic growth from a unique perspective. First, it focuses on the ecological footprint, offering a broader measure of human reliance on natural resources beyond air pollution. A larger ecological footprint in developing countries like Indonesia often correlates with declining environmental quality. Second, it examines Indonesia's ecological footprint over the past 30 years regarding human capital, forest rent, and mineral rent. Third, Indonesia, a country with one of the world's highest ecological footprints (Global Footprint Network), is the focal point. Limited research has explored the simultaneous relationship between ecological footprint, natural resource rents, human capital, and economic growth in Indonesia.

Fourth, the study applies the Environmental Kuznets Curve (EKC) hypothesis, utilising cubic GDP terms to assess the ecological footprint-economic growth connection. On the basis of these aspects, the study addresses two key questions: (1) Does Indonesia's economic growth reduce environmental pollution? (2) Do natural resource rents (mineral and forest rents) and human capital mitigate or worsen Indonesia's environmental challenges? This research aims to contribute in two ways. First, it examines the Kuznets curve, using ecological footprint as the dependent variable. Second, it employs time-series data, which differs from conventional cross-section or panel data studies on the EKC hypothesis. Time-series analysis provides a deeper understanding of pollution trends across economic development stages. Third, it assesses the impact of mineral rent, forest rent, and human capital on environmental degradation, especially when natural resource dependence is high. By providing insights into these relationships, this study enhances the literature on

sustainability, economic growth, and environmental management in Indonesia, ultimately guiding policy decisions toward sustainable development.

## RESEARCH METHODOLOGY

The study employs time series data from 1991Q1 to 2021Q4 in Indonesia, and the analysis period is related to the availability of mineral rent, forest rent, and human capital data. Ecological footprint data is collected from the Global Footprint Network. The World Development Indicator database provides economic development, forest rent, and mineral rent information. The Penn World Table, which calculates human capital using the human capital index, is the source of human capital data. Table 1 defines the variables used in the analysis.

**Table 1:** Description of Studied Variables

Variable(s)	Symbol(s)	Measurement(s)	Data Source(s)
Ecological Footprint	ECF	Ecological footprint (global hectares per capita)	Global Footprint Network
Economic Growth	GDP	GDP per capita (constant 2010 US dollars)	World Development Indicator
Mineral Rent	MRR	Mineral resource rent (percentage of GDP)	World Development Indicator
Forest Rent	FRR	Forest resource rent (percentage of GDP)	World Development Indicator
Human Capital	HC	Measured by human capital index	Penn World Tables

This study evaluates the validity of the EKC hypothesis and the relationship between ecological footprint, mineral rent, forest rent, and human capital in Indonesia from 1991Q1 to 2021Q4. Environmental impact is proxied by ecological footprint. Following Charfeddine & Mrabet (2017), some research variables were converted from logarithms to natural logarithms because of issues with normality. The following model investigated the relationship between ecological footprint and other variables.

$$ECF_t = \delta_0 + \delta_1 LGDP_t + \delta_2 LGDP_t^2 + \delta_3 LGDP_t^3 + \delta_4 MRR_t + \delta_5 FRR_t + \delta_6 HC_t + \varepsilon_t \quad (1)$$

Where ECF represents ecological footprint (per capita), GDP per capita or LGDP, is the natural logarithm of economic growth,  $(LGDP)^2$  is square of the logarithm of economic growth,  $(LGDP)^3$  is cubic of the logarithm of economic



growth, mineral rent (MRR) is expressed as a percentage, forest rent (FRR) as a percentage, and human capital (HC) as determined by the human capital index, which takes into account years of education and results from different educational levels. This study investigates the cubic growth of the economy as it aims to explore the more complex environmental Kuznets curve hypothesis. For this purpose, if the slope coefficient for economic growth is as follows ( $\delta_1 > 0$  ;  $\delta_2 < 0$  ;  $\delta_3 > 0$ ), showing an N-shaped relationship consistent with the EKC hypothesis (Arshad Ansari et al., 2020).

Following Arshad Ansari et al. (2020), Cai & Magazzino (2019) and Sun et al. (2023), this study employs time series approaches in the form of unit root tests to examine integration ordering using the ADF test. The unit root indicates which technique is suitable for further empirical investigation (Huang et al., 2020). After examining the unit root qualities, cointegration analysis is undertaken to analyse long-term equilibrium relationships and estimate long- and short-run effects. The ARDL methodology needs stationary variables at I(0) or I(1), and the current research fits these criteria. We utilise the following model within the ARDL framework to study the relationships between variables.

$$\begin{aligned}
 \Delta ECF_t = & \beta_0 + \sum_{k=1}^{\rho} \beta_{1k} \Delta(ECF)_{t-k} + \sum_{k=0}^{\rho} \beta_{2k} \Delta(LGDP)_{t-k} \\
 & + \sum_{k=0}^{\rho} \beta_{3k} \Delta(LGDP)_{t-k}^2 + \sum_{k=0}^{\rho} \beta_{4k} \Delta(LGDP)_{t-k}^3 \\
 & + \sum_{k=0}^{\rho} \beta_{5k} \Delta(MRR)_{t-k} + \sum_{k=0}^{\rho} \beta_{6k} \Delta(FRR)_{t-k} \\
 & + \sum_{k=0}^{\rho} \beta_{7k} \Delta(HC)_{t-k} + \delta_1 (ECF)_{t-1} + \delta_2 (LGDP)_{t-1} \\
 & + \delta_3 (LGDP)_{t-1}^2 + \delta_4 (LGDP)_{t-1}^3 + \delta_5 (MRR)_{t-1} \\
 & + \delta_6 (FRR)_{t-1} + \delta_7 (HC)_{t-1} + \varepsilon_t
 \end{aligned} \tag{2}$$

The lag length is denoted by  $\rho$  in equation (2), the error term by  $\varepsilon_t$  and the first difference operator by  $\Delta$ . The first section uses the symbol. The short-term relationship is articulated by the symbol ( $\Sigma$ ) in the first portion, while the long-term relationship is stated in the second part by the coefficients  $\delta_1$  to  $\delta_7$ . In the following phase, we run various diagnostic tests to determine the likelihood of heteroskedasticity, normality, and serial correlation, as well as the commonly used CUSUM and CUSUMsq tests to ensure parameter stability.

## RESULTS AND DISCUSSION

Table 2 presents descriptive statistics revealing that the average economic growth is significantly high at 6.408065, ranging from 5.950 to 6.900. This indicates a substantial impact of economic growth on Indonesia's ecological footprint throughout the analysis period. The ecological footprint (ECF), which indicates environmental damage, ranges from a minimum of 0.290 to 0.430. Mineral rent (MRR) and forest rent (FRR) increase from 0.030 and 0.100, respectively, to 0.690 and 0.510. Human capital (HC) increases from 0.480 to 0.610 from 1991Q1 to 2021Q4.

**Table 2:** Result of Descriptive Statistics

Statistics	ECF	LGDP	MRR	FRR	HC
Mean	0.351	6.408	0.212	0.189	0.559
Median	0.345	6.335	0.190	0.150	0.570
Minimum	0.290	5.950	0.030	0.100	0.480
Maximum	0.430	6.900	0.690	0.510	0.610
Std.Dev.	0.0378	0.288	0.150	0.088	0.036

The stationarity test results utilising the Augmented Dickey-Fuller (ADF) method are shown in Table 3. The time series variable FRR is integrated at the I(0) level, as shown by the unit root test results, while ECF, LGDP, LGDP<sup>2</sup>, LGDP<sup>3</sup>, MRR, and HC are integrated at the I(1). These findings suggest that the time series variables have a varied order of integration. Given the heterogeneous order of integration in the time series data, employing the ARDL model in this investigation is appropriate.

**Table 3:** Result of Stationary Testing using Augmented Dickey-Fuller.

Variable	At Level		At First Difference	
	t-Statistic	Prob.	t-Statistic	Prob.
ECF	-3.3125*	0.0692	-	-
LGDP	-2.1371	0.5196	-3.5961**	0.0344
LGDP <sup>2</sup>	-2.0087	0.5903	-3.6466**	0.0301
LGDP <sup>3</sup>	-1.8859	0.6556	-3.7038**	0.0259
MRR	-1.8083	0.6947	-3.4787**	0.0465
FRR	-3.5548**	0.0383	-	-
HC	-0.2373	0.9915	-8.4541***	0.0000

Note: \*, \*\*, and \*\*\* are significance levels at 10 %, 5 %, and 1 % respectively.

The cointegration test findings in Table 4 demonstrate that the long-term link is obvious in the model. Since the F-statistic of the model is bigger than the crucial value at the 5% level, we cannot reject the presence of a long-term link. Therefore, we may proceed with estimating both the long-term and short-term associations.

**Table 4:** Result of Cointegration Analysis using ARDL Bounds Testing Approach

Model	Long-run result		
	Lower bound	Upper bound	Significance level
Fc (lgdp, lgdp <sup>2</sup> , lgdp <sup>3</sup> , mrr, frr, hc)	2.53	3.59	10%
F = 7.152208	2.87	4	5%
	3.19	4.38	2.5%
	3.6	4.9	1%

The ARDL results in Table 5 indicate that economic growth, forest rent, and human capital drive environmental degradation, while mineral rent enhances environmental quality in the long run. Natural resource rents impact the environment differently based on resource type and extraction methods. In Indonesia, forest rent increases ecological footprints over time, as forest exploitation surpasses regeneration capacity. This aligns with Zhang & Zhang (2023), who found a negative environmental impact of natural resources in developing countries, particularly due to deforestation. However, Bilgili et al. (2023) argue that forest rent mitigates environmental harm in the MENA region, while mineral rent exacerbates it. Mineral rent negatively correlates with ecological footprints in the long run, suggesting that revenues from mineral resources can fund sustainable mining practices, thereby reducing environmental damage.

He et al. (2024b) describe mineral rent as a tax that ensures fair corporate contributions for resource extraction, minimising long-term harm. Kang et al. (2023) also found that mineral rent lowers ecological footprints in the U.S. because mining often occurs in isolated areas, reducing its environmental impact. Human capital increases Indonesia's short- and long-term ecological footprint, suggesting weak environmental education. This aligns with Nathaniel (2021), who found ASEAN's human capital lacks environmental conservation awareness, similar to Zia et al.'s (2021) findings in China. Danish et al. (2019) also link human capital to a higher ecological footprint in Pakistan due to limited environmental knowledge. However, Nathaniel (2021c) suggests that educated human capital fosters sustainability through efficient resource use, energy conservation, and green technology adoption. Sahoo & Sethi (2021) emphasise that populations with higher human capital indices are more environmentally conscious and take measures to protect the ecosystem.

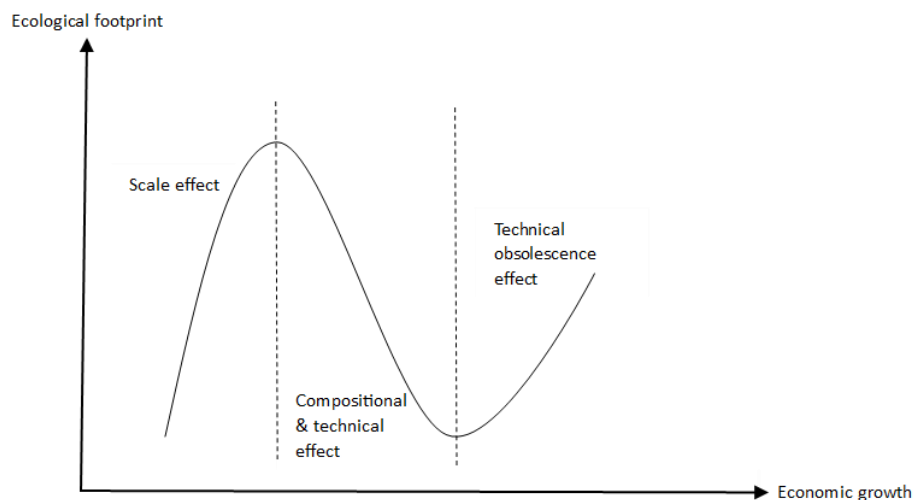
**Table 5: Result of ARDL Estimations**

Variable(s)	Coefficient	Std. Error	t-Statistic	Prob.
Short-run results				
D(ECF(-1))	0.3943***	0.0845	4.6675	0.0000
D(ECF(-2))	0.1237	0.0878	1.4089	0.1631
D(ECF(-3))	0.2611***	0.0878	2.9732	0.0040
D(LGDP)	-33.1502	51.2526	-0.6468	0.5198
D(LGDP(-1))	-137.1707**	57.1292	-2.4011	0.0189
D(LGDP(-2))	-45.6964	59.0028	-0.7745	0.4411
D(LGDP(-3))	-197.0605***	52.8914	-3.7257	0.0004
D(LGDP2)	4.7334	7.8915	0.5998	0.5505
D(LGDP2(-1))	21.3795**	8.8089	2.4270	0.0177
D(LGDP2(-2))	7.142042	9.1054	0.7844	0.4354
D(LGDP2(-3))	30.6183***	8.1708	3.7473	0.0004
D(LGDP3)	-0.2209	0.4042	-0.5467	0.5862
D(LGDP3(-1))	-1.1079**	0.4518	-2.4522	0.0166
D(LGDP3(-2))	-0.3697	0.4674	-0.7909	0.4315
D(LGDP3(-3))	-1.5825***	0.4198	-3.7689	0.0003
D(LGDP3(-4))	-0.0001	0.0005	-0.2102	0.8341
D(LGDP3(-5))	0.0004	0.0005	0.8411	0.4030
D(LGDP3(-6))	0.0007	0.0005	1.3524	0.1804
D(LGDP3(-7))	-0.0011**	0.0004	-2.5949	0.0114
D(MRR)	0.0066	0.0151	0.4401	0.6612
D(MRR(-1))	0.0292*	0.0154	1.9006	0.0613
D(MRR(-2))	-0.0029	0.0144	-0.2057	0.8375
D(MRR(-3))	0.0319**	0.0139	2.2999	0.0243
D(MRR(-4))	0.0293**	0.0140	2.0902	0.0401
D(HC)	0.3879***	0.1338	2.8999	0.0049
D(HC(-1))	-0.7895***	0.1745	-4.5240	0.0000
D(HC(-2))	-0.6509***	0.1719	-3.7867	0.0003
D(HC(-3))	-0.5974***	0.1691	-3.5326	0.0007
D(HC(-4))	-0.6612***	0.1644	-4.0211	0.0001
D(HC(-5))	-0.4213***	0.1589	-2.6498	0.0099
D(HC(-6))	-0.1218	0.1525	-0.7986	0.4271
D(HC(-7))	-0.1812	0.1492	-1.2143	0.2285
D(HC(-8))	0.3110**	0.1417	2.1948	0.0314
CointEq(-1)*	-0.4928***	0.0669	-7.3607	0.0000
Long-run results				
LGDP	57.1883***	17.610	3.2474	0.0018
LGDP2	-9.4639***	2.7541	-3.4363	0.0010
LGDP3	0.5210***	0.1439	3.6209	0.0005
MRR	-0.0629***	0.0161	-3.9142	0.0002
FRR	0.1426***	0.0519	2.7473	0.0076
HC	1.9873***	0.3745	5.3057	0.0000

Variable(s)	Coefficient	Std. Error	t-Statistic	Prob.
Diagnostic Tests				
Jarque-Bera	0.113751[0.944712]			
LM test	0.5098			
Breusch-Pagan- Godfrey	0.6784			
Ramsey	0.7361			

Note: \*, \*\*, and \*\*\* are significance levels at 10 %, 5 %, and 1 %, respectively.

We further observe the presence of EKC for ecological footprint in Indonesia from the positive/negative coefficients of LGDP/LGDP2/LGDP3 in Table 5. The examination of results indicates an N-shaped correlation between economic growth and ecological footprint. The N-shaped EKC curve illustrates that ecological footprints undergo three phases: "increase, decrease, and increase" in response to economic expansion (Nugraha et al., 2024). In addition, Shahbaz & Sinha (2019) posit that when  $\delta_2 > 0$ ,  $\delta_3 < 0$ , and  $\delta_4 > 0$ , the correlation between environmental degradation and economic growth exhibits an N-shaped curve (Figure 2).

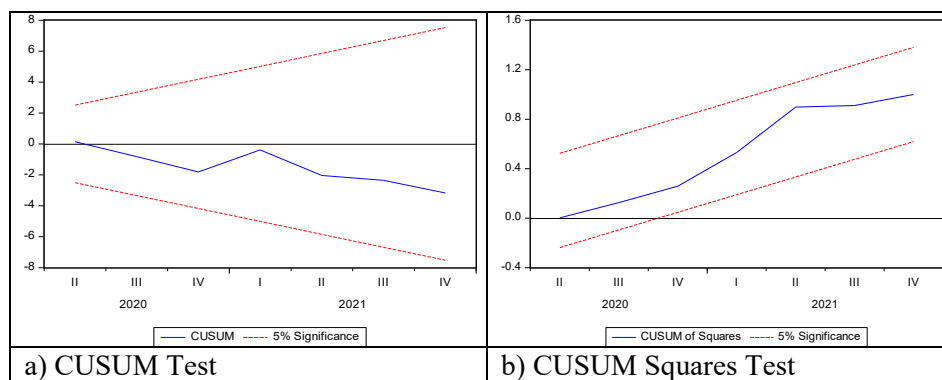


**Figure 2:** N-shaped relationship between GDP and environmental degradation

Source: Barış-Tüzemen et al., (2020) and Zhang (2021)

The study reveals a transition from scale effects to composition and technique effects through changes in energy consumption patterns. This contrasts with Rahman et al. (2024), who found that Indonesia rejects the Environmental Kuznets Curve (EKC) as air pollution rises with economic growth. However, Alam et al. (2016) observed that Indonesia follows the EKC for CO<sub>2</sub> emissions

in both the short and long term. The N-shaped EKC suggests that pollution may resurge at advanced economic stages if innovation lags behind economic growth (Álvarez-Herránz et al., 2017). This model indicates that pollution declines initially but rises again with further progress (Wang et al., 2024). Theoretical research suggests the N-shaped EKC emerges when environmental protection efforts and clean technologies slow down. Based on findings, the N-shaped EKC is supported, implying that pollution decreases alongside economic success in the second phase, albeit with a relatively low coefficient.



**Figure 3:** Result of CUSUM and CUSUM Squares Test

The findings of the diagnostic tests for normality, serial correlation, and heteroscedasticity, shown in Table 5, indicate that this research model is stable. Additionally, the CUSUM and CUSUM Squares plots in Figure 3 are within the required 5 percent boundaries, confirming model stability.

## CONCLUSION

Indonesia must understand the Environmental Kuznets Curve (EKC) to address its ecological footprint. This study examines EKC validity and the effects of mineral rent, forest rent, and human capital on Indonesia's ecological footprint using the ARDL test. Findings indicate an N-shaped EKC, suggesting that environmental degradation may persist if green innovation fails to counterbalance economic expansion. Economic growth, forest rent, and human capital increase the ecological footprint, while mineral rent reduces it in the long run. These findings offer key policy insights. First, Indonesia must reduce reliance on forests and minerals by investing in research, development, and technology to enhance energy efficiency and sustainability. Second, resource exploitation, from extraction to production, contributes to environmental damage.

Imposing proportional taxes on mined resources can mitigate these effects. Third, the government should promote renewable energy while

discouraging environmentally harmful resource use. Raising public awareness and implementing stricter standards can support this transition. This study has limitations. It does not explore broader economic factors such as international trade and financial development. Additionally, it focuses on mineral and forest rent, excluding natural gas, coal, and oil rent. Future research should incorporate these variables for a more comprehensive analysis.

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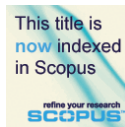
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**EVALUATION OF FLOOD SUSCEPTIBILITY MAPPING IN KEDAH  
WITH AHP AND GIS: A CASE STUDY OF KOTA SETAR AND  
PADANG TERAP, KEDAH MALAYSIA**

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**Abstract**

Model estimations of flood susceptibility often face challenges in assigning appropriate weights to factors that contribute to flooding. This study focuses on evaluating flood-prone areas in Kota Setar and Padang Terap, Kedah, Malaysia, by applying optimum weights to proposed flood parameters using the Analytical Hierarchy Process (AHP) model integrated with a Geographic Information System (GIS). Physical features, including slope, elevation, topographic wetness index (TWI), and flow accumulation, were extracted using Interferometric Synthetic Aperture Radar (IFSAR) data, alongside land use and rainfall data. For validation, approximately 1,279 historical flood marks from the Department of Irrigation and Drainage (DID) were used. The resulting flood susceptibility map and historical flood data aligned well with an RMSE of 92.2% after weighted flood parameter integration. The most significant contributors to flood susceptibility were identified as slope (39%), land use (21%), rainfall (19%), and elevation (11%). The findings indicate that optimizing parameters with weights improves susceptible area prediction for future flood mapping research using AHP and GIS.

**Keywords:** Analytical Hierarchy Process (AHP), GIS, Malaysia Flood Mapping, Weighted Overlay Analysis

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## **INTRODUCTION**

Flood susceptibility is the most important component of early warning systems or strategies for preventing and mitigating flood impact (Dano et al., 2019). According to the Department of Irrigation and Drainage (DID), Kubang Pasu and Baling, Kedah had the highest number of floods in 2021, with 14 flood events reported (DID, 2020; 2022). DID released a 2023 report with infographic data showing that Kubang Pasu and Baling are frequently affected by floods, highlighting the urgent need for the government to implement more proactive and effective flood management strategies to mitigate the impact of future flooding events (DID, 2024). Although the government has allocated RM1.3 billion in the 12th Malaysia Plan (RMK12) to implement Flood Mitigation Plans (RTB) to minimize the impact of flood disasters in Kedah, the situation is getting worse due to developments near High-risk flood reservoir triggering flash floods, leading to the increasing number of flood victims (Bernama, 2022). The worsening flood situation pushed the authorities to continue monitor flood-prone areas, especially those near the riverbank (Zulkiffli, 2021). Several studies have been conducted to create a flood map (AlAli et al., 2023; Eslaminezhad et al., 2022; Narimani et al., 2021), focusing on identifying flood-prone areas and improving disaster management. However, due to the absence of proper preventive measures or the consideration of various parameters, inappropriate flood parameter selection for the flood-susceptible area estimation is still inaccurate (Tariq et al., 2022).

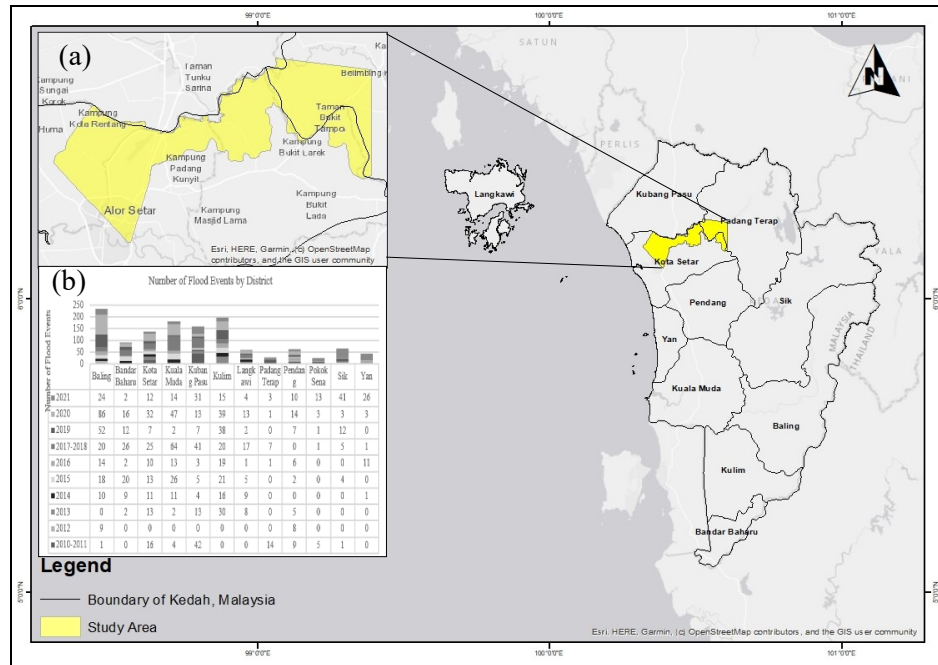
The flood susceptibility mapping relies on various condition parameters to characterise the physical characteristics of the area of interest. The flood susceptibility mapping relies on various condition parameters to characterise the physical characteristics of the area of interest. The AHP model, with appropriate weights and ranks for each parameter, is used to estimate flood-prone areas and significant flood parameters, while the integration of AHP and GIS (AHP-GIS) enhances the visualization of flood susceptibility mapping and the evaluation of flooding risks sensitivity (AlAli et al., 2023; Lappas & Kallioras, 2019; Nsangou et al., 2022; Msabi & Makonyo 2021; Swain et al., 2020). AHP provides a structured decision-making hierarchy utilizing a specified reference scale, taking into consideration the variables that influence decisions and the significance of decision points relative to these factors (Mabahwi & Nakamura, 2024). Most of the data used to be embedded in the AHP is elevation, Landsat 8 OLI, soil map, geological map, drainage density, flow accumulation (FA), land use, and soil type (Dano et al., 2019; Lappas & Kallioras, 2019; Nsangou et al., 2021). In another study, Tariq et al. (2022) flood susceptibility map was generated using six parameters (slope, elevation, distance from the stream, drainage density, flow accumulation, land use/land cover (LULC), soil and geology). According to Saaty (1988), a Consistency Ratio (CR) value of less than 0.10 indicates a reliable

ranking and weighting of significant flood parameters. However, the study's information fails to fully capture the physical characteristics of areas susceptible to flooding. As a result, estimate and map the susceptible area for development planning to ensure informed decision-making and sustainable land use practices is necessary.

Due to inconsistency in the selection of the flood parameters in producing the susceptible flood map, the study aims to improve flood management by providing a clearer identification of flood-prone areas, which supports better mitigation strategies. The comprehensive insights from the study can help local authorities prioritize resources, improve land use planning, and develop targeted disaster preparedness measures, making it highly relevant for shaping policies and strategies to minimize flood risks, strengthen community resilience, and ensure effective long-term flood management.

## **RESEARCH METHODOLOGY**

Figure 1a shows the study area of this research: the distribution of the historical flood marks recorded the flood events from 2010 until 2021 for the Padang Terap and Kota Setar, Kedah. Figure 1b displays a bar graph of district flood incidents from 2010 to 2021. From 2010 to 2021, numerous districts in Kedah faced persistent flooding, with the frequency of incidents rising annually and affecting all districts by 2020-2021. In 2024, Said et al. assessed flood vulnerability in Padang Terap district due to its long history of flooding, with recorded incidents dating back to 1937 and a noticeable increase in flood frequency between 2000 and 2010, during which the district suffered total losses amounting to RM16,615,439.00. Table 1 indicates the data used to accomplish the objectives of the study. Historical flood marks which were recorded in non-spatial data from the DID Malaysia (<http://sprhin.water.gov.my>) only in 2010-2021 was then converted to the spatial based on shapefile format (.shp) were used to identify the spatial distribution of the flooded area at Kedah, Malaysia. The data on elevation, slope, and TWI of the study area were created using the IFSAR-DEM (5-meter resolution) provided by Intermap Technologies Malaysia. The land use and rainfall data were obtained from PLANMalaysia. All were georeferenced and projected to Kertau (MRSO).



**Figure 1:** Map of Kedah. Study Area (a), Total of Flood Occurrences (b)  
 Source: Department Irrigation and Drainage (DID) Annual Report (2010-2022)

**Table 1:** Dataset of Study

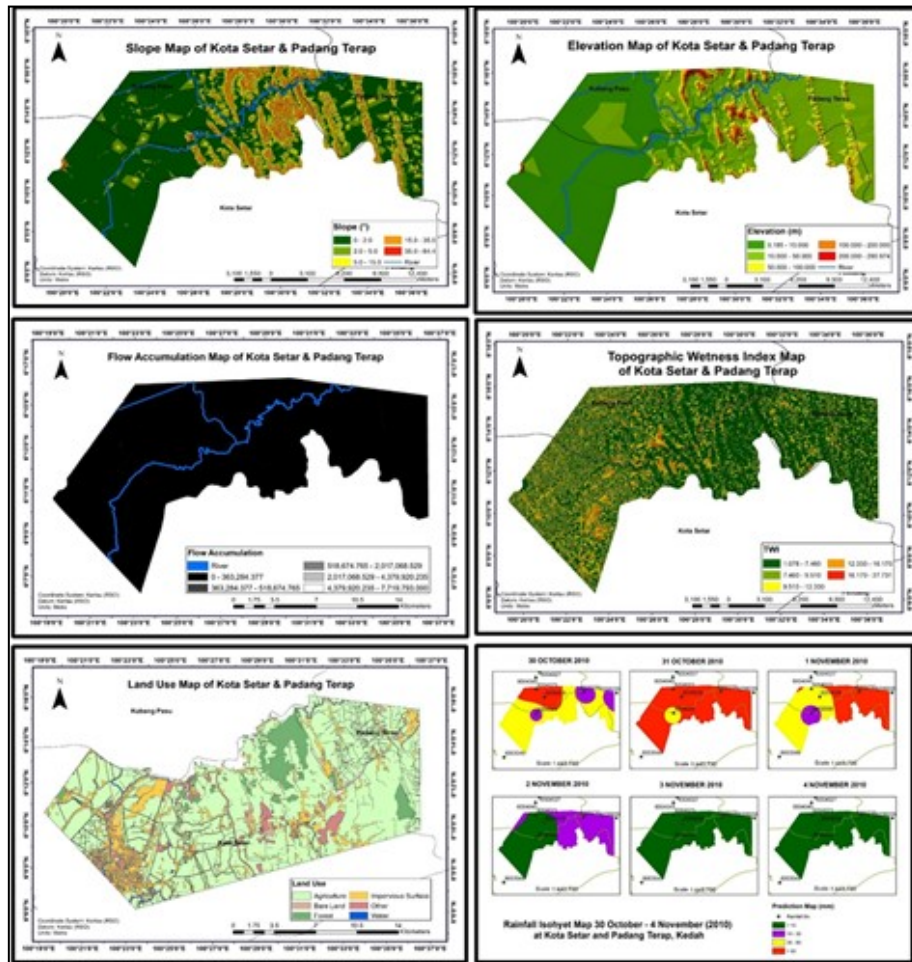
Data Type	Date	Source	Scale/Resolution	Purpose
Historical flood mark	2010-2021	DID	Table with (x and y)	Validation of Results
IFSAR-DEM	2019	INTERMAP Technologies Malaysia	5 m, vertical accuracy $\pm 1$ m	Topographic and hydrologic variables
Land-use	2019	PLANMalaysia	1:50,000	Land use
Rainfall	30 October – 4 November 2010	DID	Daily	Runoff

The elevation of the study area is determined in ranges between 0.185m to 290.974 m (Figure 2b). Most data used for hydraulic purposes, such as slope, flow accumulation, TWI, and elevation, were generated using the provided IFSAR DEM dataset. Figure 2a shows the slope map in degrees ( $^{\circ}$ ), which was generated from the DEM dataset with five classes ranging from  $0^{\circ}$  (green) to  $64.4^{\circ}$  (red). Figure 2c, which generates the flow accumulation based on the flow direction and catchment area, aids in comprehending the movement of water across the terrain. The higher the parameter value, the more susceptible the area is to flood because it shows the flow accumulation of the nearby pixels indicating

the areas of run-off surface (Lappas & Kallioras, 2019). The ArcGIS environment prepares the TWI map by running the Raster Calculator (Nsangou et al., 2021). Figure 2d shows the TWI map where the class ratings range from 0 to 20.030 pixels. TWI levels are typically greater in situations near floodplains.

The land use map, another spatial dataset, falls into six categories: (i) agriculture, (ii) bare land, (iii) forest, (iv) impervious surfaces, (v) others, and (vi) water bodies (Figure 2e). To generate the cumulative rainfall map, the spatial interpolation of the Inverse distance weighted (IDW) model (González-álvarez et al., 2019) is generated using the points of the telemetry station with rainfall data volume provided by DID. Each of the rainfall data starting from October 30 until November 4, 2010, had been interpolated, showing the pattern of rainfall distribution (Figure 2f). The rainfall map is divided into different categories using the natural break (Jenks) method (Swain et al., 2020) and kernel density to identify areas with higher and lower flood risk within the study area. The process involved collecting spatial data, including flood marks, elevation, and slope which depicts the concentration of flood events, with higher density values indicating areas more vulnerable to flooding.





**Figure 2:** Slope Map (a), Elevation Map (b), Flow Accumulation (FA) (c), Topographic Wetness Index (TWI) Map (d), Land-use Map (e) and Rainfall Map (f)

This study used the Saaty (1988) approach, where the scale is 1 to 9, which indicates 1 is the least important and 9 is the most important. The relative rank of values in the AHP model is compared to determine the priority or importance of one element over another in pairwise comparisons (Table 2). Weights were assigned to all variables based on the authors' judgement and their relative significance, achieved through constructing a pairwise comparison matrix (Table 3). Subsequently, the scale weights were derived using an eigenvalue. The pairwise comparison matrix was then normalized using the weighted arithmetic mean method to produce the standard pairwise comparison matrix (Table 4) which conducted systematically to determine the weight of flood

parameters (Das, 2019). It was calculated using a pairwise comparison matrix, applying a standardized rating scale.

**Table 2: Pairwise Comparison Matrix Scale**

Importance	Definition
1	Equally significant
2	Weak or slight
3	Moderately more significant
4	Moderate plus
5	Strongly more significant
6	Strong plus
7	Very strong more significant
8	Very, very strong more significant
9	Extremely more significant

*Sources: Saaty, 1988*

**Table 3: Pairwise Comparison Matrix**

Parameters	(A)	(B)	(C)	(D)	(E)	(F)
Slope (A)	1.00	2.00	3.00	4.00	5.00	7.00
Land use (B)	0.50	1.00	1.00	2.00	4.00	6.00
Rainfall (C)	0.33	1.00	1.00	2.00	3.00	5.00
Elevation (D)	0.25	0.50	0.50	1.00	2.00	3.00
TWI (E)	0.20	0.25	0.33	0.50	1.00	2.00
FA (F)	0.14	0.17	0.20	0.33	0.50	1.00
SUM	2.43	4.92	6.03	9.83	15.50	24.00

*Source: Author's Calculation*

**Table 4: Normalized Factor Weights**

Parameters	(A)	(B)	(C)	(D)	(E)	(F)	SUM	Criteria Weight
Slope (A)	0.41	0.41	0.50	0.41	0.32	0.29	2.34	0.39
Land use (B)	0.21	0.20	0.17	0.20	0.26	0.25	1.29	0.21
Rainfall (C)	0.14	0.20	0.17	0.20	0.19	0.21	1.11	0.19
Elevation (D)	0.10	0.10	0.08	0.10	0.13	0.13	0.64	0.11
TWI (E)	0.08	0.05	0.06	0.05	0.06	0.08	0.39	0.06
FA (F)	0.06	0.03	0.03	0.03	0.03	0.04	0.23	0.04
SUM	1.00	1.00	1.00	1.00	1.00	1.00	6.00	1.00

*Source: Author's Calculation*

The weighted overlay technique overlays several raster layers by giving the relative weights calculated using AHP to each raster layer according to their importance (Saaty, 1988). This study used the weighted overlay method (Narimani et al., 2021) to produce the flood susceptibility map. The previous study (Kaya & Derin, 2023) determined the relative importance of the weights, assigning them both externally and internally. The total of the external weights

must be 100 and the internal weights are referred as the class values (Munier & Hontoria, 2021; Saaty, 1988). Root Mean Square Error (RMSE) is a statistical measure used to validate flood susceptibility mapping by comparing flood susceptibility maps generated from AHP with recorded flood mark data from recent flood marks (Mokhtar et al., 2017). The process involves calculating the differences between the predicted susceptibility values and the measured flood marks, squaring these differences to eliminate negative values, averaging the squared differences, and then taking the square root of this mean to obtain the RMSE. Lower RMSE values indicate a better fit between the predicted values and actual flood marks, suggesting that the mapping is reliable, while higher RMSE values indicate significant discrepancies, highlighting the need for model refinement (Eslaminezhad et al., 2022). Table 5 shows each column under a country's name references a specific study, indicating which parameters were used in that study.

**Table 5:** Flood's Parameters on Flood Susceptibility Mapping

Parameters	Korea	Greece	India	Tanzania	China
	Narimani et al. (2021)	Lappas & Kallioras (2019)	Das (2019)	Msabi & Makonyo (2021)	Wang et al. (2019)
Land use	✓	✓	✓	✓	✓
Slope	✓	✓	✓	✓	✓
Rainfall	✓	✓	✓		✓
Flow Accumulation	✓	✓	✓	✓	
TWI	✓	✓	✓		✓
Plan Curvature	✓				
Elevation	✓	✓	✓	✓	✓
Lithology					✓
NDVI					✓
Distance from the drainage network		✓	✓		✓
Drainage Network		✓			
Soil			✓		✓
TRI			✓		
Stream Power Index (SPI)					✓
Population Density					✓
Sewer System Density					✓

## ANALYSIS AND DISCUSSION

Based on Table 6, the parameters are ranked based on their calculated weights and found that the highest weight was assigned to the slope (39%), and land-use

(21%), followed by rainfall (19%), elevation (11%), TWI (6%), and flow accumulation (4%) and additionally, the total weight is equal one. This study successfully achieved acceptable values for the CI and CR, which are  $CI = 0.02$  and  $CR = 0.01$ , which are below the threshold, which is 0.1, indicating that the judgments were consistent, and the weights were acceptable (Dano, 2021). Higher weights indicate greater importance, establishing a hierarchy that reflects their contribution to flood susceptibility. In this study CI and CR are considered better compared to Lappas & Kallioras (2019), with the consistency of the threshold value being 0.058. The authors used similar flood parameters such as TWI, elevation, and distance from drainage, while the factors for geology, soil types, and flow accumulation. Historical flood marks indicate that most flood distribution marks occur in high-risk zones, while only a few are found in the yellow regional area, which is classified as moderate-risky. This study achieved a better accuracy rate of 92.2% in comparison to the previous study (Vojtek et al., 2021), which 70.9% of historical flood episodes aligned with the flood-susceptible mapping.

**Table 6:** Pairwise Comparison Matrix for Sub-Criteria of the Six Parameters

Criteria	Weight	Sub-criteria / Class	Pairwise Comparison Matrix						CR	Sub Weight
Slope	0.390	0.0 - 2.0	1.00	4.00	5.00	6.00	8.00	0.005	0.504	
		2.0 – 5.0	0.25	1.00	4.00	5.00	6.00		0.261	
		5.0 – 15.0	0.20	0.25	1.00	4.00	3.00		0.129	
		15.0 – 35	0.17	0.20	0.25	1.00	2.00		0.063	
		> 35	0.13	0.17	0.33	0.50	1.00		0.043	
Land Use	0.210	Water bodies	1.00	2.00	4.00	5.00	6.00	7.00	0.020	0.410
		Impervious Surface	0.50	1.00	2.00	3.00	5.00	6.00		0.250
		Other	0.25	0.50	1.00	2.00	3.00	4.00		0.140
		Bare Land	0.20	0.33	0.50	1.00	2.00	3.00		0.090
		Agriculture	0.17	0.20	0.33	0.50	1.00	2.00		0.060
		Forest	0.14	0.17	0.25	0.33	0.50	1.00		0.040
Rainfall	0.190	> 60	1.00	2.00	3.00	6.00		0.003	0.496	
		30.0 - 60.0	0.50	1.00	2.00	3.00			0.267	
		10.0 - 30.0	0.33	0.50	1.00	2.00			0.154	
		<10	0.17	0.33	0.50	1.00			0.083	
Elevation	0.110	0.185-10.000	1.00	4.00	6.00	7.00	9.00	0.005	0.519	
		10.000-50.000	0.25	1.00	4.00	6.00	7.00		0.259	
		50.000-100.000	0.17	0.25	1.00	4.00	5.00		0.131	
		100.000-200.000	0.14	0.17	0.25	1.00	2.00		0.055	
		200.000-290.974	0.11	0.14	0.20	0.50	1.00		0.036	
		16.170 - 27.131	1.00	4.00	5.00	6.00	7.00		0.487	
		12.330 - 16.170	0.25	1.00	4.00	5.00	7.00		0.263	

TWI	0.060	9.510 - 12.330	0.20	0.25	1.00	4.00	5.00	0.005	0.143			
		7.460 - 9.510	0.17	0.20	0.25	1.00	3.00			0.069		
		1.078 - 7.460	0.14	0.14	0.20	0.33	1.00				0.038	
Flow Accumulation	0.040	4,379,920.235 - 7,719,793.000	1.00	4.00	5.00	6.00	7.00	0.011	0.137			
		2,017,068.529 - 4,379,920.235	0.25	1.00	4.00	5.00	6.00			0.064		
		518,674.765 - 2,017,068.529	0.20	0.25	1.00	3.00	5.00				0.042	
		363,284.377 - 518,674.765	0.17	0.20	0.33	1.00	2.00					0.02
		0 - 363,284	0.14	0.17	0.20	0.50	1.00					
Consistency Index								0.02				
Consistency Ratio								0.01				

Source: Author's Calculation

Figure 3 shows the flood susceptibility map with 3D elevation and the percentage of areas classified as flood-vulnerable of Kota Setar and Padang Terap, Kedah, Malaysia. The finding shows that area coverage for the 'Moderate' potentially susceptible area is 69.553 km<sup>2</sup> (34.860%), which includes Kampung Bukit, Kampung Padang Lalang, Kampung Pokok Machang, Kampung Rambutan, Kampung Seberang Paya Empa, and Kampung Tanjung Putus. As for the TWI, the areas with moderate susceptibility have slight degree slopes, resulting in some water accumulation. The difference between moderate and low-risk areas is that the flow accumulation in moderate-risk areas causes more water to collect during heavy rainfall. As for the area coverage for flood susceptibility classes, the 'High' susceptible level covers a surface of 49.274% of the study area, mainly belonging to the flat area. Based on DID flood reports, over the past eleven years, flooding has occurred frequently in seven (7) places. Floods have inundated Kampung Alor Senjaya seven times, Kampung Alor Gunong six times, Kampung Bukit Pinang, Taman Nakishah, and Taman Uda four times, and two times occurred at Taman Sireh and Kampung Derang. These seven places had the highest frequency among the other areas where floods in the past year had inundated. As a result, Kampung Alor Senjaya and Kampung Alor Gunong are highly susceptible to future flood occurrences. Kampung Alor Senjaya and Kampung Alor Gunong used the impervious surface on land. As mentioned in the literature review by Loumi & Redjem (2021) the bare lands and impervious surfaces increase the surface run-off rate, which has a high possibility of flooding. Table 7 shows the flood-prone region impacted, categorized by the classes with the lowest to highest area coverage in the study area: very low (more tangible), low (moderately affected), and very high (Highly affected).

**Table 7:** Flood Risk Area Coverage and Place Affected.

<b>Flood Susceptibility</b>	<b>Area (Km<sup>2</sup>)</b>	<b>Area (%)</b>
Very High	0.056	0.028
High	98.311	49.274
Moderate	69.553	34.860
Low	31.270	15.673
Very Low	0.327	0.164

*Source: Author's Calculation*

The flood susceptibility maps validated using the 90 historical flood marks shows a very good agreement between the flood susceptibility map and the historical flood marks, with 92.22% falling within the 'High' class. The 'Low' and 'Very Low' susceptibility areas are characterized by higher slopes and elevations, significantly reducing the flood-prone area. As supported by the literature, areas with higher vegetation tend to have a reduced probability of flooding (Saleh et al., 2022). In these regions, water runoff is facilitated by steeper slopes, while lower TWI values and minimal flow accumulation further decrease the likelihood of flooding. The 'Moderate' susceptibility areas are associated with sloped surfaces, typically ranging between 5° and 15° (Vojtek et al, 2021). These areas are more likely to accumulate water during heavy rainfall due to moderate flow accumulation and land use, such as agriculture and bare land (Vojtek et al, 2021; Loumi & Redjem, 2021). The higher flow accumulation causes more water to collect. However, the moderate slopes still allow for some water drainage, reducing the likelihood of extensive flooding compared to the high-susceptibility areas.

The 'Very High' and 'High' susceptibility levels have the lowest slope and elevation, the land is dominated by impervious surfaces and the rainfall is high intensity. Elevation is a key conditioning factor for floods, where the lowest elevation classes (0.185–10.000 m) significantly increase flood susceptibility. Additionally, the areas with the highest TWI values tend to be more susceptible to flooding, particularly in the TWI classes of 9.510– 12.330, 7.460–9.510, and 1.078–7.460. This indicates that TWI is a crucial factor in triggering floods in the study area. Heavy rainfall, particularly one with a cumulative 60 mm or more, also plays a significant role in increasing the flood risk. The lowest slope classes (0–2°) are the most prone to flooding due to the water's static position in flat areas, as observed in Tella & Balogun (2020).

In contrast to Vojtek et al. (2021) where only 70.9% of flood markings agreed with the "Very High" and "High" susceptibility categories, this research shows higher agreement between historical flood marks and the flood susceptibility map. The findings indicate locations in Kota Setar and Padang Terap that are most susceptible to flooding, which serves as a basis for more

focused flood control measures. This data can be used by local government entities to set priorities for flood control and drainage system upgrades.

## **CONCLUSION**

The flood susceptibility map for Kota Setar and Padang Terap was created using an AHP model integrated with GIS based on assigning a numerical weight to each flood parameter. The flood susceptibility indices were computed utilizing the weighted overlay technique, and subsequently, the flood susceptibility map was generated within the ArcGIS environment. The flood susceptibility map categorized the research area into distinct categories of susceptibility, namely: very high, high, moderate, low, and very low. According to the finding of the study, approximately 49% of the study area is classified as highly susceptible to flooding. This is mostly located at flat terrain, low elevation, and heavy rainfall. Based on the data, it can be concluded that Kampung Alor Senjaya and Kampung Alor Gunong are highly vulnerable to future flooding. These two locations are situated in Kota Setar, near the Kedah River.

Conversely, approximately 16% is categorized as having low and extremely low susceptibility levels (Figure 3). The flood susceptibility mapping was validated by comparing it to historical flood marks, and the verification process demonstrated an accuracy of 92%. The validated outcome demonstrated a strong correlation between the historical flood mark and the susceptibility map generated for the area. Hence, the results of this study are confirmed to be applicable for assessing flood risk, implementing measures to reduce it, and guiding future urban development in the region.

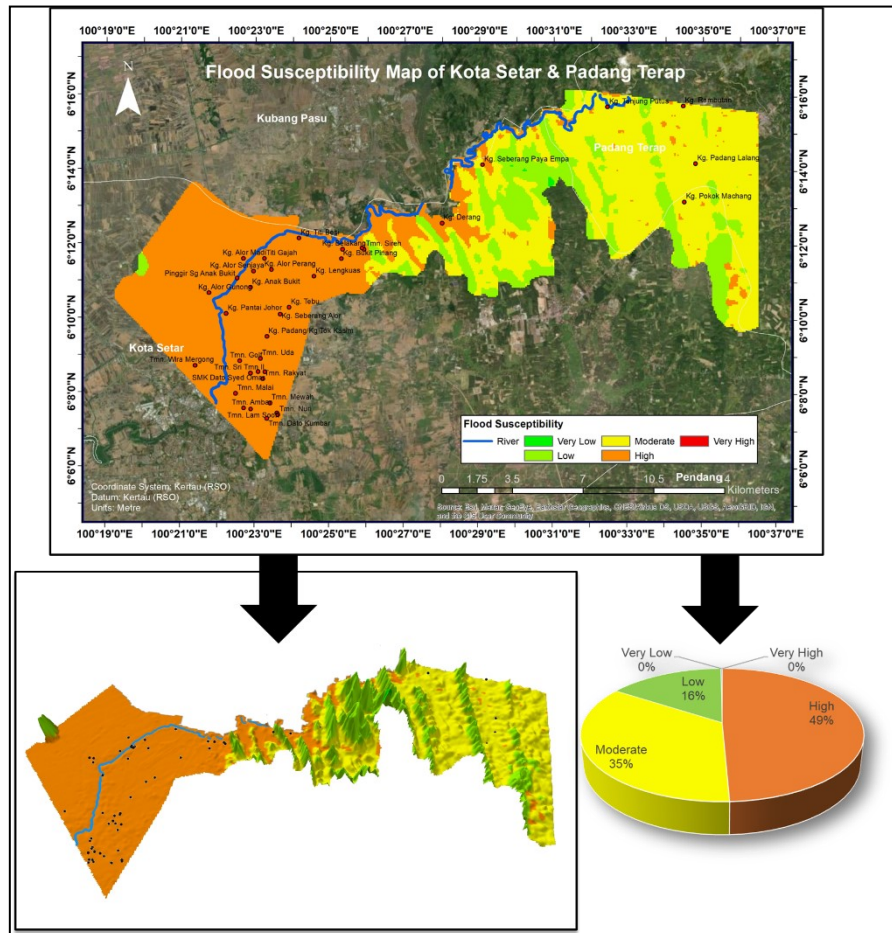


Figure 3: Overall Flood Susceptibility Mapping

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## **INVENTORY OF CARBON EMISSIONS FOR NET ZERO EMISSION POLICIES IN THE TRANSPORTATION SECTOR IN THE NEW CITY CENTER OF BANDA ACEH, ACEH, INDONESIA**

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### **Abstract**

Carbon emissions, a major cause of global warming, predominantly originate from the transportation sector. Countries worldwide, including Indonesia, are committed to achieving Net Zero Emissions (NZE) by targeting a 29% to 41% reduction in emissions by 2030. As Aceh Province's capital, Banda Aceh strives to become a low-carbon city through various mitigation strategies. This study focuses on Mr Teuku Muhammad Hasan Street in the New City Center area of Banda Aceh, a high-traffic zone that significantly contributes to carbon emissions. The research aims to (1) measure vehicular CO<sub>2</sub> emissions using traffic counting methods and (2) assess the CO<sub>2</sub> absorption capacity of roadside vegetation along this route. Employing the IPCC 2019 Guidelines Tier 1 methodology, the study adopts a quantitative approach with spatial and descriptive analysis supported by field surveys and literature review. Findings indicate a residual emission of 2,676.17 tons of CO<sub>2</sub> per year, unabsorbed by existing vegetation. Two key policies are proposed to support NZE goals: (1) increasing vegetation to enhance carbon sequestration and (2) optimizing public transportation, particularly the Trans Koetaradja bus service. Scenario analysis suggests that implementing these policies could reduce residual emissions by up to -114.29 tons CO<sub>2</sub> per year, potentially transforming the area into a carbon-negative zone and advancing Banda Aceh's transition toward a low-carbon city.

**Keywords:** CO<sub>2</sub>, Net Zero Emission, Policy, Transportation, Vegetation

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## INTRODUCTION

Global warming has become a prominent issue over the past few decades. The significant increase in the earth's average temperature is heavily influenced by the greenhouse gas (GHG) effect. Carbon dioxide (CO<sub>2</sub>) is responsible for over 75% of GHG emissions and is the largest contributor to global warming (Labiba & Pradoto, 2018). Urban areas generate approximately 60-70% of these emissions, with the transportation sector, particularly motor vehicles, being a major source (Albuquerque et al., 2020; Kim, 2018).

The 2015 Paris Agreement saw nations commit to maintaining the earth's average temperature below 2°C to mitigate climate change impacts. This commitment led to the rise of Net Zero Emission (NZE) policies. The Indonesian government has pledged to reduce GHG emissions by 29% independently and 41% with international support by 2030. This commitment is reinforced through local initiatives, such as Banda Aceh City's Regional Action Plan for GHG Reduction (RAD-GRK Kota Banda Aceh 2020-2025).

As the capital of Aceh Province, Banda Aceh has expanded southward, particularly into the New City Center in Batoh area, following the 2004 tsunami. Consequently, traffic has surged along main arteries like Mr Teuku Muhammad Hasan Street. CO<sub>2</sub> emissions from the transportation sector in Banda Aceh have risen from 242,577 tCO<sub>2</sub>eq in 2011 to 285,321 tCO<sub>2</sub>eq in 2019 (RAD GRK Kota Banda Aceh 2020-2025). This increase underscores the need for effective emission reduction strategies to ensure future quality of life.

In this context, Low Carbon Development (LCD) and NZE have become essential frameworks for promoting sustainable growth with lower energy and carbon usage. For Banda Aceh, particularly in the New City Center area, these frameworks provide a pathway to address pollution and reduce emissions through effective policies. Compared to the more congested Old City Center, the New City Center offers greater flexibility for implementing low-carbon initiatives, such as (1) Expanding green open spaces (GOS) to enhance CO<sub>2</sub> absorption and (2) Enhancing public transportation, specifically the Trans Koetaradja bus system. These strategies support the NZE goal of balancing CO<sub>2</sub> emissions with absorption, ultimately aiming to transform the New City Center into a carbon-negative zone and advancing Banda Aceh's aspiration to become a low-carbon city.

To achieve these goals effectively, conducting an emission inventory—a detailed record of air pollutants within a specific area and timeframe—is crucial. This inventory aligns with international standards, such as the 2019 IPCC Guidelines for GHG Inventories (Purwanto et al., 2015), and serves as an essential step in managing urban air quality. It ensures Banda Aceh's strategies meet national and global emissions reduction benchmarks.

## LITERATURE REVIEW

### Indonesia's Principles in Implementing the NZE Concept

To reduce its carbon footprint and achieve Net-Zero Emissions (NZE), the Indonesian government adheres to five main principles:

1. Increasing the use of renewable energy replacing fossil fuels with renewable energy sources.
2. Reducing fossil energy consumption.
3. Promoting the use of electric vehicles.
4. Enhancing electricity utilization.
5. Implementing Carbon Capture and Storage (CCS) technology to capture industrial carbon emissions.

This research focuses on principles 2 and 5, referencing the Resilience Development Initiative (RDI) & Greenpeace Indonesia (2022) study on Jakarta's transportation transformation, which implemented emission reduction policies by improving public transportation services and efficiency to reduce private vehicle use. While CCS technology is beneficial, plant-based carbon absorption is more cost-effective and environmentally beneficial.

### Carbon Absorption Capacity of Vegetation

Planting vegetation is an effective strategy for reducing CO<sub>2</sub> emissions (RAD-GRK Kota Banda Aceh 2020-2025). The CO<sub>2</sub> absorption capacity varies by tree species. The list of vegetation along the Mr. Teuku Muhammad Hasan Street and its absorption ability is shown in the following table.

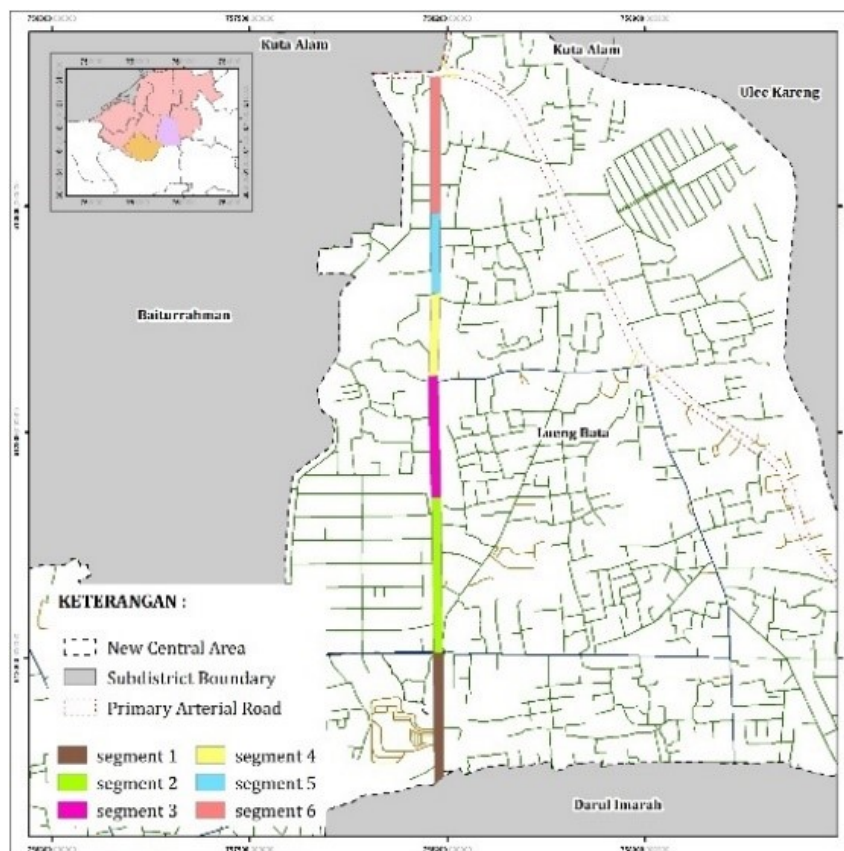
**Table 1:** CO<sub>2</sub> Absorption Capability Based on Tree Species

No.	Name	Scientific Names	CO <sub>2</sub> Absorption (kg/tree/year)
1	Trembesi <sup>(1)</sup>	<i>Samanea Saman</i>	28,448.39
2	Tabebuia Kuning <sup>(1)</sup>	<i>Tabebuia aurea</i>	135.27
3	Flamboyan <sup>(1)</sup>	<i>Delonix regia</i>	42.2
4	Tanjung <sup>(1)</sup>	<i>Mimusops elengi</i>	34.29
5	Angsana <sup>(1)</sup>	<i>Pterocarpus indicus</i>	11.12
6	Asam <sup>(1)</sup>	<i>Tamarindus indica</i>	1.49
7	Ketapang Kencana <sup>(2)</sup>	<i>Terminalia mantaly</i>	23.48
8	Glodokan Tiang <sup>(3)</sup>	<i>Polyalthia longifolia</i>	602.03
9	Palem Raja <sup>(3)</sup>	<i>Roystonea regia</i>	31.87
10	Mimba <sup>(4)</sup>	<i>Azadirachta indica</i>	126.51
11	Ketapang <sup>(5)</sup>	<i>Terminalia catappa</i>	105.87
12	Palem <sup>(6)</sup>	<i>Arecaceae</i>	52.52
13	Cemara <sup>(6)</sup>	<i>Casuarinaceae</i>	394.2
14	Pohon Kuda-Kuda <sup>(7)</sup>	<i>Lannea coromandelica</i>	60.00

Source : (1) Dahlan (2007); (2) Febriansyah et al. (2022); (3) Trisandy (2018); (4) Setyowati et al. (2020); (5) Milantara & Gustin (2023); (6). Suryaningsih et al. (2015); (7) Trisetio (2022)

## RESEARCH METHODOLOGY

This study was conducted in the new city center in Batoh area, Banda Aceh City, specifically along the 2.49 km stretch of Mr. Teuku Muhammad Hasan Street, from Surabaya Intersection to Batoh Bus Station. This road was divided into six segments (**Figure 1**) based on signalized and non-signalized intersections, significantly affecting traffic movement in each segment.



**Figure 2.** Map of The Mr. Teuku Muhammad Hasan Street Segment  
*Source: Map elaborated from The Regional Development Planning Agency of Banda Aceh*

Surveys were conducted to collect data on traffic and vegetation on weekdays and weekends during four peak periods: 8-9 AM, 12-1 PM, 4-6 PM, and the evening peak at 8-10 PM. The research employed a quantitative approach with descriptive analysis to summarize data and formulate CO<sub>2</sub> emission reduction policies and spatial analysis to understand the distribution patterns.

## CO<sub>2</sub> Emission Calculation

The emission calculation used the Tier 1 approach, leveraging activity data from global sources and default emission factors:

$$Em = n \times l \times Kes \times KE \times EF \quad (1)$$

Description:

$Em$  = Emission per hour (kg)

$n$  = Number of vehicles

$l$  = Length of road segment (km)

$Kes$  = Specific energy consumption (liter/km)

$KE$  = Energy conversion (MJ/liter)

$EF$  = Emission factor (kg/MJ)

**Table 2:** Specific Energy Consumption of Vehicles

Vehicle Type	Specific Energy Consumption (liters/Km)
Car	0.118
Bus	0.169
Mini Bus	0.118
Taxi	0.109
Truck	0.158
Pick-Up	0.081
Motorcycle	0.027

Source: Kusuma (2010)

Emission factors represent the weight of pollutants produced by fuel combustion of a certain amount of fuel over a specific period (Rohman, 2018).

**Table 3:** Energy Conversion Units and Emission Factors by Fuel Type

Fuel Type	Energy Content (MJ/liter)	Default Emission Factor (kg/Mj)
Gasoline	33	0.0693
Diesel	36	0.0741

Source: Kementerian Lingkungan Hidup (2012)

The results obtained represent emissions in kg/hour. Data on the number of active vehicles per day was required to calculate the total emissions in kg/year. Based on observations, active driving hours ranged from 6 AM to midnight or 18 hours/day. Therefore, the following formula was used to calculate annual emissions (Milantara & Gustin, 2023).

$$M = Em \times 18 \times 365 \quad (2)$$

Description:

$M$  = Total emissions (kg/year)

$Em$  = Emissions (kg/hour)

### **Absorption Capacity**

Based on Rawung (2015), vegetation absorption capacity is calculated as:

$$AC = n \times AC_{rate} \quad (3)$$

Description:

AC= Absorption capacity (ton/year)

n= Number of trees

AC<sub>rate</sub>= Absorption rate (ton/tree/year)

Unabsorbed emissions are derived from:

$$E_{unabsorbed} = E_{total} - AC \quad (4)$$

Description:

E<sub>unabsorbed</sub> = Unabsorbed emissions (ton/year)

E<sub>total</sub>= Total Emissions (ton/year)

AC= Absorption capacity (ton/year)

### **Formulation of CO<sub>2</sub> Emission Reduction Policies**

*Vegetation Addition Scenario*

Emission reduction from vegetation planting followed Rohman (2018):

$$E_{total} = N \times A_{co2} \quad (5)$$

$$E_{total} = \frac{L_{land}}{D_{plant}} \times A_{co2}$$

Description:

E<sub>total</sub> = Total CO<sub>2</sub> emission reduction (ton/year)

N = Number of trees planted

A<sub>co2</sub> = CO<sub>2</sub> absorption rate per tree (ton/year)

L<sub>land</sub> = Land area required

D<sub>plant</sub> = Planting distance per tree

The planting distance adhered to the Regulation of Minister of Public Works of Indonesia Number 05/PRT/M/2012), which categorized the planting distance as follows:

- Large trees : 6 meters
- Small trees (shrubs) : 2 meters
- Bushes : 0.3 meters
- Vine bushes : No specific distance



### **Optimization Scenario of BRT-Trans Koetaradja Usage**

This study proposed an optimization scenario for BRT by increasing the bus arrival frequency to every 10 minutes. With a maximum capacity of 80 passengers per bus, 6 buses would operate every hour, accommodating up to 480 passengers per hour. Assuming that, on average, one private vehicle carries one passenger, the reduction in private vehicles was calculated:

$$RPV = \%RPV_{usage} \times 480(6)$$

Description:

$RPV$  = Reduction in private vehicles (units)

$\%RPV_{usage}$  = Percentage of private vehicle usage

Next, calculate the reduction in CO<sub>2</sub> emissions from private vehicles:

$$T_{reduction} = RPV \times l \times Kes \times KE \times EF(7)$$

Description:

$T_{reduction}$  = Total emission reduction (ton/year)

$RPV$  = Reduction in private vehicles (units)

$l$  = Road Length (km)

$Kes$  = Specific energy consumption (liter/km)

$KE$  = Energy conversion (MJ/liter)

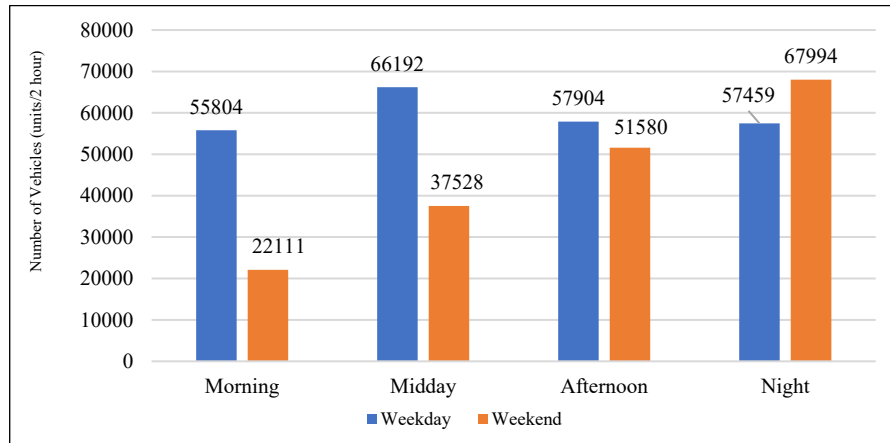
$EF$  = Emission Factor (kg/MJ)

## **RESULT AND DISCUSSION**

The Batoh Area, designated as Banda Aceh's New City Center in the city's Spatial Masterplan, serves as a commercial, residential, and office hub with a type 1 main terminal. Dominated by trade and services in the first layer and residential zones in the second, this mixed land-use configuration drives high traffic volumes along Mr Teuku Muhammad Hasan Street.

### **Traffic Flow on Mr. Teuku Muhammad Hasan Street**

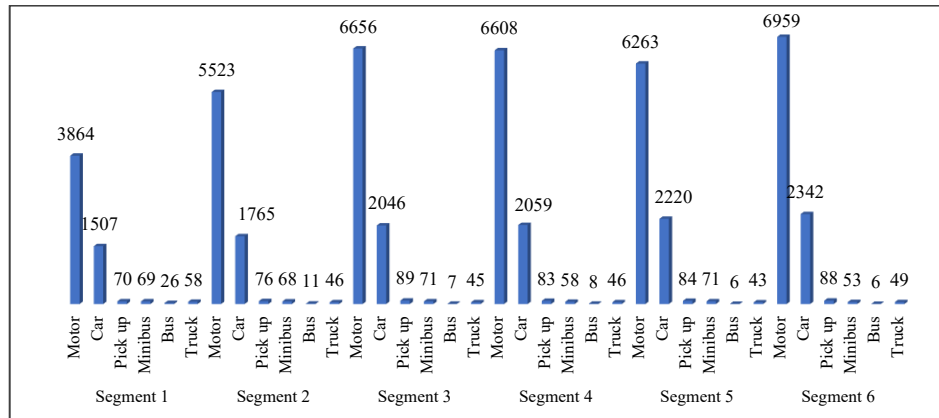
The average vehicle counts per segment along Mr Teuku Muhammad Hasan Street is displayed in **Figure 2**.



**Figure 3.** Traffic Flow Graph of Mr. Teuku Muhammad Hasan Street

Based on the graph above, traffic flow along Mr. Teuku Muhammad Hasan Street varies between weekdays and weekends. On weekdays, traffic fluctuates during four peak periods, reflecting daily activity patterns in the area. The morning period (8-9 AM) shows increased traffic flow as people begin daily activities such as commuting to work or school, though this increase is less pronounced than during midday. The midday period (12-1 PM) reaches peak traffic volumes due to commercial, business, and social activities, including lunch breaks and shopping. These weekday patterns demonstrate how regular schedules and routines influence traffic movement dynamics.

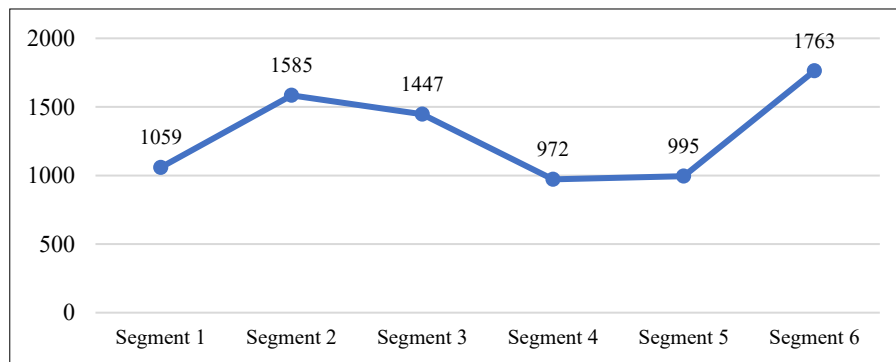
Weekend traffic patterns differ significantly, with smoother morning flow as residents begin activities later in the day. However, from midday through the evening, a substantial increase occurs, peaking between 8-10 PM due to heightened commercial and recreational activities. When commercial activity peaks, this results in greater road congestion during afternoon and nighttime hours. While initial weekend traffic appears lighter, vehicle numbers ultimately surpass weekday volumes. Analysis shows personal vehicles, particularly motorcycles, dominate all segments, with segment 6 recording the highest count at 6,959 units. The average number of vehicles per segment on Mr Teuku Muhammad Hasan Street is displayed in **Figure 3**.



**Figure 4.** Vehicle Volume Graph for Each Segment

### CO<sub>2</sub> Emission and Absorption Inventory

The relationship between traffic flow and CO<sub>2</sub> emissions is direct and proportional, with increased traffic volume generating higher emissions.



**Figure 5.** Annual CO<sub>2</sub> Emissions Production Graph

**Figure 4** reveal significant variation in emissions production across different road segments. Segment 6 produces the highest emissions at 1,762.91 tons/year, while segments 4 and 5 show the lowest levels at 88.9 tons/year and 995 tons/year, respectively. These disparities suggest that emission levels are influenced by factors beyond simple vehicle counts, including vehicle type, fuel type, and segment length. Total CO<sub>2</sub> emissions for the study area amount to 7,820 tons/year, as illustrated in **Figure 5a**.

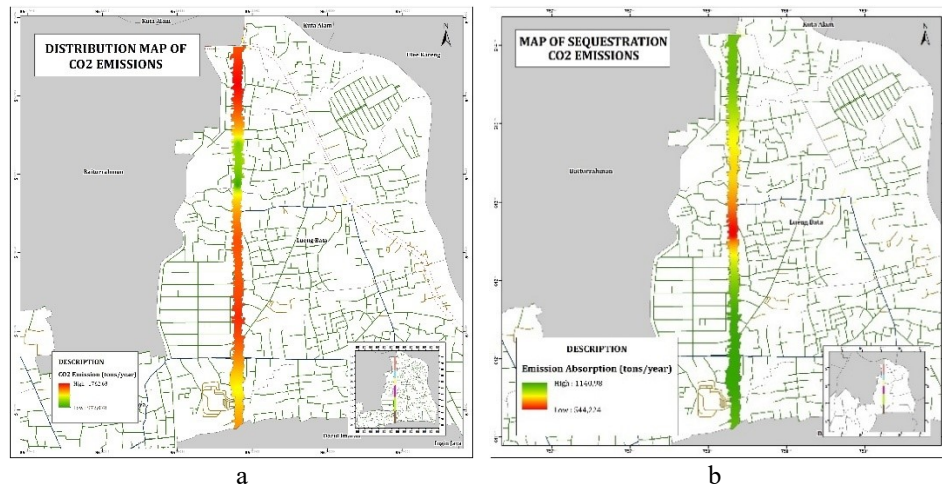


Figure 6. a) CO2 Emissions Distribution Map; b) CO2 Absorption Distribution Map

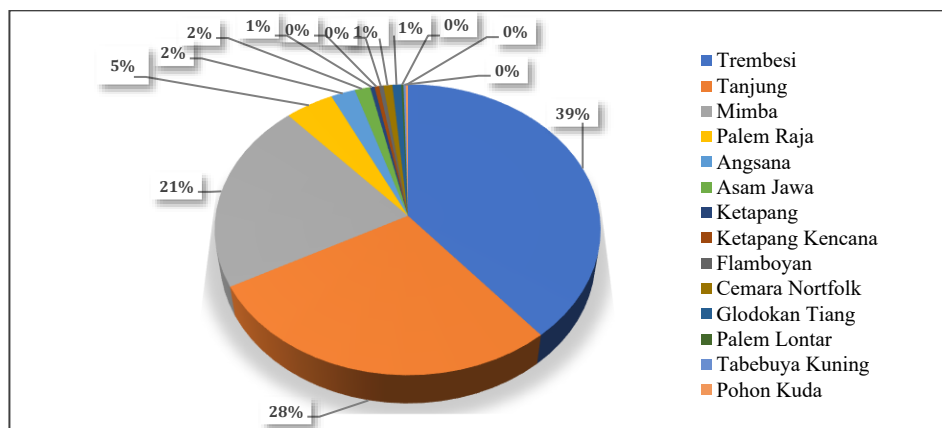
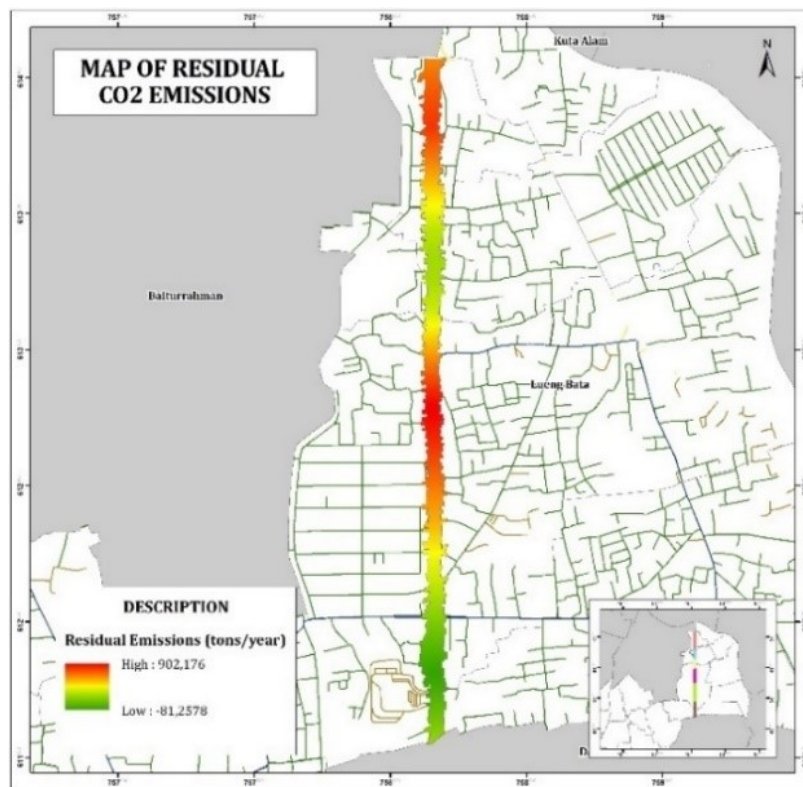


Figure 7. Percentage of Trees in the Green Belt of Mr. Teuku Muhammad Hasan Street

Urban vegetation, particularly roadside trees, plays a crucial role in CO<sub>2</sub> absorption, helping to mitigate air pollution and improve urban air quality (Milantara & Gustin, 2023). The analysis of the green belt along Mr Teuku Muhammad Hasan Street identified 14 different plant species totaling 491 individual trees. By multiplying the quantity of each tree species as shown in **Figure 6** by its specific absorption rate (Rohman, 2018), the total CO<sub>2</sub> absorption capacity was calculated. Segment 1 shows the highest absorption at 1,140.2 tons/year, with the entire study area vegetation absorbing 5,143.71 tons/year collectively, as shown in **Figure 5b**.

However, a significant gap remains between emissions production and vegetative absorption capacity. The unabsorbed emissions, or residual emissions, amount to 2,676.17 tons/year, as illustrated in **Figure 7**, indicating that the green belt in this area is not fully effective in offsetting vehicle emissions.



**Figure 8.** Residual Emissions Distribution Map

This finding aligns with Milantara and Gustin's (2023) research in Padang City, where green belts along Khatib Sulaiman Street absorbed only 0.06% of CO<sub>2</sub> emissions. These consistent results underscore the limitations of urban green belts as standalone solutions and highlight the need for comprehensive mitigation strategies in urban planning frameworks.

### **CO<sub>2</sub> Emission Reduction Policies**

#### ***Increasing Vegetation in District-Level Green Open Spaces (GOS)***

The study results show that the role of green belts in CO<sub>2</sub> absorption is not optimal, with residual emissions of 2,676.17 tons/year unabsorbed. Based on these results, additional tree vegetation is needed to reduce CO<sub>2</sub> emissions from

transportation activities. The choice of tree species is based on the highest absorption capacity and suitability for planting in the location, referring to the Regulation of Minister of Public Works of Indonesia Number 05/PRT/M/2012), and previous study from Pratiwi (2020) and Rohman (2018). Five types of vegetation are recommended for planting in the GOS of the New City Center area: glodokan (*Polyalthia longifolia*), kenanga (*Canangium odoratum*), flamboyan (*Delonix regia*), mahoni (*Swietenia mahagoni*), and angšana (*Pterocarpus indicus*).

The planting of these five vegetation types is aligned with the GOS development plan in Lueng Bata District by 2029, as mentioned in the Banda Aceh City Green Open Space Masterplan 2029 document, specifically in Blang Cut, Batoh, and Lueng Bata villages. The addition of 23,05 hectares of city parks and 17,8 hectares of green belts is planned for green open space development in Lueng Bata District. The following is the scenario calculation for reducing CO<sub>2</sub> emissions by increasing vegetation in developing green belts and city parks.

**Table 4:** Recommendations for Vegetation Enhancement to the Green Belt

Tree Type	Area for GOS Development (Ha)	Land Requirement (Ha)	Planting Distance (Ha)	Total Trees	CO <sub>2</sub> Absorption Capacity (kg/tree/year)	Total CO <sub>2</sub> Absorption (tons/year)
a	b	c	d	e = c/d	f	g = e x f
Glodokan	12,46	5.0	0,0036	1,384	602.03	833.48
Flamboyan		3.7		1,038	42.2	43.82
Mahoni		2.5		692	295.73	204.71
Angšana		1.2		346	11.12	3.85
<b>TOTAL</b>				<b>3,461</b>		<b>1,085.85</b>

Source: Analysis Result (2024)

**Table 5:** Recommendations for Vegetation Enhancement to City Parks

Tree Type	Area for GOS Development (Ha)	Land Requirement (Ha)	Planting Distance (Ha)	Total Trees	CO <sub>2</sub> Absorption Capacity (kg/tree/year)	Total CO <sub>2</sub> Absorption (tons/year)
a	b	c	d	e = c/d	f	g = e x f
Flamboyan	18.44	9.2	0,0036	2,561	42.2	108.08
Kenanga		6.1		1,707	756.59	1,291.81
Angšana		3.1		854	11.12	9.49
<b>TOTAL</b>				<b>640</b>		<b>1,409.38</b>

Source: Analysis Result (2024)

The recommendations for expanding green open space for city parks and green roadways at the district level follow the Ministerial Regulation of ATR/BPN Number 14 of 2022. This regulation stipulates that district park green cover should be 80%, and green roadways should have 70% green cover. The

planting distance is adjusted according to the Regulation of Minister of Public Works Number 5/PRT/M/2012, recommending that large trees be planted 6 meters apart, requiring a land area of 36 m<sup>2</sup> or 0.0036 hectares per tree.

The scenario of GOS development through vegetation enhancement in the study area is estimated to absorb 2,495.23 tons of CO<sub>2</sub> annually. Nevertheless, a residual emission of 180.93 tons of CO<sub>2</sub> per year remains. These results indicate that the GOS development alone is insufficient to fully mitigate transportation-related emissions. Therefore, additional mitigation strategies are essential to achieve the zero-emission target within the area.

### ***Optimization of Trans Koetaradja Public Transportation***

Personal vehicles, such as motorcycles and cars, are the largest contributors of emissions in the New City Center Area. The greenhouse gas (GHG) emission reduction strategy for the transportation sector in Banda Aceh, as outlined in the 2020-2025 Regional Action Plan for GHG Reduction, can be optimized by developing the Bus Rapid Transit (BRT) system. According to Anisah (2022), BRT is a strategic public policy designed to reduce reliance on private vehicles and support of low-carbon initiatives. Similarly, Abdullah et al. (2024) emphasized that public transportation serves as a governmental policy to decrease carbon emissions and preserving environmental quality, especially in urban areas.

The Government of Aceh Province operated Trans Koetaradja, a BRT-lite system, in 2016 to reduce private vehicles use. However, the system has yet to effectively curb the growth of personal vehicles, especially motorcycles. Optimizing the system, coupled with strategic land use management in the Batoh area, could significantly lower GHG emissions in Banda Aceh. The following scenario estimates the reduction in private vehicles use and corresponding emissions along Mr Teuku Muhammad Hasan Street, assuming optimal operation of Trans Koetaradja system based on the average vehicle count data.

**Table 6:** Reduction in Private Vehicle Numbers

Vehicle Type	Private Vehicle Usage (units/hour)	%	Trans Koetaradja BRT Units (units/hour)	Passengers per Bus	Passengers per Hour	Total Reduction in Private Vehicles (units/hour)
a	b	c	d	e	f = d x e	g = c x f
Motorcycles	2.989	73 %	6	34	204	149
Cars	995	24 %				49
<b>TOTAL</b>						<b>198</b>

*Source: Analysis Results (2024)*

**Table 7: Reduction in CO2 Emissions**

Vehicle Type	Reduction in Private Vehicles (units/ hour)	Road Length (km)	Fuel Consumption (l/km)	Energy Conversion (MJ/l)	Emission Factor (kg/MJ)	Total CO <sub>2</sub> Reduction (kg/jam)
a	b	c	d	e	f	g
Motorcycles	149	2,49	0,027	33	0,0693	22,91
Cars	49		0,118			32,92
TOTAL						55,83

*Source: Analysis Results (2024)*

According to Ryansyah (2018), Trans Koetaradja buses arrives at the stop every 10 minutes or six busses per hour with a maximum capacity of 80 passengers per bus. However, this figure is considered overestimated under real operating conditions. A more realistic figure of 34 passengers per bus reflects the average active ridership during peak periods. Based on traffic analysis during weekdays and holidays, the average number of motorcycles is 73% of 4,087 total vehicles or 2,989 units, while the average number of cars is 24.3% or 995 units. Assuming each private vehicle (motorcycle or car) carries only one passenger, 204 bus passengers per hour could replace an equivalent number of private vehicles on the road.

The Trans Koetaradja system operates 14 hours daily, from 6:00 AM to 8 PM, amounting to 5,110 operating hours annually. With the optimization of BRT use along Mr. Teuku Muhammad Hasan Street, it is estimated that annual CO<sub>2</sub> emissions reduced by approximately 285,29 tons CO<sub>2</sub>/year. Previous analysis indicates that the remaining emissions in the area are about 181 tons per year. However, with further optimization of BRT Koetaradja operations, these remaining emissions could be reduced to a negative value of -114.29 tons CO<sub>2</sub> per year.

## CONCLUSIONS

The results indicate that motorized transportation in the New City Center area in Batoh, Banda Aceh, generates 7,820 tons CO<sub>2</sub> annually. In contrast, the existing greenway vegetation absorbs only 5,143.71 tons CO<sub>2</sub> per year, leaving 2,676.17 tons/year of unabsorbed emissions. To mitigate the residual emission, it is recommended to enhance vegetation in district-scale Green Open Spaces (GOS) and optimize the use of Trans Koetaradja public transportation system. These combined measures could reduce emissions by up to -114.29 tons/year, with the negative value indicating that CO<sub>2</sub> absorption exceeds the generated emissions. This outcome aligns with the Net Zero Emission target of the 2015 Paris Agreement, establishing the New City Center area as a negative carbon zone.



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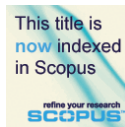
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## **MEASURING RESIDENTS' INTENTION TO ENERGY RETROFIT EXISTING RESIDENTIAL BUILDINGS: SCALE DEVELOPMENT AND VALIDATION**

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### **Abstract**

Residential building energy retrofitting (RBER) is essential for enhancing energy efficiency in homes. The intention of residents to undertake energy retrofits has increasingly attracted the attention of governments and construction firms. This study develops and tests a multidimensional Residential Building Energy Retrofit Intention Scale (RBERIS) to identify the critical dimensions influencing residents' intentions to adopt energy retrofit technologies for improving the energy efficiency of their existing homes. Drawing on literature related to scale development and measurement theory, we created a 22-item, 4-dimensional scale encompassing retrofit motivation, attitude, subjective norms, and perceived behavioural control, supported by evidence of unidimensionality (all factor loadings  $>0.5$ ) and reliability (Cronbach's  $\alpha >0.7$ ). The RBERIS reliably and effectively assesses residents' intentions to undertake RBER, assisting building energy retrofit companies and promoters in formulating development strategies and offering new insights into understanding these behavioural intentions. Future research directions are also discussed.

**Keywords:** Residential Building Energy Retrofit, Retrofit Intention, Scale Development, Intention Survey, Validation

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## **INTRODUCTION**

Reducing energy loads in residential buildings is a critical issue in urban planning (Hamzah et al., 2023). These structures encompass various forms, including detached houses, semi-detached houses, townhouses, and multi-story apartments. Their energy efficiency significantly varies due to differing construction phases, necessitating retrofitting to meet net-zero standards (Zawawi et al., 2024). Enhancing energy efficiency can effectively reduce urban energy demand and bolster energy security.

Residential building energy retrofit (RBER) is a regenerative technology essential for improving the energy performance of these buildings (Liu et al., 2023). However, global adoption of RBER remains limited (Zhang et al., 2021), resulting in many residential buildings exhibiting "high energy consumption and low comfort," which adversely affects residents' quality of life and health (Gillingham et al., 2021). Consequently, promoting RBER adoption and understanding retrofit intentions are crucial (Li et al., 2022).

Retrofit intention serves as a precursor to implementation, reflecting self-reported predictions about future retrofit behaviours. It can be defined as the extent to which individuals are willing to invest effort into implementing RBER (Conradie et al., 2023), encompassing their motivations, attitudes, and specific plans (Irfan et al., 2021). Such behavioural intention primarily arises from residents' cognitive evaluations and rational judgments regarding RBER, rather than from emotions or habits. The stronger the intention, the more likely residents are to engage in retrofit behaviours (Klößner and Nayum, 2017).

Current research on measuring retrofit intention predominantly concentrates on singular dimensions, such as residents' willingness to pay (Huang et al., 2021) or their desire to adopt retrofits (Fernandez-Luzuriaga et al., 2022). While these behavioural intentions are relevant to RBER implementation, they address distinct aspects; for instance, a willingness to accept a retrofit does not necessarily imply a willingness to pay for or cooperate in its execution. Few studies have employed a multidimensional approach, and issues with mapping effectiveness remain (Bakaloglou & Belaïd, 2022). Existing scales often lack comprehensive coverage, failing to capture the diverse facets of retrofit intention, which may contribute to the intention-behaviour gap in RBER. Thus, an effective tool for evaluating residents' intentions to engage in RBER is still needed.

To address this gap, we have developed an instrument for measuring and quantifying RBER behavioural intention, termed the Residential Building Energy Retrofit Intention Scale (RBERIS). This study aims to outline development process of this instrument, report its reliability and validity, and provide insights into retrofit intentions.

## **LITERATURE REVIEW**

### **Theoretical Framework of RBERIS**

Understanding residents' intention to undertake Residential Building Energy Retrofit (RBER) has yet to reach a consensus, as various theories offer different insights. Research has primarily drawn from the Theory of Planned Behaviour (TPB) (Conradie et al., 2023), the Diffusion of Innovations (DoI) (Alam et al., 2014), and the MOA model (Bjørneboe et al., 2018). TPB, developed by Ajzen(1991), explains retrofit intention through psychological factors and rational decision-making. The three dimensions of retrofit intention—attitude towards retrofitting, subjective norms regarding retrofitting, and perceived behavioural control—account for 70.2% of the overall variance in retrofit intention (Scott et al., 2014). The Stieß model (Stieß et al., 2009) and the Michelsen model (Michelsen & Madlener, 2010), both based on TPB, have been employed to investigate the drivers and barriers of RBER (Miller et al., 2018; Stieß & Dunkelberg, 2013). Consequently, the structure of the scale developed in this study is primarily informed by TPB.

However, the theory of TPB does not fully address how residents develop a need for RBER, particularly regarding their motivations, which encompass triggers, interests, and needs. This aspect is critical for understanding technology adoption, as highlighted by the DoI theory (Broers et al., 2019; Wilson et al., 2018). Even if residents possess a positive attitude towards RBER, align with social norms, and have the resources for retrofitting, they may still lack motivation, especially if their building already achieves net-zero energy emissions. This can lead to biased measurement results. Therefore, incorporating retrofit motivation into TPB can enhance its explanatory power and provide a more comprehensive understanding of retrofit intention (Klößner & Nayum, 2016; Stieß & Dunkelberg, 2013).

### **Conceptualisation of the Dimensions of RBERIS**

#### ***Retrofit Motivation***

Retrofit motivation refers to the internal drivers that prompt residents to undertake RBER, including needs and desires. It serves as an incentive for behaviour, explaining why residents engage in RBER. Bjørneboe et al. (2018) identified that motivation is a prerequisite for retrofit behaviours, such as achieving energy cost savings and enhanced thermal comfort. A stronger motivation is positively correlated with higher RBER intensity (Baumhof et al., 2018). Sources of motivation include external rewards, internal rewards, and the desire to maintain a positive self-concept. Economic and non-economic indicators, such as energy cost savings, property value, residential comfort, and environmental protection, also play significant roles (Ebrahimigharehbaghi et al., 2022).

### ***Retrofit Attitude***

Retrofit attitude can be assessed using two indicators. The first indicator is residents' approval of RBER, evaluated based on its perceived value, which includes reducing energy costs, protecting the environment, and enhancing residential quality (He et al., 2019; Klöckner & Nayum, 2017). The second indicator is residents' willingness to undertake RBER, which is reflected in positive emotions and enthusiasm following the retrofit (Tan et al., 2023).

### ***Subjective Norms to Retrofit***

Subjective norms refer to the social pressures that influence decisions regarding RBER (Klöckner & Nayum, 2017). These pressures can arise from external sources, such as demands from organisations or individuals, as well as internal sources, such as personal psychological needs to conform after observing the decisions of others. Assessment can be made using two indicators: external demands and expectations from decision-making advisors, public organisations, or institutions, and self-imposed requirements stemming from the internalisation of external information or personal values (Conradie et al., 2023).

### ***Perceived Behavioural Control to Retrofit***

This dimension involves individuals' perception of factors that facilitate or hinder RBER, including confidence and resource control (Alam et al., 2014). The first indicator is confidence in the implementation of retrofits, which is divided into self-confidence and the ability to meet expected outcomes (Li et al., 2022). The second indicator pertains to control over necessary resources, such as funding, time, capabilities, and technical knowledge (Goh et al., 2024; Stieß & Dunkelberg, 2013).

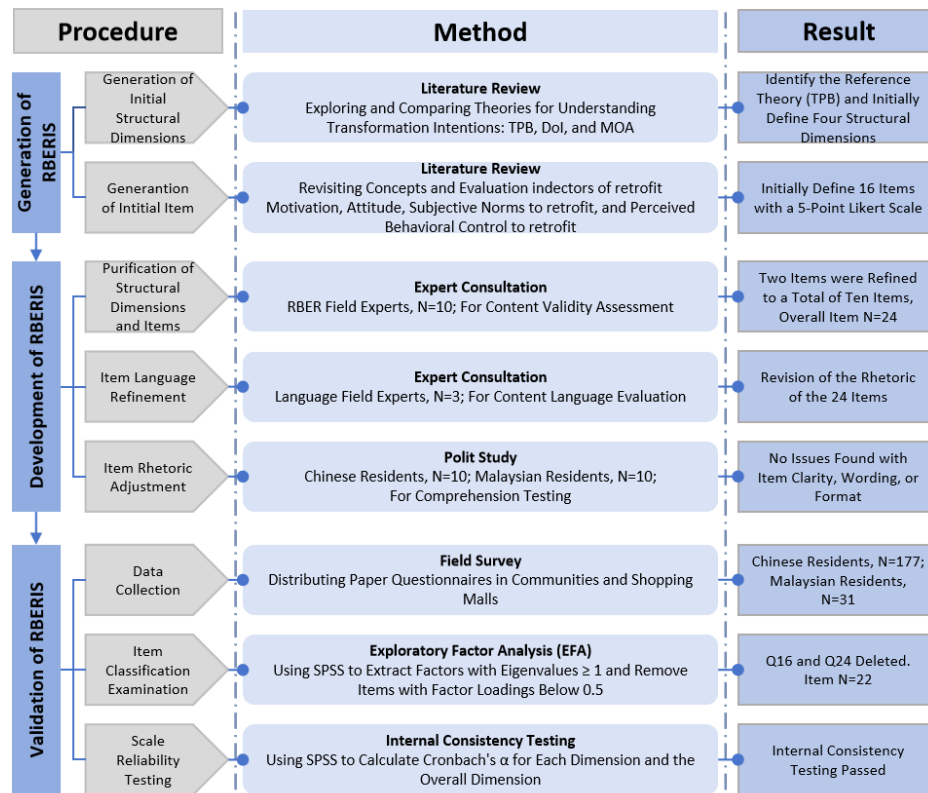
## **METHODS**

The scale was developed based on the paradigm proposed by Churchill (1979) and informed by the scale development processes outlined in Mishra et al. (2022) and Yu et al. (2022). Figure 1 illustrates the primary process from development to validation of the instrument. The following sections provide a detailed elaboration of this process.

### **Generation of RBERIS**

The first step involved developing the structural dimensions, items, and scales of the RBERIS. A comprehensive literature review identified the structural dimensions related to retrofit motivation, attitude, subjective norms, and perceived behavioural control. Subsequently, we drafted 16 items for the RBERIS, ensuring that each item covered the conceptual content of its respective dimension. The items were evaluated using a five-point Likert scale, with ratings

ranging from 1 to 5. Scales were tailored to each dimension, with "not at all strong" to "very strong" for retrofit motivation, and "strongly disagree" to "strongly agree" for attitude, subjective norms, and perceived behavioural control. The mean score of each dimension indicated the respondent's level within that dimension, with possible scores ranging from 1 to 5. The sum of the mean scores across all dimensions represented the overall level of retrofit intention, yielding a total score range of 4 to 20. This score was categorised into five levels: very low (4–7.2), low (7.2–10.4), moderate (10.4–13.6), high (13.6–16.8), and very high (16.8–20).



**Figure 1: Scale Development Process**

### Development of RBERIS

Experts (n=11) in the RBER field reviewed and refined the initial draft of the study, focusing on content validity (Jenn, 2006). They assessed the representativeness of the structural dimensions in capturing retrofit intention and identified any redundancies or omissions in the items. While the four structural dimensions were retained, the number of items was modified. Specifically,



additional items were added to the retrofit motivation dimension to address the limitations of simple self-reporting by presenting potential retrofit targets to respondents. This adjustment increased the motivation items from two (economic and non-economic motivations) to nine. A semi-open item was also recommended to capture other potential motivations, bringing the total number of items to 24.

Language experts (n=3) reviewed the wording and sequence of the scale items in Chinese and English to ensure clarity, conciseness, and accuracy. The items were further adjusted, simplified, and standardised in the first person for improved comprehension (Gonzalez-Franco & Peck, 2018). A pilot study involving ten residents from China and Malaysia was conducted to evaluate the clarity and potential ambiguity of the items. Chinese residents reviewed the Chinese version, while Malaysian residents reviewed the English version. Feedback indicated that respondents understood the items clearly, without ambiguity.

Following statistical validation, the finalised scale was employed for data collection, as detailed in Table 1. The survey included this scale alongside an information page, which provided an overview of the survey's purpose, confidentiality terms, and a brief introduction to the concept and scope of RBER. It distinguished RBER from simple building renovations or daily energy-saving behaviours, emphasising substantial physical modifications to residential buildings (Vasseur et al., 2019).

**Table 1:** The proposed RBERIS scale adapted from literature review and experts' validations

Dimension	Indicator	NO.	Item	Format Reference
Retrofit Motivation	Save energy costs	Q1	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to save on energy costs?	(Touré-Tillery & Fishbach, 2014)
	Increase property value	Q2	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to increase its value?	
	Enhance property marketability	Q7	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to make it more marketable?	
	Improve living comfort	Q8	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to improve living comfort?	
	Improve ventilation	Q13	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to improve ventilation?	
	Reduce noise	Q14	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to reduce noise?	
	Maintenance	Q18	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to maintain it?	
	Environmental protection	Q19	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to protect the environment?	
	Enhance property appearance	Q22	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home to enhance its appearance?	
	Other	Q24	How strong is my motivation to carry out energy-saving retrofits on my (or my family's) home for other reasons?	

Dimension	Indicator	NO.	Item	Format Reference
Retrofit Attitude	Acknowledgement of economic value	Q3	I believe that energy-saving retrofits on my (or my family's) home are beneficial for saving on energy costs.	(He et al., 2019; Klöckner & Nayum, 2017; Scott et al., 2014)
	Acknowledgement of environmental protection	Q9	I believe that energy-saving retrofits on my (or my family's) home are beneficial for saving energy and protecting the environment.	
	Acknowledgement of improved living quality	Q15	I believe that energy-saving retrofits on my (or my family's) home are beneficial for improving the quality of living.	
	Acknowledgement of emotional value	Q20	I would feel pleased about carrying out energy-saving retrofits on my (or my family's) home.	
Subjective Norms to Retrofit	Self-imposed requirements	Q4	Due to my values/beliefs/sense of responsibility, I feel it is necessary to carry out energy-saving retrofits in my (or my family's) home.	(He et al., 2019; Irfan et al., 2021; Klöckner & Nayum, 2017; Scott et al., 2014)
	Advisors' hopes and expectations	Q10	People who can influence my decisions want me to carry out energy-saving retrofits on my (or my family's) home.	
	Public organisations' hopes and expectations	Q5	Some public organisations and institutions (e.g., government, environmental groups, media) want me to carry out energy-saving retrofits on my (or my family's) home.	
	Voluntariness after being influenced	Q11	Seeing people around me (neighbours, relatives, friends) carrying out energy-saving retrofits on their homes motivates/influences me.	
	Hopes and expectations of key individuals	Q16	People important to me want me to carry out energy-saving retrofits on my (or my family's) home.	
Perceived Behavioural Control to Retrofit	Self-confidence	Q6	I believe that I can carry out energy-saving retrofits on my (or my family's) home.	(Alam et al., 2014; He et al., 2019; Irfan et al., 2021; Klöckner & Nayum, 2017)
	Confidence in expected outcomes	Q12	I believe my life will improve after carrying out energy-saving retrofits on my (or my family's) home.	
	Perceived economic resources	Q17	I have enough funds for energy-saving retrofits on my (or my family's) home.	
	Perceived time resources	Q21	I have enough time for energy-saving retrofits on my (or my family's) home.	
	Perceived knowledge resources	Q23	I have enough knowledge (or support from professionals) to carry out energy-saving retrofits on my (or my family's) home.	

### Target Population

The target population for this study comprises homeowners and landlords who own completed properties and are the primary decision-makers regarding RBER. Participants must be 18 years or older, proficient in either Chinese or English, and of sound mental capacity. These criteria are essential for ensuring data quality and facilitating efficient questionnaire completion. Tenants and non-primary decision-makers are excluded from the study, as tenants generally lack obligations or responsibilities for RBER, which involves complex construction processes beyond typical tenant renovations (Scott et al., 2014).

### **Sampling and Data Collection**

This study employed convenience sampling to collect data from participants in China and Malaysia (n=208) between December 2023 and July 2024. In China, data were obtained from residents of Shanghai, Hangzhou, Hefei, and Shantou, resulting in 177 valid responses. In Malaysia, data were collected from Kuala Lumpur and Selangor, yielding 31 valid responses. Questionnaires were distributed and collected in person at malls and residential communities in these cities. The English version of the RBERIS was used in Malaysia, while the Chinese version was used in China. The questionnaire included a screening question to confirm respondents' role as the primary decision-makers for RBER. Those who did not meet this criterion were instructed to terminate the survey. The survey took approximately 8-15 minutes to complete; responses submitted in less than 5 minutes were deemed invalid, resulting in the exclusion of 21 samples.

### **Statistical Analysis**

In addition to presenting descriptive statistics for each dimension's scores, this study utilised SPSS version 26 to conduct several statistical analyses: First, Exploratory Factor Analysis (EFA) was performed using Principal Component (PCA) to identify the underlying factor structure of the scale and determine the factor loadings for each item. Factors with eigenvalues greater than 1 were extracted (Papadas et al., 2017), and Varimax rotation was applied. Variables with communalities below >0.3 were eliminated, and cross-loadings were reviewed to ensure that each item primarily loaded onto a single dimension. Items with factor loadings below 0.5 were removed (Lu et al., 2019), ensuring that each item contributed meaningfully to its respective dimension. Based on these criteria, both convergent and discriminant validity were assessed. Subsequently, Reliability Analysis was performed to evaluate the internal consistency of the scale, including both the overall scale and individual dimensions. Cronbach's  $\alpha$  values were calculated, with values greater than 0.7 indicating acceptable internal consistency (Marikyan et al., 2022).

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these criteria, both convergent and discriminant validity were assessed. Subsequently, Reliability Analysis was conducted to evaluate the internal consistency of the scale, encompassing both the overall scale and individual dimensions. Cronbach's  $\alpha$  values were calculated, with values exceeding 0.7 indicating acceptable internal consistency (Marikyan et al., 2022).

## RESULTS

The demographic characteristics of the surveyed residents are presented in Table 2. Participants' ages ranged from 24 to 75 years, with 37.5% reporting that their residences were over 20 years old. The majority of residences were multi-story apartments (149, 71.63%), while detached and semi-detached houses were the least common, comprising 8 (3.85%) and 7 (3.37%) of the total, respectively. The mean (SD) score for residents' intention toward RBER, as measured by RBERIS, was  $11.88 \pm 2.57$ .

**Table 2: Demographics and RBERIS Scores**

Participants- no. (%)	
China	177 (85.10)
Malaysia	31(14.90)
Age – year (SD)	47.97±13.48
Male - no. (%)	150 (72.12)
Construction Date of the House- no. (%)	
Within ten years (2014 to present)	34 (16.35)
10-20 years (2004 - 2013)	96 (46.15)
20-30 years (1994 - 2003)	36 (17.31)
31-40 years (1984 - 1993)	40 (19.23)
40 years or more (before 1984)	2 (0.96)
Housing Type- no. (%)	
Detached House	8 (3.85)
Semi-Detached House	7 (3.37)
Townhouse	31 (14.90)
Multi-story Apartment	149 (71.63)
Other Types	13 (6.25)
RBERIS (SD, excluding Q16 and Q24)	
Retrofit motivation	3.04±0.84
Retrofit attitude	2.64±0.86
Subjective norms to retrofit	3.22±0.76
Perceived behavioural control to retrofit	3.03± 1.01
Retrofit intention	11.92±2.60

The KMO value and Bartlett's Test of Sphericity yielded results of 0.993 and  $p = 0.000$ , respectively, indicating that the data were suitable for factor analysis (Shrestha, 2021). Using an eigenvalue cutoff of 1, the initial 24 items were grouped into four main components, accounting for a cumulative explained variance of 65.44%. All items, except for Q16 (Factor Loadings in  $D_3 = 0.49$ ) and Q24 (Factor Loadings in  $D_1 = 0.433$ ; Factor Loadings in  $D_2 = 0.405$ ), exhibited factor loadings greater than 0.5, indicating a positive correlation with their

respective dimensions. Loadings below 0.5 suggest a weaker contribution of the variable to the dimension (Lu et al., 2019); consequently, Q24 and Q16 were excluded. Subsequent EFA revealed that the cumulative explained variance increased to 68.34%, with the classification of the remaining items generally aligning with the preliminary structure of the RBERIS.

The internal reliability of the four dimensions and all items was assessed using Cronbach's  $\alpha$ , with results presented in Table 3. All values for the dimensions and the overall scale exceeded the reliability threshold of 0.7, indicating satisfactory internal consistency of the revised RBERIS. Furthermore, the factor correlation matrix showed that none of the correlation coefficients exceeded 0.7, demonstrating that the dimensions are sufficiently independent without excessive correlation.

**Table 3: Results of Reliability Testing**

Dimension	EFA Analysis Retained Item Numbers	Cronbach's $\alpha$ for Each Dimension	Overall Cronbach's $\alpha$
Retrofit motivation	Q1,Q2,Q7,Q8,Q13,Q14,Q18,Q19,Q22	0.919	0.930
Retrofit attitude	Q3,Q9,Q15,Q20	0.819	
Subjective norms to retrofit	Q4,Q10,Q5,Q11	0.909	
Perceived behavioural control to retrofit	Q6,Q12,Q17,Q21,Q23	0.909	

## DISCUSSION

Following the testing phase, the RBERIS retained four dimensions: retrofit motivation, attitude, subjective norms, and perceived behavioural control. Exploratory Factor Analysis (EFA) confirmed that the 24 items fit into these dimensions, supporting the initial structure and aligning with prior research on retrofit intention (Klöckner & Nayum, 2017). Item Q24 was removed from the motivation dimension due to cross-loading (0.433 on motivation and 0.405 on perceived behavioural control), which may have been caused by the extensive number of items in the motivation dimension or its semi-open nature. Additionally, Q16 was excluded for its low factor loading (0.490), indicating a weak fit with its dimension and misalignment with rational decision-making (Kastner and Stern, 2015).

After these adjustments, the RBERIS demonstrated acceptable discriminant validity and internal consistency. The motivation dimension now comprises nine items that focus on the respondents' motivations for RBER, a crucial factor influencing retrofit intention (Klöckner & Nayum, 2016; Wilson et al., 2018). The remaining three dimensions—retrofit attitude (4 items), subjective norms (4 items), and perceived behavioural control (5 items)—align well with respondents' views, values, and perceived capacity to undertake RBER, consistent with studies by Xiao et al. (2023) and Irfan et al. (2021).

Theoretically and practically, this study significantly contributes by addressing the need for tools that assess residents' intention to undertake RBER. It advances the literature by revealing that retrofit intention is multidimensional, emphasising the necessity of considering multiple factors when understanding and predicting these intentions (Klößner & Nayum, 2017; Wilson et al., 2018). By providing a structured approach to developing and evaluating tools for measuring retrofit intention, the study fills a critical gap in the literature. The rigorous scale development methodology ensures the reliability and validity of the RBERIS, identifying four key dimensions that capture the psychological complexity and latent aspects of residents' intentions to engage in RBER (Irfan et al., 2021). Furthermore, the RBERIS distinguishes itself from previous research on technology acceptance (Alam et al., 2014; Broers et al., 2019) by focusing specifically on retrofit intention and highlighting the importance of environmental and social considerations alongside utilitarian and hedonistic aspects. The identification of motivation as a crucial factor offers new insights, distinguishing RBERIS from earlier models.

Practically, the RBERIS serves as a valuable tool for practitioners, researchers, and policymakers. Practitioners can utilise the RBERIS to gauge and manage retrofit intentions, providing essential data for market research and investment planning, particularly in developing countries. For example, the study finds that respondents' retrofit intentions are moderate (score:  $11.92 \pm 2.60$ ), indicating limited market demand and suggesting caution in industry expansion, which aligns with expectations of energy-efficient retrofit progress in China, as noted by Jia et al. (2021). Researchers can analyse the impact of each RBERIS dimension to understand the obstacles residents face in undertaking retrofits, leading to more targeted recommendations for practitioners and policymakers. For instance, enhancing residents' attitudes toward RBER, which were found to be lower than motivation and perceived behavioural control, could be a key area for development. Additionally, RBERIS can assist government and public organisations in understanding and improving residents' views on RBER by assessing retrofit intentions across different regions, housing types, and development stages. This understanding can contribute to formulating more effective retrofit policies, reducing free-rider effects and promoting wider adoption (Egner et al., 2021). Finally, it supports resident self-assessment, enabling individuals to better understand their retrofit needs and conditions, leading to more informed decisions and robust support for family retrofit plans.

### **Limitations and Future Research**

The primary aim of this study was to develop and validate the RBERIS. However, several limitations must be acknowledged. Firstly, the sample size is relatively small, with data collected solely from China and Malaysia. This limitation may

affect the generalisability of the results and the applicability of practical recommendations for retrofit practices in other countries, particularly in developed regions. Secondly, the RBERIS is based on cross-sectional data, which means retrofit intentions may fluctuate due to changes in local policies, such as energy prices, retrofit subsidies, and loan policies (Wilson et al., 2018). As a result, the scale's ability to predict and assess these dynamic changes is limited.

These limitations highlight several areas for future research. Firstly, revalidation of the scale is necessary, focusing on different cultural and technological contexts and expanding the sample size to enhance its reliability and validity. Further research should explore residents' intentions to undertake RBER in varied empirical contexts to provide practical recommendations for promoting and implementing retrofit practices.

Secondly, future studies should develop models to understand retrofit intention more comprehensively by examining longitudinal changes from intention to actual retrofit behaviour. This approach will help elucidate the relationships and mechanisms of the RBERIS dimensions and enhance the understanding of behavioural intentions. Additionally, investigating retrofit intention from the perspectives of other stakeholders, such as community managers or government officials, could yield valuable insights. Incorporating objective measures, such as residents' daily energy-saving behaviours and pro-environmental indices, could also address the limitation of relying solely on self-reports.

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## **CYCLIST SAFETY: IDENTIFYING HIGH-RISK GROUPS THROUGH DATA ANALYSIS**

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### **Abstract**

Cycling has gained global popularity due to its health, environmental, and cost benefits; however, cyclist safety remains a significant concern. Understanding the factors contributing to risky cycling behaviours in Malaysia is therefore crucial for developing effective safety interventions. This study aimed to identify high-risk cyclist groups in Kuala Terengganu and Dungun, Terengganu, Malaysia, focusing on helmet non-use, reflective clothing non-use, and riding two abreast. A total of 2,205 cyclists were observed at eight locations over six days, revealing significant associations between behaviours and explanatory variables such as age, time of day, day of the week, speed, and road type, using a binary logistic regression model. Helmet non-use increased at speeds above 10 km/h, was less common among children and adolescents, and was less likely to occur during morning peak hours and on municipal roads. Non-use of reflective clothing increased during evening peak hours, was less common at speeds between 10 and 20 km/h and decreased on state roads. Riding two abreast was more common on weekdays and on state roads but less likely at speeds over 20 km/h and on municipal roads. The findings of this study may support the development of targeted interventions, including cyclist awareness programmes for specific groups, policy enforcement, promotion of safety gear, and other safety initiatives essential for improving cyclist safety.

**Keywords:** Cyclist Safety, Risky Cycling Behaviours, Helmet Non-Use, Reflective Cloth Non-Use, Riding Two Abreast

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## **INTRODUCTION**

Every year, approximately 1.35 million lives are lost due to road crashes, making it the eighth leading cause of death worldwide, based on the report from the World Health Organisation (WHO, 2024). Pedestrians and cyclists account for 26% of fatalities, with low-income countries experiencing threefold higher death rates due to inadequate infrastructure and traffic growth (Barajas, 2018; Cahen, 2016; Lusk et al., 2019; Nantulya & Reich, 2003). In contrast, high-income regions typically have better safety provisions, leading to fewer collisions. Factors contributing to these crashes include distracted drivers, elderly bicyclists, careless operations, and riding in dark conditions (Das et al., 2023). These insights are essential for implementing strategies to reduce injury rates and improve cyclist safety both globally and in Malaysia.

Cycling has gained considerable popularity over recent decades, supported by growing awareness of its health benefits, environmental advantages, and potential to address urban mobility challenges. Many cities and countries have actively promoted cycling to enhance liveability and sustainability, contributing to a marked rise in cycling levels. Mason et al. (2015) reported that countries such as the Netherlands, Germany, and Denmark experienced significant growth in cycling due to environmental awareness and the promotion of healthier lifestyles. In South Tangerang City, Indonesia, Almassawa et al. (2024) found that expanding bicycle lane networks could encourage greater bicycle use and support the implementation of smart mobility initiatives. A survey conducted in Putrajaya, Malaysia revealed that almost all respondents' agreed cycling is a form of sustainable transport (Hashim et al., 2017). This global trend reflects the increasing recognition of cycling as a practical, eco-friendly, and health-conscious mode of transport. It also highlights the urgent need for improved cycling infrastructure and the introduction of comprehensive safety policies to address risky behaviours and protect the growing number of cyclists. In Malaysia, for instance, a study in Shah Alam, Selangor identified weaknesses in the bicycle path infrastructure and its lack of compliance with established guidelines (Abdullah et al., 2020).

Many factors have been identified that are related to risky cycling behaviours. For example, a study by Radun and Olivier (2018) in Finland revealed that many cyclists do not wear helmets despite their benefits in reducing head injuries. They identified factors influencing these health beliefs, sociodemographic characteristics, and risk-taking tendencies. Meanwhile, a study by Hounkpè Dos Santos et al. (2022) discovered that adolescents often skip helmets to seek peer approval. Similarly, Piatkowski and Marshall (2020) asserted that college students often do not wear helmets due to low health belief scores and perceived barriers. Engbers et al. (2018) reported that not wearing reflective clothing significantly increases crash risk, especially in low visibility conditions. Similarly, Wang et al. (2020) stated that only a small percentage of

adult cyclists consistently wear reflective jackets at night. Addressing these details is crucial for effective safety interventions and educational programmes. Moreover, Abdur et al. (2021) and Fraser and Meuleners (2020) reported that riding two abreast can enhance cyclist visibility and safety. Useche et al. (2024) posited that demographic factors like age, education level, and urban setting predict traffic rule violations among cyclists. Notably, young motorcyclists who seek excitement and exhibit aggressive attitudes tend to ride riskily. Although there are fewer studies on cyclists, these traits also likely apply to young cyclists, making them a high-risk group.

## **METHOD**

### **Data Collection**

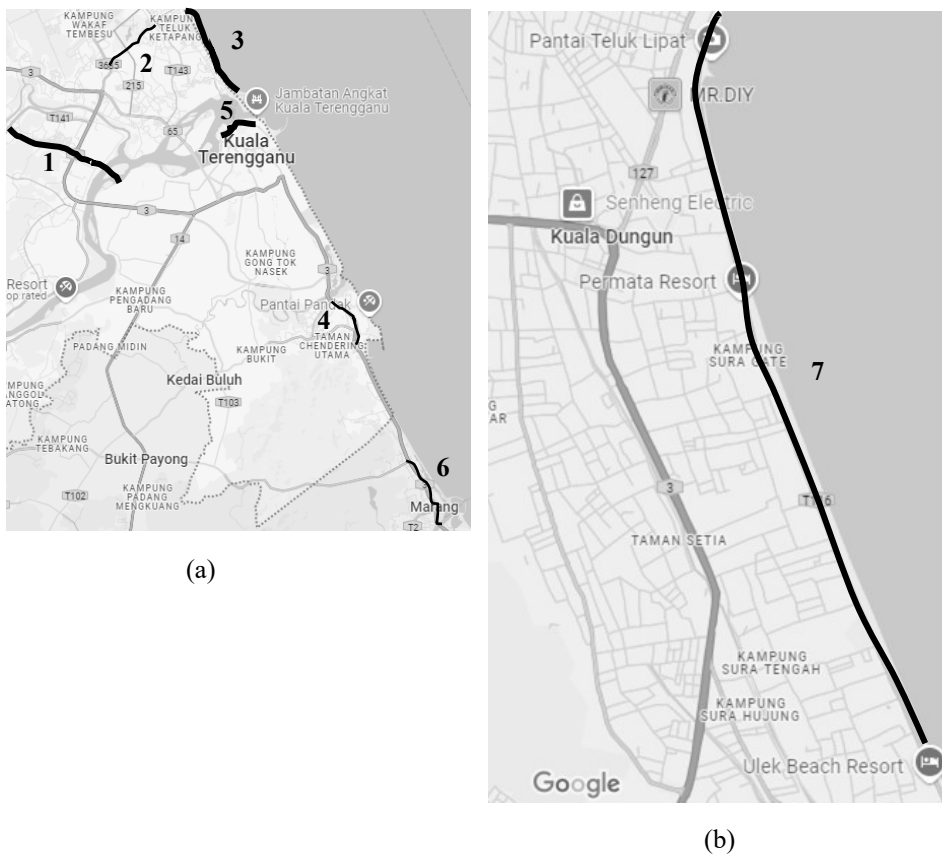
This research used a field observation survey conducted at seven road locations in Kuala Terengganu and Dungun, Terengganu, Malaysia, as displayed in Figure 1. Sites included two along (1) Kuala Terengganu Bypass Road, and one each on (2) Jalan Lapangan Terbang, (3) Jalan Pantai Teluk Ketapang, (4) Jalan Batu Buruk, (5) Jalan Balik Bukit, (6) Laluan Persekutuan 3, and (7) Jalan Pantai Sura in Dungun. The roads, classified as federal, state, and municipal, are managed by respective authorities. Observations were conducted from March 19th to March 22nd, 2021, during peak hours: 7:00-9:00 AM and 5:00-7:00 PM. To capture the effect of daily trends, this study was conducted on weekends (Friday and Saturday) and weekdays (Sunday to Thursday). It should be noted that Terengganu takes Friday and Saturday as their weekend. Clear weather was noted during the observations, and this variable was dropped from the further analysis of the same observations across days and times. Accordingly, seven research assistants have been appointed to collect data on risky behaviours, helmet, and reflective clothing non-use, and riding two abreast. They also recorded other information such as gender, age group, speed, bike type, time of the day, day of the week, and road type.

### **Data Analysis**

In this study, three different binary logistic regression models related to the three risky riding behaviours (helmet non-use, reflective clothes non-use, and riding two abreast) were estimated using seven explanatory variables: gender, age, time of the day, day of the week, speed, type of bike, and type of road. Binary logistic regression allows for examining multiple variables within a complex model. This study reported all three logistic regression models. Notably, binary logistic regression has been used in this study to predict the probability of a binary outcome based on one or more predictor variables. It applies a logistic function to transform the output to a probability between 0 and 1. This technique is useful for classification tasks where the dependent variable has two possible outcomes. Eq. 1 represents the binary logistic regression employed in this study.

$$Z = \log (p/(1-p)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \epsilon \quad (1)$$

where  $Z$  is the logit (log-odds) of the probability  $p$  of the binary logistic regression,  $p$  is the probability of the event occurring,  $p/(1-p)$  represents the odds of the event occurring, and  $\log (p/(1-p))$  is the natural logarithm of the odds, also known as the logit. Meanwhile,  $\beta_0$  is the intercept term,  $\beta_1, \beta_2, \beta_3 \dots$  are the coefficients corresponding to the predictor variables (gender, age, time of day, day of week, speed, type of bike, and type of road)  $X_1, X_2, X_3$ , and  $\epsilon$  is the error term.



**Figure 1:** Location of observations in (a) Kuala Terengganu, and (b) Dungun, Terengganu, Malaysia  
*Source: Google Maps (2025)*

## RESULTS

### Descriptive Analysis

Table 1 presents the distribution of risky behaviours among cyclists based on contextual and demographic factors. Helmet non-use was observed at similarly high rates among male (87.1%) and female (81.2%) cyclists. Across age groups, the highest percentage was recorded among adults (87.4%), followed by adolescents (68.7%) and children (68.5%). Helmet non-use was consistently prevalent during peak hours, with 87.7% recorded in the morning and 85.0% in the evening. Rates were also comparable between weekdays (86.3%) and weekends (86.7%). However, significant differences were observed based on cycling speed. Cyclists travelling below 10 km/h recorded a lower rate of helmet non-use (67.2%) compared to those riding at 10–20 km/h (90.0%) and above 20 km/h (97.6%). In terms of bicycle type, standard bicycles showed a slightly higher rate of helmet non-use (86.1%) compared to electric bicycles (83.3%). The most pronounced variation was noted across road types, with federal roads recording the highest rate (90.8%), followed by state roads (86.8%) and municipal roads (55.2%).

The analysis of reflective clothes non-use among cyclists reveals significant patterns across various demographic and situational factors. Notably, female cyclists are slightly more likely to not wear reflective clothes, with a non-use rate of 98.9% compared to 97.2% for male cyclists. Age-wise, adults exhibit a non-use rate of 97.4%, adolescents 97.0%, and children 100%, indicating consistent non-use among cyclists age groups. Reflective clothes non-use indicated 97.7% observed during evening peak hours and 97.2% during morning peak hours. Similarly, non-use rates are relatively stable between weekends (97.3%) and weekdays (97.5%). Cyclists travelling at higher speeds are associated with higher non-use rates, with those cycling above 20 km/h having a non-use rate of 95.3%, while cyclists between 10–20 km/h exhibit a rate of 97.8%. Cyclists on standard bikes exhibit a non-use rate of 97.4%, whereas none of the cyclists on electric bikes were observed without reflective clothing. However, non-use rates also vary by road type, with the highest non-use rate of 100% on municipal roads, 99.6% on state roads, and the lowest rate of 95.6% on federal roads.

Female cyclists (32.3%) are observed riding two abreast more frequently than their male counterparts (27.0%). Furthermore, children exhibit the highest rate of riding two abreast (33.3%), followed by adults (27.8%) and adolescents (23.5%). Interestingly, riding two abreast is more prevalent during the morning peak hour (29.1%) compared to the evening peak hour (26.5%). On weekends, there is a higher likelihood of cyclists riding two abreast (32.3%) compared to weekdays (23.3%). Additionally, the prevalence of riding two abreast decreases with increasing speed, with cyclists travelling below 10 km/h exhibiting the highest rate (39.6%). Notably, electric bikes demonstrate no

observation for riding two abreast, while standard bikes exhibit a moderate rate (28.0%). Furthermore, riding two abreast behaviour varies significantly across different types of roads, with state roads exhibiting the highest prevalence (58.5%), followed by federal roads (20.6%) and municipal roads (4.1%).

**Table 1:** Risky behaviours of cyclists by demographic and contextual factors

Variable	Helmet non-use		Reflective clothes		Riding two-abreast	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
<b>Gender</b>						
Male	1,865(87.1)	249(12.9)	1,880(97.2)	54(2.8)	215(27.0)	581(73.0)
Female	220(81.2)	51(18.8)	268(98.9)	3(1.1)	41(32.3)	86(67.7)
<b>Age</b>						
Adult	1,822(87.4)	262(12.6)	2,029(97.4)	55(2.6)	243(27.8)	631(72.2)
Adolescent	46(68.7)	21(31.3)	65(97.0)	2(3.0)	8(23.5)	26(76.5)
Children	37(68.5)	17(31.5)	54(100.0)	0(0.0)	5(33.3)	10(66.7)
<b>Time of the day</b>						
Evening Peak-hour	888(85.0)	157(15.0)	1,021(97.7)	24(2.3)	131(26.5)	363(73.5)
Morning Peak-hour	1,017(87.7)	143(12.3)	1,127(97.2)	33(2.8)	125(29.1)	304(70.9)
<b>Day of the week</b>						
Weekend	851(86.7)	132(13.4)	956(97.3)	27(2.7)	131(32.3)	275(67.7)
Weekdays	1,054(86.3)	168(13.7)	1,192(97.5)	30(2.5)	392(3.3)	125(24.2)
<b>Speed</b>						
<10 km/h	299(67.2)	146(32.8)	434(97.5)	11(2.5)	61(39.6)	93(60.4)
10-20 km/h	1,316(90.0)	147(10.0)	1,431(97.8)	32(2.2)	176(29.9)	431(71.0)
>20 km/h	290(97.6)	7(2.4)	283(95.3)	14(4.7)	19(11.7)	143(88.3)
<b>Type of bike</b>						
Standard	1,875(86.1)	294(13.6)	2,112(97.4)	57(2.6)	256(28.0)	657(72.0)
Electric	30(83.3)	6(16.7)	36(100.0)	0(0.0)	0(0.0)	10(100)
<b>Type of road</b>						
Federal	1,105(90.8)	112(9.2)	1,163(95.6)	54(4.4)	140(20.6)	539(79.4)
State	699(86.8)	106(13.2)	802(99.6)	3(0.4)	114(58.5)	81(41.5)
Municipal	101(55.2)	82(44.8)	183(100.0)	0(0.0)	2(4.1)	47(95.9)

*Source: Author's Calculation*



### Binary Logistic Regression

Table 2 presents the model fits examining the relationship between demographic and contextual factors across three risky cycling behaviours. Adolescents ( $OR = 0.323$ , 95% CI: 0.185–0.597) and children ( $OR = 0.251$ , 95% CI: 0.127–0.496) showed lower odds of helmet use compared to adults. Helmet non-use was also less likely in the morning ( $OR = 0.650$ , 95% CI: 0.516–0.923) than during the evening peak hour. Speeds of 10–20 km/h and above 20 km/h were associated with 3.2 times (95% CI: 2.428–4.327) and 16 times (95% CI: 7.207–34.987) higher odds of helmet non-use, respectively, compared to speeds below 10 km/h. Additionally, the odds of helmet non-use were significantly lower on municipal roads ( $OR = 0.193$ , 95% CI: 0.131–0.284) than on federal roads.

For reflective clothes non-use, significant odds in the morning were lower than in the evening ( $OR = 0.545$ , 95% CI: 0.285–1.043), and for speed, the odds ratio was lower for speeds of 10–20 km/h compared to speeds less than 10 km/h ( $OR = 0.467$ , 95% CI: 0.226–0.968). Speeds more than 20 km/h demonstrated no significant association with reflective clothes non-use. State roads had a lower odds ratio ( $OR = 0.077$ , 95% CI: 0.024–0.250) than federal roads, while municipal roads revealed no significant association.

Only three significant variables were determined of seven for riding two abreast. Weekdays presented a higher odds ratio, with 2.4 times higher (95% CI: 1.549–3.666) than weekends. Regarding speed, speeds more than 20 km/h had a lower odds ratio than speeds less than 10 km/h ( $OR = 0.197$ , 95% CI: 0.102–0.379). State roads had an odds ratio of 9.1 times higher (95% CI: 5.962–13.804) than federal roads, while municipal roads had a lower odds ratio ( $OR = 0.208$ , 95% CI: 0.049–0.883) than federal roads.

### DISCUSSION

Out of seven explanatory factors selected for forward selection logistic regression, age, speed, type of road, and time of day were statistically significant for helmet non-use. Meanwhile, time of day, speed, and type of road were statistically significant for the non-use of reflective clothes. For riding two abreast, the day of the week, speed, and type of road were reported to be significant.

Table 2: The model estimation of the binary logistic regression for high-risk groups of cyclists

Variable	Reference	Helmet non-use			Reflective clothes non-use			Riding two-abreast		
		Odds Ratio	Confidence Interval (95%)	P-Value	Odds Ratio	Confidence Interval (95%)	P-Value	Odds Ratio	Confidence Interval (95%)	P-Value
<i>Gender</i>										
Female	Male	0.805	0.559-1.160	0.245	0.397	0.120-1.315	0.131	1.089	0.668-1.774	0.733
<i>Age</i>										
Adolescent	Adult	0.332	0.185-0.597	0.001***	1.122	0.251-5.010	0.88	0.900	0.376-2.151	0.812
Children		0.251	0.127-0.496	0.001***	0.000	0.000	0.997	0.521	0.162-0.521	0.272
<i>Time of the day</i>										
Morning Peak-hour	Evening Peak-hour	0.690	0.516-0.923	0.012*	0.545	0.285-1.043	0.067*	0.828	0.542-1.266	0.383
<i>Day of the week</i>										
Weekdays	Weekends	0.932	0.697-1.246	0.633	1.341	0.713-2.524	0.363	2.383	1.549-3.666	0.001***
<i>Speed</i>										
10-20 km/h	<10 km	3.241	2.428-4.327	0.001***	0.467	0.226-0.968	0.041*	0.986	0.617-1.575	0.954
>20 km/h		15.879	7.207-34.987	0.001***	1.112	0.470-2.634	0.809	0.197	0.102-0.379	0.001***
<i>Type of bike</i>										
Electric	Standard	0.466	0.185-1.175	0.105	0.000	0.000-0.000	0.998	0.000	0.000-0.000	0.999
<i>Type of road</i>										
State	Federal	0.847	0.624-1.150	0.288	0.077	0.024-0.250	0.001***	9.072	5.962-13.804	0.001***
Municipal		0.193	0.131-0.284	0.001***	0.000	0.000-0.000	0.995	0.208	0.049-0.883	0.033*

Source: Author's Calculation

\*significant at 0.05 level, \*\*significant at 0.01 level, \*\*\*significant at 0.001 level

### **Demography**

Research into the cycling habits of different demographics has uncovered varying tendencies toward safety measures. This study observed that female and male cyclists often do not wear helmets at high rates. Notably, cultural norms and personal comfort may influence helmet use among female cyclists, especially in Islamic countries, with some studies asserting diverse perceptions of the necessity and benefits of helmets (Fallah, Hezaveh, & Nordfjærn, 2018; Ledesma et al., 2019; Valero-Mora et al., 2020). A study by Yuan et al. (2022) suggested that women are more aware of the practical benefits of helmets, potentially leading to higher usage rates compared to men. Interestingly, helmet usage appears more consistent among children and performance cyclists across genders (Hounkpè Dos Santos et al., 2022).

Research on cyclist safety reveals age-related patterns in helmet usage. Our finding indicates that adults wear helmets more consistently than adolescents and children, who often forgo helmets due to discomfort, overconfidence, or unawareness of regulations. Similarly, Piatkowski and Marshall (2020) discovered no evidence to support the common assumption that youth who wear helmets are more likely to engage in risk-taking behaviours. This current study also observed that helmet use among children was less common in low-income areas, consistent with findings reported by Lajunen (2016) study. Lajunen (2016) further noted that children's helmet use was influenced by prevailing social norms.

The role of reflective clothing in preventing collisions is still debated. While reflective clothing may increase visibility, its impact on reducing crash risk is inconclusive (Wood et al., 2012). Some studies argue that reflective gear makes cyclists more noticeable to drivers, potentially reducing the likelihood of crashes during low-light conditions. However, others suggest that its effectiveness may be limited by factors such as driver awareness and road lighting. As such, research has proven that commuting cyclists are less likely to use reflective clothing compared to recreational cyclists and children, who often prioritise visibility for safety reasons (Pérez-Zuriaga et al., 2021). Despite mixed findings, promoting the use of reflective clothing remains a critical component of safety campaigns aimed at reducing cycling crashes.

Riding two abreast, where two cyclists ride side by side, has debated safety benefits. Some studies suggest that this practice can improve visibility, making it easier for drivers to see cyclists and potentially reducing crash risk. Research by Haworth et al. (2018) asserted that drivers give similar passing distances to male and female cyclists riding two abreast, suggesting that this practice does not disproportionately affect one gender. The systematic review conducted by Rubie et al. (2020) also supported this finding, suggesting that cyclist gender does not consistently influence lateral passing distances. Hence, drivers' perceptions and behaviours are key in determining passing distances.

Studies have emphasised that drivers who are also cyclists tend to give more space, likely due to a better understanding of cyclists' needs (Cubbin et al., 2024). Therefore, educating cyclists on when it is appropriate to ride two abreast can help improve safety and reduce risks.

### ***Temporal Factors***

Temporal factors significantly influenced risky cycling behaviours. Helmet non-use was more prevalent during morning peak hours and on weekends, suggesting that cyclists may feel rushed or perceive a reduced need for helmets during these periods. A similar trend was observed for the non-use of reflective clothing, which was more common during bright daylight hours when cyclists may underestimate the importance of visibility aids (Lahrmann et al., 2018). However, non-use of reflective wear poses safety risks during low visibility conditions (Vegas & Lin, 2019). The use of reflective wear also varies according to cycling patterns, with those riding in urban areas at night more likely to adopt such safety measures compared to those cycling during daylight. Miller et al. (2010) found no significant difference in reflective clothing use between weekdays and weekends, which is consistent with the findings of the present study.

This study found that riding two abreast was more common during weekends. No significant gender differences were observed. However, this finding contrasts with research by Babu and Anjaneyulu (2021), which highlighted that young male cyclists are generally more risk-prone, often engaging in behaviours such as riding two abreast. Such actions may result in traffic regulation violations and elevate the risk of road traffic crashes. The higher occurrence of this behaviour during weekdays may be linked to heightened stress and tension, potentially prompting cyclists to ride side by side for social or psychological comfort.

### ***Speed and Type of Bike***

The current study reported a significant association between risky behaviours and cycling speed. Helmet non-use was most prevalent at speeds over 20 km/h, particularly on federal roads, suggesting cyclists might underestimate head injury risks or find helmets uncomfortable at higher velocities. Fyhri et al. (2018) noted that experienced cyclists tend to ride faster without helmets, prioritising comfort over safety. Note that reflective clothing was generally used, but non-use increased at higher speeds, highlighting the need for better visibility aids to enhance safety. Cyclists travelling at 10-20 km/h were more likely to wear reflective clothing compared to those going below 10 km/h, underscoring the significance of visibility aids at moderate speeds. As such, Yan et al. (2018) reported that cyclists are less likely to ride side by side at speeds over 20 km/h due to safety, heavier traffic, and regulations. Moreover, research by Fu et al. (2017) demonstrated that cyclist speeds vary significantly, with a mean speed

estimation of 15.84 km/h. This indicates the need for targeted interventions to promote helmet and reflective clothing use, particularly among high-speed cyclists.

The type of bike does not influence the risky behaviours in this study. Standard bikes and electric present insignificant results in all three risky behaviours. Conversely, some research indicates that while the type of bike can impact risky behaviours, other factors such as rider demographics, psychological attributes, and situational contexts play more significant roles. A study by Rodon and Ragot-Court (2019) in Shanghai has suggested that electric bikes (e-bikes) often exhibit different risky behaviours compared to traditional bikes. The study also indicated that, due to their speed and power, e-bikes are more similar to motorised two-wheelers in terms of risky behaviours. Riders of e-bikes tend to engage in behaviours such as running red lights and riding on sidewalks more frequently than traditional cyclists. However, the type of bike alone does not fully account for these behaviours, as other factors like rider confidence and risk perception also play crucial roles (Wang et al., 2020b).

### ***Type of Road***

Road type was a significant factor in risky cycling behaviours. Helmet non-use was most common on federal roads, where higher speeds and traffic volumes might contribute to a false sense of security or urgency among cyclists. Conversely, reflective clothing non-use was less common on federal roads, possibly due to better lighting and infrastructure that improve overall visibility. Meanwhile, riding two abreast was more frequent on state roads, where traffic conditions might allow for more leisurely and social cycling. On municipal roads, narrower lanes and higher traffic density often necessitate single riding, resulting in lower incidences of helmet non-use and riding two abreast (Wang et al., 2020a; Lehmann et al., 2001). Accordingly, these findings highlight the impact of road conditions on cycling behaviours and safety practices, suggesting that the environment strongly influences cyclists' safety behaviours.

## **CONCLUSION**

This study aimed to identify high-risk cyclist groups in Kuala Terengganu and Dungun, Terengganu, Malaysia, by examining three risky behaviours: helmet non-use, reflective clothing non-use, and riding two abreast. Field observations were conducted at seven locations over six days, capturing demographic and contextual data. Binary logistic regression analysis revealed significant associations between these behaviours and variables such as age, time of day, day of the week, speed, and road type. The results showed that helmet non-use was more common at speeds above 10 km/h, less frequent among children and adolescents, and less likely during morning peak hours and on municipal roads. Non-use of reflective clothing occurred more often during evening peak hours,

was less frequent at speeds between 10 and 20 km/h and declined on state roads. Riding two abreast was more prevalent on weekdays and state roads but less likely at speeds exceeding 20 km/h and on municipal roads. These findings highlight the need for targeted interventions such as cyclist awareness programmes, policy enforcement, promotion of safety gear, and other safety strategies to encourage safer cycling behaviour. The outcomes of this study offer valuable guidance for community planners, policymakers, researchers, and academicians, contributing to the advancement of sustainable transportation and the promotion of cyclist safety in Malaysia.

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## ETHICAL STATEMENT

This study received approval from the Research Ethics Committee (REC) of Universiti Teknologi MARA (UiTM) under reference number REC/10/2024 (ST/MR/223).

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## **EVALUATING URBAN PUBLIC BUS TRANSPORT SERVICE QUALITY: PERSPECTIVES FROM TWO USER GROUPS**

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### **Abstract**

This paper aims to compare the views of passengers and non-passengers on the service quality of public bus transport in urban areas. The methodology used combines importance and performance analysis, as well as importance and performance map analysis, to identify the critical components of the views of both groups. The sample consisted of 55 questions completed by passengers and non-passengers conducted around the Trans-Batam bus line in Batam City through an online panel. The analysis results show that non-passenger satisfaction is 65.59%. In comparison, passengers reach 66.19%, both of which fall into the "satisfied" level range. Still, both groups have different views on the priorities for improving service quality, primarily related to "travel time", "infrastructure", and "reaching time". However, both groups agree that the current service quality is in line with expectations, especially concerning "fit connections", "speed", and "accessibility". However, four indicators need to be improved, such as "distance of stops", "safety stops", "comfort in stops", and "waiting time". The other two indicators, namely "line frequency" and the "need for transfers", need to be maintained at the same level of improvement. The government and public transport operators can use the findings to identify areas where the quality of public bus transport services in urban areas can be improved.

**Keywords:** Service Quality, Urban public bus transportation, Service Satisfaction

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## INTRODUCTION

In recent years, local governments and transport operators have paid serious attention to improving the quality of public transport services in urban areas, and decision-making regarding the continuous improvement of public transport involves considering factors such as habits, the environment, and the interests of various stakeholders. The critical contribution of public participation in improving the quality of urban transport services is recognised as key to achieving the goal of service quality improvement (Moslem & Duleba, 2018). Long-term improvement efforts with approaches that integrate the views of different groups in society are expected to reduce negative impacts, including perceptions and interest in public transport use, urban public transport improvement planning, stakeholder skills, and public transport use decisions. Improving service quality in urban public transport significantly impacts increasing the number of users. Local government statistics show a significant increase in private vehicle (PV) use each year in Indonesia, which poses a significant challenge for local governments and public transport operators in managing adequate and sustainable public transport. Therefore, the best step stakeholders can take is to improve the sustainability of service quality in public transport.

However, city governments and researchers need to consider the costs and potential problems associated with improving service quality, especially in public transport facilities and infrastructure in urban areas (Koryagin et al., 2018). These efforts should also take into account the subjective views of the public, both users and potential users, who are consumers of public services. Their views on travel, service, and quality can influence perceptions of public service improvements. Before implementing improvements, it is advisable to examine conflicts between the needs of the groups involved. Measuring the boundaries of requirements is an excellent first step in decision-making to resolve conflicts of views or opinions. Therefore, the purpose of this paper is to evaluate the views of two user groups in decision-making related to improving the quality of public transport services in urban areas. also to answer several questions, namely: (1) whether there is a significant difference in views between passengers and non-passengers on service quality improvement, (2) how the quality improvement affects them, (3) what are the causes of low use of urban public transport, and (4) how service quality improvement should be carried out based on passengers' and non-passengers viewpoints. Using the *Importance Performance Analysis* (IPA) and *Customer Satisfaction Index* (CSI) methods, it is hoped that this paper can provide the answers to these questions to be helpful for the government and transport operators, especially policymakers, in improving the quality of sustainable public transport services in the future.

## **LITERATURE REVIEW**

### ***Service Quality in Urban Public Transport***

Transport is crucial to urban development, involving various aspects such as infrastructure, culture, economy, and behaviour (Sugito et al., 2024). Improving urban public transport is important, especially in terms of environmental impact (Zawawi et al., 2024). Therefore, assessing sustainable service quality is important when choosing the most suitable urban transport option. The concept of service quality has sparked significant debate among researchers and policymakers due to its inherent challenges in measurement and explanation (Kandeepan et al., 2023). This discourse comes from various perspectives, but service quality generally refers to how well a service meets customer expectations. Alternatively, it can be seen as the gap between customer expectations and perceptions of the service. Quality encompasses various dimensions of service, including reliability, convenience, affordability, safety, and range of services. Understanding service quality is critical for businesses to ensure sustainability and competitiveness. In public bus transport, service quality is also influenced by the passengers' perspective, considering factors such as comfort, safety, performance, journey time, waiting time, cost, cleanliness, and safety (Rocha et al., 2023).

### ***Public Bus Transportation in Urban Areas***

Public bus transport in urban areas plays a crucial role in providing affordable, accessible, and sustainable mobility solutions for residents, especially in developing countries where urban public transport is still highly dependent on the role of government in its planning and operation (Fadhlullah Abu Bakar et al., 2023). A well-planned and efficiently run public bus transport system is essential to promote sustainable urban mobility, improve quality of life, and foster economic growth in urban areas (Tuvikene et al., 2023). As a result, public bus transport has been recognised as an efficient, convenient, and economical travel option. The introduction of Bus Rapid Transit (BRT) systems has provided significant benefits to low-income communities, including time and cost savings, improved accessibility, and safety and health benefits (Saleem et al., 2023), so a comprehensive performance evaluation of public bus transport systems is important to consider various aspects of the service and the viewpoints of all stakeholders in helping to reduce private vehicle use and alleviate congestion in urban areas.

### ***Service Satisfaction in Public Bus Transportation***

The measurement of public transport satisfaction is described as a result of the quality of services provided by the urban transport system (Minelgaite et al., 2020). However, satisfaction and quality of the urban public transport sector can be taken into account from various aspects, which consist of three parts, namely

service quality, transfer quality, and service production. However, when it comes to satisfaction, according to Hasan et al. (2021), satisfaction is influenced by four factors: convenience, staff, systems, and security, and can be categorised into transfer conditions, information, safety and security, emergencies, service design and image, and comfort. So, in evaluating the quality of urban public transport services, recommending analysing the quality of public transport services suggests including and evaluating the level of satisfaction as an important indicator of service quality that includes the operator's image, people's expectations, and perceived service quality (Abenzoza et al., 2017).

## **METHODOLOGY**

### ***Sample and Research Location***

In this study, a questionnaire was designed to measure public satisfaction with the quality of urban public transport services related to "Approachability" which consists of "distance of stop" (APL1), "safety stop" (APL2), "comport in stop" (APL3), "Directness" consists of "need to transfer" (DRS1), "fit connection" (DRS2), "Reliability" consists of "Accessibility" (RBT1), "Infrastructure Maintenance" (RBT2), "Time Availability" consists of "frequency of lines" (TAT1), "limit time to use" (TAT2), "Speed" consists of "travel time" (SPD1), "waiting time" (SPD2), "reaching time" (SPD3). The total consists of 10 items using a Linkert scale of 1 to 5 (1: strongly disagree; 2: disagree; 3: undecided; 4: agree and 5: strongly agree). On the same scale, participants were also asked about their overall satisfaction with the quality of public transport. Table 1 illustrates the two types of user mean and standard deviations regarding perceptions of service quality attributes obtained from recent research. Random sampling was selected for public bus transport passengers and non-passengers with the minimum sample size recommended by Barclay in 481 respondents consisting of 230 passengers and 251 non-passengers, where sampling was taken using probability sampling with simple random sampling technique to the public who use public transport and the community around the public transport line. This study is limited to public bus transport in Batam City. The path used in this study is the public users of Trans-Batam bus transportation with a bus operation path consisting of 8 travel routes.

**Table 1:** Statistical Indicator from Two Users

Code	Variable	Passenger		Non-Passenger	
		Mean	STDEV	Mean	STDEV
<b>APL1</b>	Distance of stop	3.28	1.15	3.27	1.15
<b>APL2</b>	Safety stop	3.27	1.15	3.27	1.15
<b>APL3</b>	Comport in stop	3.16	1.19	3.21	1.19
<b>DRS1</b>	Need to transfer	3.31	1.19	3.33	1.23
<b>DRS2</b>	Fit connection	3.32	1.20	3.34	1.19
<b>RBT1</b>	Accessibility	3.36	1.18	3.36	1.14
<b>RBT2</b>	Infrastructure	3.29	1.22	3.30	1.20
<b>TAT1</b>	Frequency of lines	3.32	1.23	3.28	1.15
<b>TAT2</b>	Limit time to use	3.31	1.20	3.34	1.18
<b>SPD1</b>	Travel time	3.25	1.20	3.27	1.17
<b>SPD2</b>	Awaiting time	3.24	1.18	3.24	1.18
<b>SPD3</b>	Reaching time	3.35	1.19	3.32	1.17

### ***Analysis Methods***

In the initial phase, the research database will be prepared, and data from the questionnaires will be analysed using SPSS. The main objective is to demonstrate reliability and validity with a significance level of 5%, using Cronbach Alpha values between 0.7 and 0.9. Validity and significant correlation are considered achieved if the r-calculated value exceeds the r-table value (Streiner, 2003). The next step is to apply the Importance Performance Analysis (IPA) method by giving a score to the assessment of the importance of service quality and performance satisfaction, given a scale of (1) very bad, (2) not good, (3) good, and (4) very good. The total value of the level of importance of service quality and performance satisfaction is obtained from the sum of the respondents' assessment scores, and the results will be described in a Cartesian diagram, with each attribute illustrated based on its average score. To evaluate the satisfaction of both groups towards improving the quality of public transport services, CSI analysis was used concerning the satisfaction index levels, namely 0 - 34% (very dissatisfied), 35% - 50% (unsatisfied), 51% - 65% (quite satisfied), 66% - 80% (satisfied) and 81% - 100% (very satisfied).

## **RESULT AND DISCUSSION.**

### ***Test Validity and Reliability***

In the early stages of testing, validity and reliability become important as the data quality depends on these two aspects. Overall, the validity and reliability test steps are essential in maintaining the reliability and accuracy of the data collected, as well as in making a significant contribution to knowledge in the field under study. From the test results involving 481 respondents, the r-calculated value > 0.088 was obtained so that it was stated that this data was valid and in the adequate reliability test based on the Cronbach's alpha value of 0.966 from the

questionnaire so that the questionnaire data could be declared reliable. All the values obtained from data processing show that the data can be processed for further testing.

### **Customer Satisfaction Index (CSI) Test Results**

The Customer Satisfaction Index (CSI) has several advantages in a service context. Firstly, CSI provides a clear measure to assess the level of customer satisfaction with a given product or service. This allows companies to understand the extent to which customers are satisfied with the service provided. Second, CSI enables evaluation of the effectiveness of strategies in meeting customer expectations. By knowing how satisfied customers are, companies can assess whether the strategies used have been successful or need to be adjusted. Thirdly, CSI helps identify areas where improvements are required. By knowing which aspects of the service are less satisfying for customers, companies can focus on improving service quality in those areas. In the context of this research, the Customer Satisfaction Index (CSI) value is calculated by multiplying the average satisfaction value of each attribute by the weight factor (WF) value of each attribute. The total weight value (WT) is divided by the maximum scale used and multiplied by 100%. Thus, the result of obtaining the CSI value from non-passengers is 65.59% (see Table 2).

**Table 2:** Customer Satisfaction Index (CSI) Non-Passenger

<b>Indicator</b>	<b>MIS</b>	<b>MSS</b>	<b>WF</b>	<b>WS</b>
<b>APL1</b>	3,27	3,26	8,32	27,12
<b>APL2</b>	3,27	3,26	8,32	27,16
<b>APL3</b>	3,15	3,20	8,02	25,62
<b>DRS1</b>	3,29	3,33	8,37	27,85
<b>DRS2</b>	3,31	3,32	8,43	28,02
<b>RBT1</b>	3,35	3,35	8,53	28,53
<b>RBT2</b>	3,28	3,24	8,35	27,02
<b>TAT1</b>	3,27	3,27	8,33	27,22
<b>TAT2</b>	3,29	3,32	8,38	27,82
<b>SPD1</b>	3,24	3,29	8,26	27,15
<b>SPD2</b>	3,22	3,22	8,21	26,46
<b>SPD3</b>	3,32	3,30	8,46	27,96
<b>WEIGHT TOTAL</b>				327,95
<b>CSI Score (%)</b>				65,59

CSI passengers obtained a result of 66.19%. This shows the quality of public transport services at the "satisfied" level (Table 3).

**Table 3:** Customer Satisfaction Index (CSI) Passenger

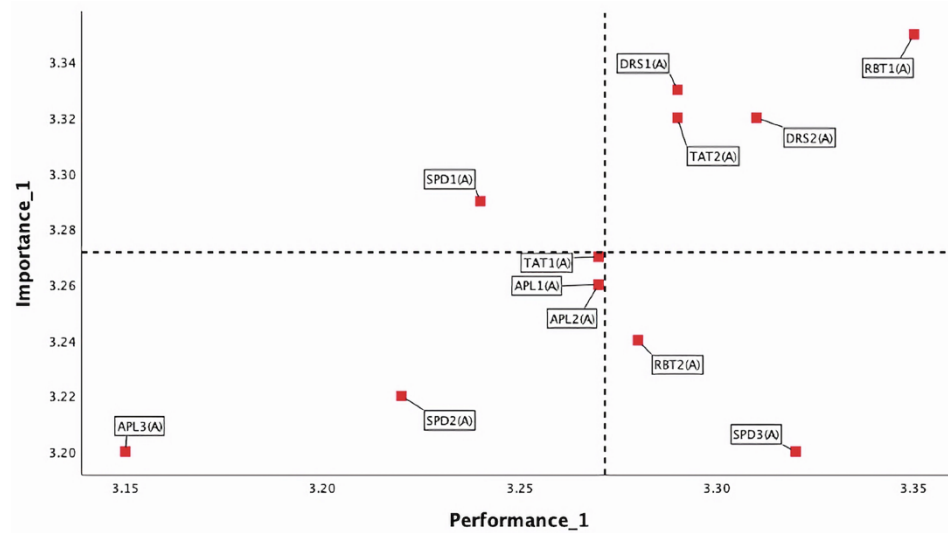
Indicator	MIS	MSS	WF	WS
<b>APL1</b>	3,28	3,28	8,27	27,12
<b>APL2</b>	3,28	3,28	8,28	27,19
<b>APL3</b>	3,17	3,22	7,98	25,73
<b>DRS1</b>	3,34	3,33	8,43	28,10
<b>DRS2</b>	3,34	3,35	8,41	28,18
<b>RBT1</b>	3,38	3,38	8,51	28,73
<b>RBT2</b>	3,29	3,37	8,30	27,99
<b>TAT1</b>	3,36	3,28	8,47	27,77
<b>TAT2</b>	3,33	3,36	8,40	27,21
<b>SPD1</b>	3,27	3,25	8,24	27,79
<b>SPD2</b>	3,25	3,25	8,20	26,69
<b>SPD3</b>	3,37	3,35	8,50	28,47
<b>WEIGHT TOTAL</b>				330,96
<b>CSI Score (%)</b>				66,19

From the evaluation results of the two user groups, both passengers and non-passengers, it can be seen that they give different ratings to the quality of public transport services in the city. Passengers scored 65.90%, while non-passengers scored 66.19%. Although there is a difference in the score, there is no significant difference in the final Customer Satisfaction Index (CSI) score for both, as both still fall into the satisfaction level category.

### **Importance Performance Analysis (IPA) Test Results**

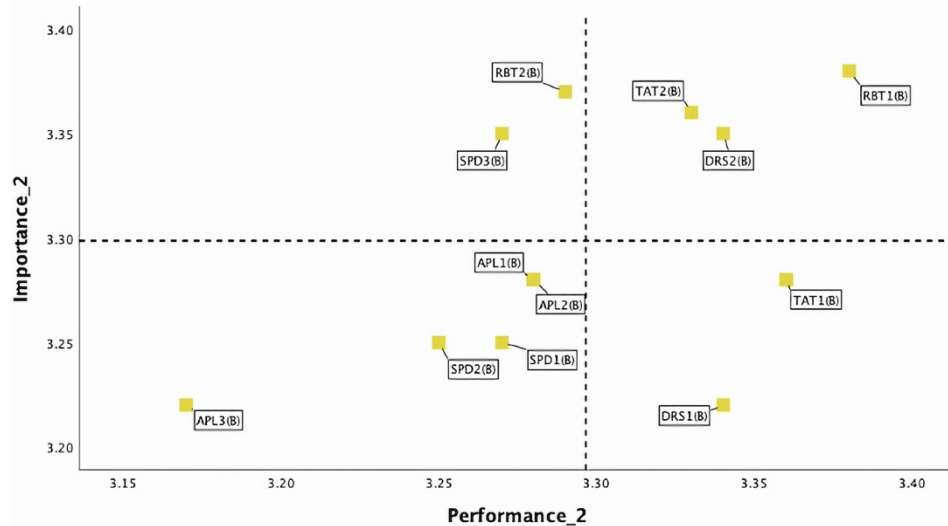
Improving performance attributes cannot be done simultaneously with other important attributes due to the limited resource allocation in urban public transport. Therefore, performance attributes that provide major benefits to service quality should be prioritised for improvement. On the other hand, attributes that should be prioritised are also considered very important to users but still have a level of performance that is considered low by users. The average importance and performance scores of passengers and non-passengers are 3.27 and 3.30, divided into four parts and plotted in a Cartesian diagram with points (a,b), forming four quadrants with different interpretations. Further details can be seen in Figures 2 and 3.





**Figure 1:** Non-Passenger Cartesian Diagram of Importance Performance Analysis

Figure 1 shows that the first quadrant shows a very low level of satisfaction, so improving service quality in urban public transport is the top priority. In this quadrant, there is one indicator, namely SPD1 (travel time), which has a very low level of satisfaction and is a top priority for improvement. The second quadrant is a picture that is expected by the community and follows the experience that has been felt by them. Four indicators fall into this quadrant, namely DRS1 (need for transfer), DRS2 (fitting connection), RBT1 (accessibility), and TAT2 (speed). Furthermore, the third quadrant is a low-priority quadrant that is considered less important by the community, but its performance could be better. There are five indicators in this quadrant, namely TAT1 (line frequency), APL1 (distance between bus stops), APL2 (safety at bus stops), APL3 (order at bus stops), and SPD2 (waiting time). Although considered less important by the public, these indicators' performance needs to be improved to increase user satisfaction. In quadrant four, there are two indicators, namely RBT2 (infrastructure maintenance) and SPD3 (time to reach destination). In this quadrant, performance is good enough and can be maintained because it already has higher satisfaction than user interest.



**Figure 2:** Passenger Cartesian Diagram of Importance Performance Analysis

In Figure 2, passengers' opinions are reflected in the first quadrant, which shows a very low level of satisfaction, making it a top priority to improve service quality in urban public transport. In this quadrant, two indicators with very low satisfaction levels are the top priority for improvement, namely RBT2 (infrastructure maintenance) and SPD3 (time to reach destination). The second quadrant reflects people's expectations and aligns with their experiences. Three indicators fall into this quadrant, namely DRS2 (proper connection), TAT2 (speed), and RBT1 (accessibility). Furthermore, the third quadrant is a low-priority quadrant that is considered less important by the community, but its performance could be better. There are five indicators in this quadrant, namely APL1 (distance between bus stops), APL2 (safety at bus stops), APL3 (order at bus stops), SPD2 (waiting time), and SPD1 (travel time). Although considered less important by the public, these indicators' performance needs to be improved to increase user satisfaction. Quadrant four shows a low level of importance but has a high level of performance implementation. There are two indicators in this quadrant, namely TAT1 (line frequency) and DRS1 (need for transfer).

### Discussion

Governments and public transport managers have focused their plans and strategies on expanding the urban bus transport network, including additional lines and operating hours, and improving fares, with the ultimate goal of increasing public transport use. However, the response to these efforts could have been better due to a lack of alignment with the needs of users and the general

public. The research results show differences in the views of both groups (passengers and non-passengers) that can help policymakers improve the quality of urban public bus services. Therefore, a focused community-derived approach is needed in designing appropriate strategies and plans to overcome these differences. Public transport operators or local governments on public transport should be able to look deeper into the factors that can improve service quality and the attractiveness of using public transport. Both groups agreed that priority aspects of improving the quality of public transport services should focus on journey times (SPD1), infrastructure maintenance (RBT2), and timeliness to destination (SPD3), as reflected in quadrant one. This is due to traffic density causes congestion, making journey times longer, and lack of maintenance of bus stops, which causes passengers discomfort while waiting. On the other hand, in quadrant three, indicators such as distance between stops (APL1), safety (APL2), orderliness at stops (APL3), waiting time (SPD2), and frequency of lines (TAT1) are considered to have low priority. They are not performing well, which requires in-depth analysis to understand all the issues, consultation with relevant parties, technology utilisation, route optimisation, improved safety and orderliness, education, collaboration with external parties, and continuous evaluation. However, indicators such as fixed connection (DRS2), speed (TAT2), and accessibility (RBT1) need to be maintained as they fulfil user expectations, as seen in quadrant two. However, the challenge for the government and transport managers is how to maintain these qualities. In quadrant four, the service is considered good and needs to be maintained to optimise the use of public bus transport. According to non-passengers, infrastructure maintenance and punctuality to the destination have increased the likelihood of using public bus transport, whereas passengers emphasise the importance of high line frequency and ease of transfer to improve service quality. Understanding these different views is important in designing more effective improvement strategies that cater to the diverse needs of public bus transport users.

To improve the quality of public bus services based on the views of the two groups, a strategy can be concluded and serve as a basis for future decision-makers, such as: (1). Improving journey times by addressing traffic congestion and adjusting travel schedules. (2). Improving infrastructure maintenance such as bus stops and roads. (3). Ensure destination punctuality by adjusting timetables and improving scheduling systems. (4). Provide safety and order facilities at bus stops to enhance passenger experience. (5). Increase the frequency of low-priority lines to match user needs. However, it is necessary to continue to maintain the indicators of fixed connection (DRS2), speed (TAT2), and accessibility (RBT1), which, according to both, have met expectations so that in the future how public transport managers can continue to maintain this is of course a challenge for the government and transport managers.

## CONCLUSION

This study adopts a quantitative approach supported by the use of open-ended questionnaires as part of the survey analysis to achieve the research objectives. The satisfaction survey was conducted from two perspectives of the public, namely passengers and non-passengers, located in Batam City and covering all operational lines of Trans-Batam public buses. It is important to note that the results of this study are highly influenced by people's social backgrounds, cultures, and customs; however, the study still has significant relevance for urban public transport planning and related decision-makers. As the main finding of this study, it is observed that the perceived satisfaction of the public, especially from passengers, is higher than non-passengers towards the quality of urban public transport. From these results, it can be concluded that passengers and non-passengers have different opinions on the service quality of public bus transport in terms of priority factors for improvement and factors that should be maintained and improved. However, both agree that they have felt the same satisfaction in improving the quality of public bus transportation services on the DRS2 (fitting connection), TAT2 (speed), and RBT1 (accessibility) factors and need to be improved on the APL1 (distance between stops), APL2 (safety at stops), APL3 (order at stops), SPD2 (waiting time), and TAT1 (frequency of lines) factors. However, improving the quality of public bus transportation services can influence them in terms of sustainability. This can be done by continuing to improve public bus services in all operational lines of public bus services so that people get the same experience and services. However, the low use of public bus transportation still occurs in several service lines due to waiting time for public buses that are still not following the predetermined schedule, order at bus stops and frequency of public buses. Of course, this is caused by insufficient supply of transportation. So how does the viewpoint of passengers and non-passengers should this service quality be improved? They concluded that the first is improving travel time by reducing waiting and making travel more efficient. The second is increased security during travel and at stops, as well as infrastructure security. The third is Facilities and security, such as comfortable seating and pending services for disabilities. Fourth is clear, accurate information and communication about schedules and service changes, including fares and travel routes. Fifth is accessibility, which is achieved by completing pedestrian lanes and increasing the number of stops on crowded passenger routes. Sixth is environmental safety, which can be achieved by reducing pollution and noise from public bus fleets. Further research can be carried out with steps such as surveys, participatory forums, and public consultations to help understand the needs and preferences of these two groups so that efforts to improve the quality of public bus transport services can be more effective and meet their overall expectations.

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## **UNIVERSITY STUDENTS' PERCEPTIONS OF PUBLIC BUS SERVICE EFFICIENCY AND EFFECTIVENESS IN INFLUENCING RIDERSHIP**

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### **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

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## INTRODUCTION

The transportation sector plays a pivotal role in driving economic development and supporting society by enabling the efficient movement of people and goods, thereby facilitating urbanisation (Othman & Ali, 2020). Access to transportation not only connects individuals to employment opportunities but also significantly contributes to the GDP through the movement of goods and services (Kriswardhana & Esztergár-Kiss, 2024). However, the sector also imposes environmental and societal costs (Roslan et al., 2024). Transportation is a major contributor to air and noise pollution, with fossil fuel-dependent vehicles exacerbating climate change, smog formation, and respiratory illnesses (Rahmat et al., 2023). Additionally, it intensifies traffic congestion, which negatively impacts time management, energy consumption, mental well-being, and overall quality of life. Prolonged congestion further increases traffic-related fatalities, as frustration and impatience heighten risks (Afrin & Yodo, 2020).

Sustainable transportation aims to minimise environmental harm, promote social equity, and ensure economic feasibility for current and future generations. It encompasses diverse modes, such as walking, cycling, public transit, and electric vehicles (Othman & Ali, 2020). Among these, public transport is particularly significant in urban areas, offering an alternative to private vehicles and mitigating traffic congestion, air pollution and carbon emissions. Key to assessing public transport services like bus systems are the concepts of "efficiency" and "effectiveness". Efficiency refers to the optimal use of resources – time, money, and energy – to provide reliable and timely services (Victorino et al., 2023). For example, Curitiba's Bus Rapid Transit (BRT) system in Brazil enhances efficiency through dedicated bus lanes and precise scheduling, reducing congestion and increasing reliability.

Effectiveness, on the other hand, measures how well a system meets users' needs, considering factors such as accessibility, convenience, and satisfaction (Tavassoli et al., 2022; Catalano et al., 2019). A system may be efficient but ineffective if it fails to address diverse user requirements. Thus, an ideal public bus network should integrate both objectives. While environmental factors, traffic issues, and societal impacts are relevant to public transport performance, they are not the sole determinants of outcomes. The focus should be on effectively managing these factors to enhance the quality and sustainability of public transit. For instance, Stockholm's public transport network integrates environmentally friendly buses with real-time information. This approach not only improves efficiency by optimising routes but also enhances effectiveness by increasing user satisfaction and engagement.



Several studies have emphasised that the quality of public transportation services significantly influences their performance (Hamzah et al., 2023; Ermagun & Witlox, 2024; Wang et al., 2022). Factors such as insufficient investment in infrastructure, inadequate maintenance, poor service quality, limited connectivity, safety concerns, accessibility challenges, and ineffective information dissemination have contributed to the subpar performance of public transportation services (Sukereman, et al 2024). In Malaysia, declining service quality has adversely affected user perception and satisfaction, leading to reduced ridership and a diminished willingness to use public transport (Baharum & Haron, 2020). Addressing these issues requires more than simply expanding infrastructure and capacity. A deeper understanding of the key determinants of public bus performance and requirements of users – particularly among young adults – is essential to enhance public bus services in the coming years.

## **LITERATURE REVIEW**

### **Public Transportation**

Public transportation encompasses any mode of transit where passengers do not rely on personal vehicles, including buses, taxis, and minibuses. It plays a critical role in providing residents with accessible and convenient travel options, often serving as a more practical alternative to private vehicles (Abu Bakar et al., 2022). In Malaysia, the Land Public Transport Agency classifies public transport services into several categories, including buses, taxis, e-hailing services, and rail (APAD, 2021). Generally, Malaysian public transportation is divided into two main categories: rail and bus services. Public bus services operate along fixed routes and schedules, catering to the community's mobility needs. These services are typically managed by government agencies or private operators. In Kuala Lumpur, for instance, RapidKL serves as a primary bus operator, Under the administration of Prasarana Malaysia Berhad, which oversees public transport operations in the Klang Valley area (Abu Bakar et al., 2022). Additionally, the Land Public Transport Agency (APAD) ensures the provision of safe and efficient public transport services, while the Ministry of Transport Malaysia (MOT) regulates fare structures, including those for bus services (Norhisham et al., 2021).

### **Efficiency and Effectiveness of Public Bus Operation**

In public bus operations, efficiency and effectiveness are interconnected concepts, addressing distinct aspects of service delivery and impact. Efficiency pertains to the optimal utilisation of resources to achieve desired outcomes. It emphasises how effectively resources such as time, fuel, labour, and funds are used to deliver services (Victorino et al., 2023). Efficient public bus services minimise costs, optimise resource allocation, and ensure smooth operations without compromising quality. This reflects operational excellence,

demonstrated by meeting customer needs with the fewest resources while reducing waste and enhancing productivity. While efficiency is vital for sustainability and economic viability, it does not necessarily address user satisfaction or adequate service coverage.

Conversely, effectiveness focuses on how well a public bus system meets the needs and expectations of its users. This includes factors such as accessibility, inclusivity, reliability, and user satisfaction. An effective bus system aligns with societal objectives, such as equitable access to services, increased ridership, and reduced dependency on private vehicles (Tavassoli et al., 2022; Catalano et al., 2019). To improve the service quality of public bus systems, a balance between efficiency and effectiveness is essential. A system that is efficient but not effective may reduce costs but struggle to attract or retain users. In contrast, an effective yet inefficient system may face sustainability challenges due to high operational expenses (Aleksandar Bajić et al., 2022).

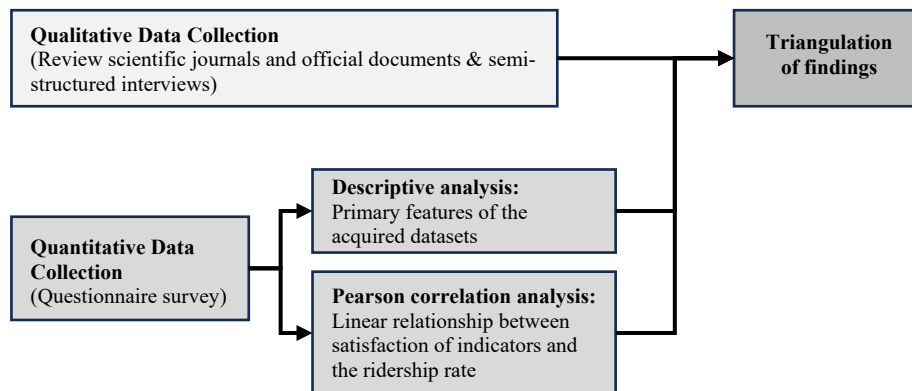
Service quality refers to how well a service meets user expectations by fulfilling anticipated needs and desires, ultimately improving user satisfaction. (Ermagun & Witlox, 2024; Wang et al., 2022). User satisfaction represents users' evaluation of an organisation's services, assessed by whether expectations are met or exceeded. In public transportation, user satisfaction is influenced by the alignment between pre-travel expectations and actual travel experiences. Achieving high service quality in public transportation necessitates identifying and prioritising the key factors that influence users' decisions to use or avoid the service. Furthermore, the ease of using public transport positively correlates with overall satisfaction levels among citizens (Ong, 2022).

## **RESEARCH METHODOLOGY**

This study employed a mixed-method research approach to comprehensively examine bus users' perceptions and their relationship to ridership rates. Mixed-method research, which integrates both quantitative and qualitative techniques, is particularly well-suited for studying perceptions as it provides a holistic understanding of the topic (Sinha et al., 2019; Lucas et al., 2021; Saxena et al., 2024; Ratchatakulpat et al., 2024). By capturing both measurable outcomes and nuanced social impacts of transport projects on individuals and communities, this approach offers valuable insights (Lucas et al., 2021). The research design involved simultaneous collection and analysis of numerical and non-numerical data, with subsequent triangulation of findings to enhance reliability and depth.

The study was conducted in two phases: quantitative and qualitative, followed by a triangulation of findings. The qualitative phase included a literature review and content analysis to identify indicators influencing the efficiency and effectiveness of public bus services. Semi-structured interviews were then conducted with a subset of survey respondents to explore these factors further, focusing on user perceptions and their willingness to adopt public buses as a

primary mode of transportation. In the quantitative phase, a questionnaire survey was distributed to gather data on respondents' perceptions of bus service efficiency and effectiveness and their influence on ridership. Data analysis involved descriptive statistics to summarise the key characteristics of the survey responses and Pearson correlation analysis to quantify the linear relationship between satisfaction with specific service indicators and ridership rates. The findings demonstrated how satisfaction with these indicators impacts ridership. The analyses incorporated data collected on campus from diverse user groups, including staff and students, each offering distinct perspectives on the services provided.



**Figure 9:** Research Methodology  
*Source: Author's work*

## ANALYSIS AND FINDINGS

### *Socio-demographic profile of the respondents*

The socio-demographic data reveals that a substantial majority of respondents (69.1%) fall within the 18-24 age group. This finding aligns closely with the study's primary objective, which is to investigate young adults, particularly university students', perceptions of the efficiency and effectiveness of public bus services within their university environment. The research also aims to assess the reliability of these services in enabling students to commute between campus and home without significant reliance on private vehicles.

**Table 8: Respondents Profile**

<b>Total Respondent: 191</b>		
	Frequency	Percentage (%)
<b>Age</b>		
18-24	132	69.1
25-29	19	9.9
35-39	30	15.7
40-44	5	2.6
50-54	5	2.6
<b>Occupation</b>		
Student	151	79.1
Employed	40	20.9
<b>Transit Service: Frequency of Using Bus</b>		
Current Ridership	182	95.3
Future Ridership with Alternative Option	40	20.9

*Source: Author's work*

With regard to occupation, only 20.9% of respondents utilising the public bus service on campus are employed, suggesting that the service primarily caters to students without private transportation and is less favoured by those with stable incomes. Supporting this, 95.3% of respondents identified public buses as their primary mode of transport, indicating significant dependence on the service. However, when asked about their willingness to continue using public bus services if more convenient alternatives, such as affordable e-hailing options, campus rail transit, or electric motorcycles, became available, 79% expressed a preference for these alternatives. Only 21% of current bus users stated they would continue using the service, underscoring dissatisfaction with the current system.

These findings suggest that while ridership rates are high, they may not necessarily reflect satisfaction with the service. Instead, the elevated ridership appears driven by a lack of viable alternatives, particularly among students with limited financial resources. For this group, public buses provide a cost-effective solution to meet their basic transportation needs, offering affordability compared to the expenses associated with private vehicle ownership and maintenance. However, their reliance on public buses stems more from necessity than preference, indicating a strong likelihood of switching to better alternatives should they become available.

### **Factors Influencing User Perception**

User perception plays a crucial role in sustaining the quality of public transportation services. For public bus services to meet user expectations, their efficiency and effectiveness must align with perceived quality. Researchers have identified key built environment factors that significantly influence user perceptions of the efficiency and effectiveness of public transit services. Through qualitative research methods, such as literature reviews and content analysis, several factors were highlighted for assessing public transit services. These

factors were subsequently validated through semi-structured interviews and questionnaire surveys with users. The built environment factors identified through qualitative approaches include the following:

**Table 2:** Identified factors influencing user perception of public transit

<b>Factors Influencing User Perception</b>	<b>References</b>
<p><b>a. Spatial availability</b>  Spatial availability refers to the ease with which individuals can access public transportation, particularly the proximity of bus stops or train station to their starting location. This concept aligns with the first-last mile principle, which underscores the importance of the journey to and from transport hubs. It highlights users' willingness to travel specific distances, often by walking, to access dependable transit options. The surrounding environment thus plays a critical role in fostering public transport usage by ensuring accessibility and convenience.</p>	(Kåresdotter et al., 2022 & Soukhov et al., 2024)
<p><b>b. Information availability</b>  Real-time information (RTI) systems significantly enhance passengers' travel experiences by delivering up-to-the-minute updates on the expected arrival times of buses and trains. Leveraging GPS tracking and electronic display boards, these systems provide accurate information, enabling commuters to reduce waiting times and plan their journeys more efficiently. By minimising uncertainty, RTI improves the perceived reliability of transit services and facilitates smoother connections between various modes of transportation.</p>	(Deng & Chen, 2021)
<p><b>c. Passenger occupancy</b>  When numerous individuals are densely packed into a confined space, it often creates discomfort, negatively impacting their perception of travel satisfaction. The lack of personal space can lead to frustration, anxiety, and irritation, overshadowing any positive aspects of the journey. Consequently, the overall experience is likely to be perceived as unpleasant, reducing both enjoyment and comfort.</p>	(Hensher, 2020 & Wang & Zacharias, 2020)
<p><b>d. Reliability</b>  Reliability refers to a bus service's capacity to consistently adhere to scheduled departure and arrival times. It reflects trustworthiness and predictability, assuring passengers that buses will operate as planned. This dependable performance is crucial for enabling users to make informed travel decisions without concerns about unexpected delays.</p>	(Paudel, 2021; Pulugurtha et al., 2022)
<p><b>e. Travel time</b>  Travel duration is a critical factor in trip planning and transport mode selection. A key aspect of this experience is the waiting time at bus stops, which can significantly impact a user's overall</p>	(He et al., 2019)

journey. Prolonged waiting periods often influence users' satisfaction and their choice of transportation, highlighting the importance of minimising delays to enhance the travel experience.	
<b>f. Safety and security</b> Safety in public transportation refers to the absence of dangers or risks that could harm passengers, ensured through measures such as well-maintained vehicles, clear signage, and trained personnel for emergency management. Security focuses on protecting passengers from potential threats through surveillance systems, security personnel, and crime deterrence protocols. Together, safety and security foster a reliable environment, instilling confidence and a sense of protection among public transport users.	(Sukereman, et al. 2024; Meena, 2024; Rodriguez-Valencia et al., 2022)
<b>g. Cost</b> Affordable transit fares are essential for many public transportation users, particularly those unable to afford the high costs of automated and connected vehicles. Reasonable pricing ensures access to reliable transportation, mitigating significant mobility challenges for financially constrained individuals.	(Dong, 2022)
<b>h. Appearance and comfort of bus stop</b> Developing efficient transit infrastructure is vital for increasing the convenience and appeal of public transportation compared to private cars. Improving waiting areas and shelters, particularly for protection during adverse weather conditions, can create a more welcoming environment that encourages greater public transit use.	(Dzyuban et al., 2022; Sun et al., 2020)
<b>i. Customer relations</b> The quality of driver service is essential to passenger satisfaction and significantly impacts their sense of safety. Professional and attentive drivers who prioritise safety foster a comfortable environment, enabling passengers to travel with peace of mind. Conversely, poor service can compromise passengers' sense of security. Therefore, transportation providers must emphasise rigorous training programmes to enhance service quality, improve passenger experiences, and cultivate long-term loyalty.	(Frinaldi et al., 2020; Weng et al., 2023)

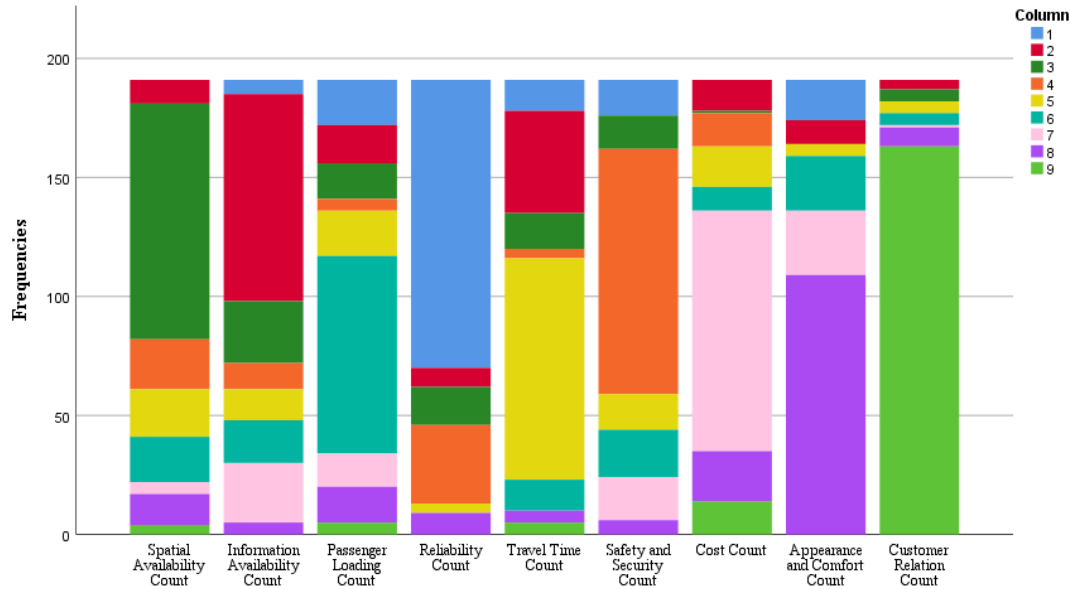
*Source: Author's own work*

To evaluate user satisfaction levels, researchers adopted a quantitative approach based on the factors influencing perceptions. Data were collected through a combination of questionnaire surveys and semi-structured interviews. The results provide insights into satisfaction with current services, as illustrated in Figure 2, which ranks nine aspects affecting bus ridership from most impactful (rank 1) to least impactful (rank 9).

Among these, "reliability" emerged as the top priority for passengers, underscoring the critical need for buses to adhere to schedules and provide dependable service. Respondent feedback highlighted partial dissatisfaction with

reliability, signalling a clear opportunity for improvement in this area. Enhancing the consistency and punctuality of bus services could significantly increase ridership. The second-ranked factor, "information availability," emphasises the importance of accurate real-time updates and accessible route and timetable details. The findings suggest room for improvement in these areas, particularly in providing clear and reliable transit information. The third significant factor is "passenger occupancy," which pertains to maintaining an optimal number of passengers on board to ensure comfort. Overcrowding negatively affects the travel experience, leading to discomfort and dissatisfaction. Ensuring adequate space for passengers to sit or stand comfortably can substantially improve their overall journey. Addressing these critical aspects can enhance the user experience, better enable passengers to plan their journeys, and foster greater satisfaction and loyalty among riders.

Spatial availability, encompassing the ease of accessing bus stops and the comprehensiveness of available routes, ranked fourth in priority. This underscores the importance of establishing a well-designed and user-friendly transportation network. Survey results indicated significant dissatisfaction among respondents regarding various aspects of spatial availability, such as the distance to the nearest bus stop, the walk from bus stops to final destinations, the absence of accessible stops directly at destinations, the pedestrian environment surrounding bus stops, and the implementation of universal design principles. These findings highlight the urgent need for enhanced accessibility and convenience of public transportation infrastructure. "Cost" ranked seventh, suggesting that while fare affordability is a consideration, it is not the most critical factor for riders. Survey results indicate general satisfaction with pricing, with respondents viewing the cost of public bus services as reasonable and offering good value for money.



**Figure 2:** Ranking of the aspects affecting the public bus ridership.

*Source: Author's work*

Conversely, "appearance and comfort" ranked eighth, indicating that aesthetic appeal and physical comfort have a relatively low impact on ridership. However, noticeable dissatisfaction was reported in this area. Riders frequently mentioned issues such as inadequate seating, limited shelter at bus stops, and lack of information boards providing schedules and routes. These shortcomings negatively affect the passenger waiting experience and can confuse first-time users. Lastly, "customer relations" ranked ninth, suggesting it has the least influence on ridership. While survey responses reflected moderate satisfaction, categorised as "neither very good nor very bad," there remains room for improvement. Commuters highlighted opportunities to enhance interactions by focusing on friendliness, consistent staff training, adherence to speed limits, and better accommodation of passenger needs.

#### ***Pearson correlation analysis***

Pearson correlation analysis was conducted to identify relationships between future ridership and satisfaction with various factors. The strength of the correlation highlights the degree to which each factor influences passengers' likelihood to continue using the service.



**Table 3:** Summary of correlation analysis for nine aspects

	No	Correlation analysis between future ridership rate and	Correlation coefficient (r)
Spatial Availability	1	distance from the origin to the bus stop	0.225
	2	distance from the bus stop to the destination	0.299
	3	location of the bus stop	0.194
	4	walking environment	0.297
	5	universal design application	0.275
Information Availability	6	accuracy of real-time information	0.266
	7	accessibility to route and timetable information	0.316
Passenger Occupancy	8	having an empty seat available when taking the bus	0.388
	9	comfortability when taking the bus	0.407
Reliability	10	frequency of bus arrivals following the schedule	0.266
	11	bus arrival time is consistent with the application	0.144
Safety and Security	12	feeling safe when waiting at the bus stop alone during the daytime	0.402
	13	feeling safe when waiting at the bus stop alone at night	0.123
	14	feeling safe inside the bus as CCTV is provided	0.459
Cost	15	affordability of current fare	0.064
Bus Stop Appearance and Comfort	16	sitting area provided	0.007
	17	standing area comfortability	0.027
	18	sheltered bus stop	0.081
	19	information boards at bus stops	0.104
Travel Time	20	travel time when using public buses	0.236

	No	Correlation analysis between future ridership rate and	Correlation coefficient (r)
Customer Relation	21	bus drivers' friendliness	0.114
	22	well-trained bus drivers who obey the law	0.327
	23	bus drivers following the speed limit	0.111
	24	drivers waiting for passengers who are running	0.054

\*\* Correlation is significant at the 0.01 level (2-tailed).

*Source: Author's work*

The results of Spearman's correlation test, as presented in Table 3, demonstrates how various aspects of service quality are positively correlated with the anticipated ridership rate. While the correlations between the individual service quality factors and future ridership are generally weak, the consistency of this pattern suggests a stable influence across all factors. This indicates that even small improvements or changes in these aspects can significantly impact ridership outcomes over time. The moderate correlation between these variables highlights that passengers perceive the various service quality aspects as equally important, reinforcing their collective influence on ridership, even if the strength of the connection is not strong. This suggests that addressing multiple factors in a balanced manner can improve future ridership, as each factor contributes to a stable and predictable user experience.

### TRIANGULATION AND DISCUSSION

The investigation into the impact of service quality on satisfaction reveals significant insights into the relationship between user perceptions and future ridership rates. The analysis highlights a direct link between lower satisfaction levels and a decline in future ridership, with negative perceptions across various dimensions. Specifically, 15 out of 24 factors from the nine service quality dimensions (see Table 3) were found to correlate negatively with future ridership, suggesting that dissatisfaction stems from multiple sources rather than a single determinant. The correlation analysis indicates that no single factor has an overwhelmingly strong effect on future ridership; instead, the decline is the result of a cumulative effect of various factors.

This suggests that to improve ridership, a comprehensive, holistic approach is necessary. Addressing the interconnected issues that contribute to dissatisfaction can help create a more positive perception of public bus services, even in the face of alternative transport options.

From an economic perspective, the analysis also sheds light on the cost-effectiveness of public bus services. The presence of more affordable alternatives, such as e-hailing services, leads to a decrease in bus ridership, reinforcing the importance of pricing in transportation decisions. This finding suggests that

affordable transit options are a key driver of continued public bus use. A deeper analysis of income levels and their influence on transportation choices could further reveal the relationship between economic factors and commuters' preferences for public buses versus other transport modes.

## CONCLUSION

In conclusion, this study underscores the importance of addressing the complex relationship between service quality, user satisfaction, and ridership rates to ensure the long-term success of public bus services. The cumulative impact of various factors and the economic motivations behind ridership provide valuable insights for strategic improvements in public transport. This study emphasises the critical relationship between the effectiveness and efficiency of service delivery, highlighting the role of economic factors in shaping public bus ridership. The findings indicate that enhancing service quality – by improving spatial availability, ensuring reliable information systems, increasing comfort during rides, and maintaining affordable fares – is essential for attracting a diverse user base. As economic conditions evolve, it is crucial for public transport systems to remain adaptive to meet the needs of all community segments and to prevent a shift toward private vehicle use. Future research should expand its focus to capture a broader range of perspectives, particularly exploring preferences across different income levels and professions. A deeper understanding of these factors will not only support the sustainability goals of public transportation systems but also encourage greater public trust and satisfaction with these services.

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## **APPLICATION OF FUZZY-AHP IN GIS-BASED ANALYSIS FOR ROAD SAFETY INDEX MEASUREMENT**

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### **Abstract**

Maintaining the safety of road users is an absolute necessity. Therefore, the road must be safe, and road infrastructure is one of the most important aspects. Several studies suggested that different road infrastructures had different impacts on road safety. Therefore, this study was conducted with two (2) objectives, which are (i) to determine the degree of importance of factors influencing road safety and (ii) to derive the road safety index. This study proposed the application of Spatial-Multicriteria Decision Analysis, where Fuzzy-AHP was chosen as the technique to deal with uncertainty in criterion weighing. Findings revealed that the criteria with the highest degree of importance is Road Marking, with a weightage of 0.392, while the least important is Street Lighting, with a weightage of 0.028. The criterion weightage was then used in GIS proximity analysis to measure the safety index, which revealed that most roads in the study area have high and very high safety indexes. The indices were verified by interviews with an expert and site verification to see if the calculated indices were accurate. Thus, this study revealed the possibility of using Fuzzy-AHP and GIS methods in measuring safety index, which can be applied in the future.

**Keywords:** fuzzy-ahp, gis, mcda, proximity analysis, road safety

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## **INTRODUCTION**

Road safety refers to the safe and secure travel of road users, including pedestrians, cyclists, public transportation riders, and motor vehicle drivers. Road safety can be influenced by factors like traffic volume, road geometry, bridge condition, business types, unsafe driving, traffic laws, police presence, warning signs, vehicle potential, and roadside emergency services (Teimourzadeh et al., 2020).

According to Sarani et al. (2018), since the early 1980s, Malaysia has struggled with road fatalities. There are numerous measures that many agencies have undertaken since there is a rising trend for fatality, and it must not be ignored. The trend of road fatality had changed from an ascending and positive trend in the 1990s to a gradual slope after 1996. In addition, the spatial distribution of road accident incidents in Malaysia between 2006 and 2015, with Selangor and Johor having the highest ratings due to their higher population density, with Shah Alam being an important city in Selangor. As it is one of the busiest cities in Selangor, there is a high number of vehicles on the roads daily, which could lead to road accidents (Shaadan et al., 2021).

Therefore, the purpose of this study is to suggest a methodology that could possibly be used for measuring road safety with Spatial-Multicriteria Decision Analysis (MCDA). When making any choice of decision about the geographical issues, the two (2) methods together were commonly used. Not only is one (1) criterion considered in the study of a geographical problem, but there are always multiple criteria, each of which has varying importance. GIS was used to conduct the spatial analysis, while MCDA was responsible for determining the weightage of the criteria. Road safety has been analyzed using GIS techniques, with the criteria that have been assigned along the roadway, which serves as the basis for the analysis.

## **LITERATURE REVIEW**

### **Factors influencing Road Safety**

There are several factors that influence road user safety. As stated by Ang (2020), there are seven (7) key factors of road infrastructure, which include (i) Road Geometry, (ii) Traffic Signs, (iii) Road Marking, (iv) Street Lighting, (v) Road Shoulder Width, (vi) Road Barriers, and (vii) Traffic Signal. These factors were developed by Ang (2020) and were used as the basis for the road safety measurement for this study. However, it still needs to be validated. Therefore, similar studies were reviewed to see if the factors by Ang (2020) are sufficient to measure road safety. Table 1 lists the factors that were used in measuring road safety based on the road infrastructure from previous studies. From Table 1, the inconsistencies of chosen factors (later called criteria in this study) can be seen based on the author's interest in road infrastructure to be used. In this study, all

the listed road infrastructures will be chosen as the criteria that will be used to determine road safety for both study areas.

**Table 1:** The Criteria of Road Infrastructure in Determine Road Safety

Author	Road Geometry	Traffic Signs & Signals	Road Marking	Street Lighting	Road Shoulder Width	Pavement Condition
(Ang, 2020)	/	/	/	/	/	
(Kanuganti et al., 2017)	/	/	/		/	/
(Budzyński et al., 2018)	/					
(Fancello et al., 2019)	/	/	/	/		/
(Martins & Garcez, 2021)	/	/				/
(Echchelhel et al., 2015)		/	/			
(Nkurunziza et al., 2021)	/				/	

### Spatial-MCDA in Measuring Road Safety

Nowadays, GIS has been implemented to solve various problems, one of which is related to road safety. Based on several research, the most popular techniques that have been used to measure road safety are the Multicriteria Decision Analysis (MCDA), Analytical Hierarchical Process (AHP), and Data Envelopment Analysis (DEA) method.

According to a previous study by Martins and Garcez (2021), the MCDA method is suggested for analyzing road safety over several time periods and dimensions. It compiles multiple multicriteria and multiperiod approaches for measuring road safety indicators over time. Human factors, accident causes and severity, road characteristics and conditions, and other elements are all interacting to determine a road's criticality. As a result, it is important to consider road or traffic incidents from a variety of angles. In addition, the decision maker's preferences can be taken into account while evaluating road performance across many criteria when employing the MCDA techniques. Based on the research paper written by Mohammad Azlan and Naharudin (2020), the combination of AHP and GIS methods could be used to measure road safety. There has been extensive use of a combination of the two (2) methods in spatial decision-making.



In the analysis of geographical problems, multiple criteria are constantly involved, and the relative weight of each criterion can be changed and vary. Therefore, the role of AHP is to derive the weightage for the criteria, and GIS's function is to employ the weightage in the geographical analysis. The words geographical problems and geographical analysis had the same meaning as spatial problems and spatial analysis.

GIS can address real-world issues, including road safety measurement. Since the 1990s, MCDA has been widely used in spatial planning, with recent trends extending to multi-criteria spatial decision support systems. This approach evaluates urban and regional development plans using methodologies that consider multiple dimensions and well-specified criteria (Ferretti & Montibeller, 2016). Spatial-MCDA is one of the methods to be used because the criteria that have been selected play the role of measuring whether the road is safe or not. Spatial-MCDA had various weighting methods that could aid in decision-making, including rating, ranking, and pairwise comparison. A simple way to figure out the weightage of the criteria is to put them in line with how important they are to the decision-maker. This is called the ranking method (Malczewski & Rinner, 2015). The ranking method is a simple technique used to determine the weightage of criteria in decision-making situations. It involves estimating the weightage of criteria based on a scale from 0 to 100, with the most essential criteria scoring 100. Lower criteria are given weights, and the least important criteria are scored. Pairwise comparison, developed by Saaty in 1980, uses a scale from 1 to 9 to rate preferences based on a pair of criteria.

Saaty (1990) came up with the AHP method, which is widely used nowadays in decision-making using GIS. The AHP can be used to evaluate the relative roles of qualitative and quantitative criteria. Over time, it has become an important method for dealing with problems of selection and prioritization, which involve many criteria (Kostagiolas, 2012). Ruslan et al. (2023) explains that AHP, which is known as a part of MCDM, is made up of techniques that are good for ranking an important management issue. The method also lets the user check for and get rid of inconsistencies in the opinions or judgments through a consistency test. According to Liu et al. (2020) and Othman et al. (2021), AHP is a widely used MCDA technique. It uses the pairwise comparison to figure out the weightage of criteria and the preferences of different options in a structured way. However, uncertainty might exist in any MCDA technique. Hence, fuzzy sets have been added to AHP because subjective judgments during comparisons can be difficult to make correctly. This is called Fuzzy-AHP. Fuzzy-AHP is used to make decisions for real-world issues, especially for the selection of problems. The methods are grouped into four (4) parts of making the Fuzzy-AHP model. First, it represents the display of the relative significance for pairwise comparison. Next, it is about the aggregating fuzzy sets for collective decisions

and weightage or priorities. Then, it is about turning a fuzzy set into a clear value for the last comparison and, lastly, measuring the consistency of the judgments.

As a widely known way to deal with unpredictability, fuzzy sets, which were first proposed by Zadeh in 1965, are combined with AHP to make Fuzzy-AHP. This combined method maintains the benefits of AHP and has been used a lot (Mardani, Jusoh, & Zavadskas, 2015, as cited in Liu et al., 2020). In order to make a fuzzy-AHP model, the method that the user needs to set up is a comparison matrix, combine multiple judgments, check for consistency, and clear up the fuzzy weightage. AHP sets up a problem in a hierarchical way, with a goal at the top, followed by criteria, sub-criteria, and options (Saaty, 1990, as cited in Liu et al., 2020). The hierarchy gives the experts a big-picture view of the context's complicated interactions and helps them figure out if things on a similar level are similar. The weights of the elements are then found by comparing them pair by pair using nine (9) level scales. However, pairwise comparison, which is the heart of AHP, adds uncertainty because it needs the opinions of experts. In real life, experts might not be able to give exact numbers to their preferences because they do not have enough information or skills (Chan & Kumar, 2008; Xu & Liao, 2013, as cited in Liu et al., 2020).

Nevertheless, adding fuzzy sets to AHP helps the decision-maker make the process of calculation easier because there are different fuzzy sets, and the operations that go with them are complicated. AHP methods like the Eigen vector method and the geometric mean cannot be used directly to figure out the weights or preferences from a fuzzy pairwise comparison. There have been numerous ideas for how to make a Fuzzy-AHP model. There are differences in terms of its most important aspects, strengths, and weaknesses. Fuzzy-AHP has not been studied much, as far as we know, except by Kubler et al. (2016), as cited in Liu et al. (2020), who talks about how it can be used. Based on the overview of the explanation in the previous paragraph, Fuzzy-AHP has been chosen as the method for measuring road safety. The selection of criteria and sub-criteria fulfilled one of the requirements for using the Fuzzy-AHP method. Just using AHP might have some limitations.

## **METHODOLOGY**

Figure 1 shows the flowchart of this study, which begins with the preliminary study and continues until visualization. The first stage is the preliminary study, in which the selection of criteria for measuring road safety was conducted based on previous studies as well as experts' interviews. The next stage is Data Acquisition, which is divided into two (2) parts, which are Fuzzy-AHP and GIS methods. In Fuzzy-AHP, the first step is to develop a hierarchical structure representing the dependencies between the criteria, followed by obtaining the expert's choice. In GIS data collection, field data collection was used to capture the data for the chosen road infrastructure. The next stage is Data Processing,

which involves weightage calculation, defuzzification for ranking, spatial data editing, and spatial dataset of criteria. Afterward, the spatial analysis was continued to determine the road safety index, and the output obtained was the road safety index. Next, for the analysis, two (2) analysis tasks were performed: to analyze areas with high and low road safety index and to compare the road safety index in the study area. Lastly, there is the visualization phase for the map of the road safety index.

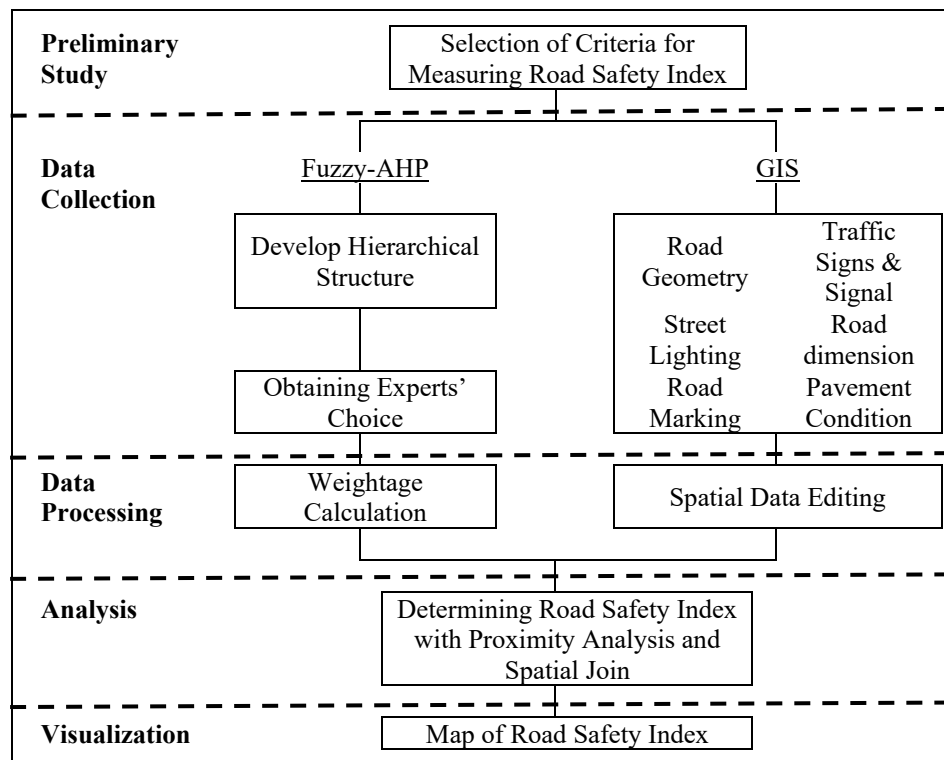


Figure 1: Research Framework

### Selection of Criteria for Measuring Road Safety

In this study, the criteria that were chosen focus on the road infrastructure. The criteria may have sub-criteria to assist in analyzing road safety for road users. The criteria and sub-criteria for measuring road safety can be seen in Table 2. They were adapted from related research and journals, as described in Table 1.

**Table 2:** The List of Chosen Criteria and Sub-Criteria for this study

CRITERIA	SUB-CRITERIA
Road Geometry	Sight Distance
	Sharp Curve
	Drainage Provision
Traffic Signs and Signal	-
Road Marking	Road Marking Paint
	Thickness
	Laying
Street Lighting	-
Road Shoulder Width	Shoulder Width
	Quality of Shoulder
	Pavement Edge Failure
Pavement Condition	Pothole
	Cracking
	Rutting

### Data Collection

The road network dataset, road infrastructure features dataset, and weightage value from experts are the data needed for this study. The road network dataset was obtained from the open-source website, while the road infrastructure features dataset was obtained by collecting data in the field by using pre-installed mobile applications on smartphones. Then, the weightage values for every sub-criterion may be obtained from local agencies or local departments. The information about the data needed is listed in Table 3.

**Table 3:** List of Data Requirement in this study

Method	Type	Name	Format	Use	Sources
Primary Data Collection	Aspatial Data	Expert's Choice of Criteria Values	Text Forms	To define the weightage value	Experts
	Spatial Data	Feature of Road Infrastructure	Shapefile	To represent road infrastructure along the road	Field Survey
Secondary Data Collection	Spatial Data	Road Network	Shapefile	To represent the specific road involved	Open-Source Website
	Spatial Data	Land Used	Shapefile	To get the boundary of the land of the study area	Open-Source Website

### GIS Data Collection

By doing the field data collection, the location for each of the road infrastructures listed in Table 2 was obtained. The data was obtained by using a mobile GIS data collector application that was installed on the smartphone.

### Fuzzy-AHP Data Collection

The step in conducting Fuzzy-AHP involves the development of a hierarchical structure and designing and obtaining an expert's choice. The expert's choice needs to be taken to obtain the rating to assist in the weightage calculation. This step needs to be utilized in this study to solve the issues with a proper process. Based on Malczewski & Rinner (2015), the values that will be used to evaluate the criteria will be treated as the most important part of the decision analysis in this chosen technique. It requires the coming up of criteria for judging the set of choices or alternatives. Figure 2 shows the key components of a problem situation that has been set up in a hierarchical structure. The goal will be at the top of the hierarchical structure, which is the Road Safety Index. Then, the hierarchy goes down to the criteria, which are the road infrastructure, until it reaches the sub-criteria.

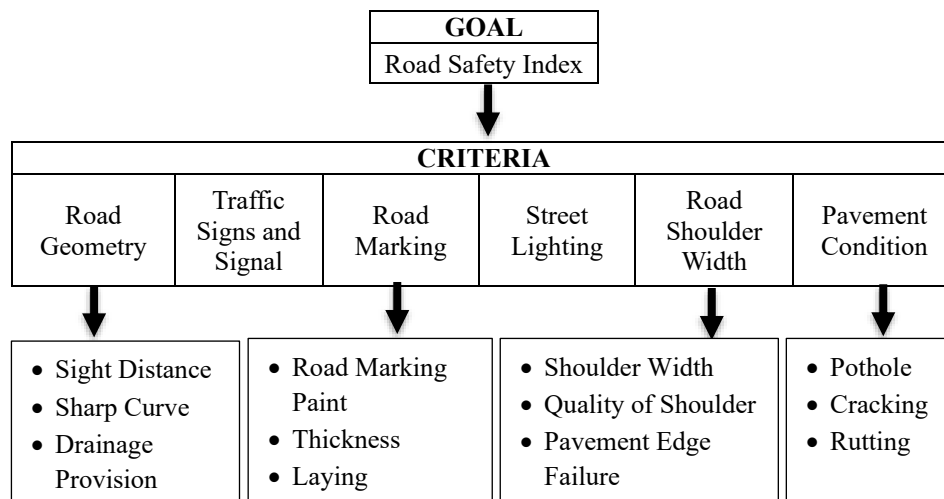


Figure 2: The Hierarchical Structure for this study

### Criterion Weightage Calculation by using Fuzzy-AHP

For weightage calculation, the Pairwise Comparison technique has been utilized. The pairwise comparison method is a technique for selecting the best option from several possible choices by contrasting them in pairs. Since this study is trying to determine which roads are the safest, more than one (1) parameter has been included in the ranking method. There are five (5) steps to calculate the weightage and one (1) last step to obtain the final rank. For the first step, based on Kanuganti et al. (2017), to utilize the Pairwise Comparison in Fuzzy-AHP, the 9-point scale needs to be fuzzified. The values from 1 – 9 will be assumed to be triangular symmetrical, the internal pair and odd integers will be differentiated, and the edge values along the scale will be adjusted. Table 4 shows the Fuzzy Scale of Relative

Importance. The next step was to create the pairwise comparison matrix. The calculation method that has been chosen for this study was the Geometric Mean method by Buckley, 1985. Geometric Mean is used to calculate the weightage values. Then, the numeric values in the pairwise comparison matrix were replaced by fuzzification numbering values.

**Table 4:** Fuzzy Scale of Relative Importance (Kannan et al., 2013)

Crisp Values	Judgment Definition	Fuzzified Value
1	Equal	(1, 1, 1)
3	Moderate	(2, 3, 4)
5	Strong	(4, 5, 6)
7	Very Strong	(6, 7, 8)
9	Extremely Strong	(9, 9, 9)
2,4,6,8	Intermediate values	(1, 2, 3) (3, 4, 5) (5, 6, 7) (7, 8, 9)

### Determining the Road Safety Index

In this study, proximity analysis was used to identify the road infrastructure that existed along the specified road. The road safety index was determined using the criteria weightage summation method. The spatial join has been used to make the process easier. The data on the road network and the features of events were combined with the aid of spatial join tools. Both data have been merged spatially in the workspace. Therefore, the criteria of event features were situated along the road dataset, which has been determined and recorded in the attribute table. To determine how many infrastructures of the road had existed along the road, the spatial join was used to combine both attribute tables.

**Table 5:** The Road Safety Index Classification

Classification	Value of Index			Symbolization
Very High	0.8	-	1.0	
High	0.6	-	0.79	
Average	0.4	-	0.59	
Low	0.2	-	0.39	
Very Low	0	-	0.19	

In this study, the road safety index was computed with the help of summary statistics, as the attribute of the criteria dataset was included with its own weightage value. The data from the tables' fields have been summarized using summary statistics. The sum of the weightage value has then been normalized or standardized between 0 and 1 value. The 0 represents the lowest index, and 1 represents the highest index. The lowest and highest index values can be found by normalizing the value of the safety index. Here, it could be seen that this study used the normalized value to measure the road safety index. For further analysis, the index value will then be reclassified into five (5) classes using the Equal Interval classification method, as shown in Table 5.

The highest and lowest index values that have been determined have been used to determine road safety for both study areas. If the index value is high, it represents the road is safe, but if the index value is low, it represents the road is unsafe. Here, it could be seen that the road safety index can be determined by using the Fuzzy-AHP and GIS method to analyze the efficiency of road safety. By obtaining the index value, it can be used for further actions as to improve the road infrastructure that had affected the safety of road user.

## RESULTS AND DISCUSSION

The first results are the weightage of criteria and sub-criteria that were calculated by using Fuzzy-AHP. The finding for the weightage is quite different from previous studies. Kanuganti et al. (2017) showed that the top three (3) most important sub-criteria were Cracking and continuing, with Sharp Curves and Potholes. As for the Sight Distance, it has been ranked as the 4th most important sub-criteria. It differs from this study in the 1st rank was the Road Marking Paint and continues with Sight Distance and Traffic Signs and Signal. As for the 4th rank, it was the Pothole.

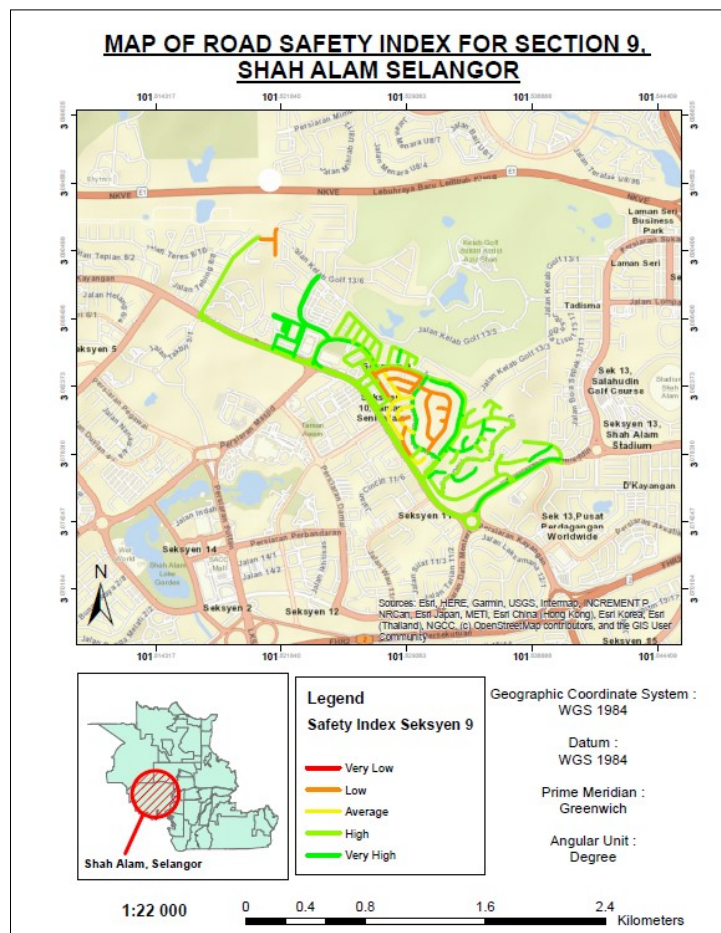
**Table 6:** Weightage of Main Criteria and their Sub-Criteria

Main Criteria	Weightage	Sub-Criteria	Weightage	Overall Priorities	Rank
Road Geometry	0.185	Sight Distance	0.659	0.122	2
		Sharp Curve	0.098	0.018	12
		Drainage Provision	0.244	0.045	8
Traffic Signs and Signal	0.121			0.121	3
Road Marking	0.392	Road Marking Paint	0.670	0.262	1
		Thickness	0.149	0.058	6
		Laying	0.181	0.071	5
Street Lighting	0.028			0.028	10
Road Shoulder Width	0.116	Shoulder Width	0.494	0.057	7
		Quality of Shoulder	0.139	0.016	13
		Pavement Edge Failure	0.367	0.043	9
Pavement Condition	0.159	Pothole	0.764	0.121	4
		Cracking	0.103	0.016	14
		Rutting	0.133	0.021	11
<b>Total</b>	1.000			1.000	

In addition, Fancello et al. (2019) indicate that Sight Distance is the most important factor for road safety, followed by the condition of the road surface and traffic flow. Another study by Nkurunziza et al. (2021) basically focuses on Road Geometry, which includes the lane width, curve radius, sight distance, super-elevation, and grades, which are the longitudinal slope. As mentioned in the previous study, there is an inconsistency in rating the safety

parameters. Lane width has been rated at 74%, curves have been rated at around 80%, sight distance at 96%, and 5% for super-elevation. In conclusion, there are different rankings for each sub-criteria due to the different sub-criteria that have been assigned as the factors to measure the safety of roads.

### Road Safety Index



**Figure 3:** Map of Road Safety Index

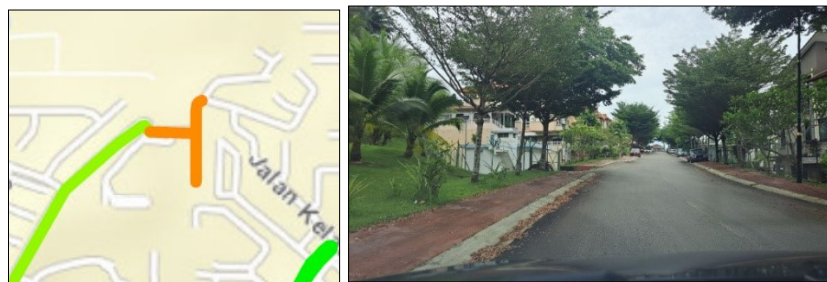
Figure 3 shows the map of the road safety index for Section 9, Shah Alam Selangor. Most of the roads in Section 9 had a high index of road safety. There is part of Section 9 roads that are in a low and average index of road safety. Based on observation on site, in the area with the low and average safety index, there are parts of the road that had no Road Markings and had several poor



Pavement Conditions. Therefore, this is the factor that caused the index value to become low and average. Basically, most of the roads in Section 9 followed the specifications of road safety. There are almost 16 roads with a very high safety index and 33 roads having a high safety index. There are four (4) roads in Section 9 Shah Alam, which have an average value of safety index, and 11 roads with a low safety index.

### Analyzing the Impact of Road Infrastructure Existence on Road Safety

According to site verification, the criteria of Road Marking and several Pavement Conditions are the reasons why the road being presented was an average in the safety index. Figures 4 and 5 and Tables 7 and 8 show different classes of the Road Safety Index. This analysis was conducted to test the impact of the existence and weightage of road infrastructure on the road safety index and validate the method chosen. As mentioned previously, road marking has the highest ranking among the overall sub-criteria. Therefore, if the road has no road marking, it will affect the index value and will make the index value of the road near the low safety index value.



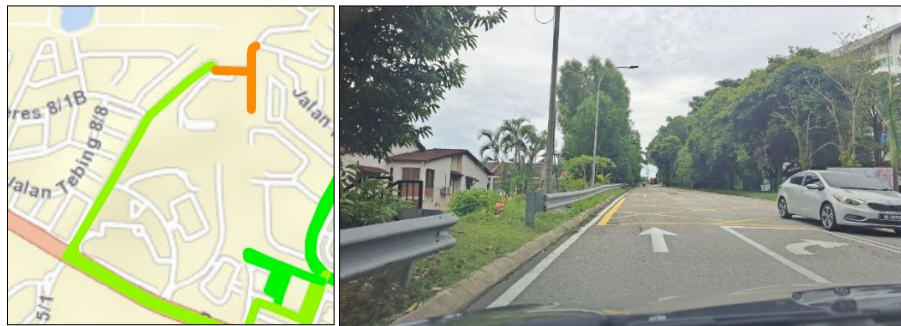
**Figure 4:** Example of Road without Road Marking

**Table 7:** Example of Road Safety Index for Road without Road Marking

Traffic Sign & Signal/ Street Lighting/Pavement Condition	Sight Distance	Sharp Curve	Drainage Provision	Road Marking Paint	Thickness	Laying	Shoulder Width	Quality of Shoulder	Pavement Edge Failure
	Exist	Exist	Exist	None	None	None	Exist	Paved	None
<b>Weightage Value</b>									
0.028	0.122	0.018	0.045	0	0	0	0.057	0.016	0.043
<b>Sum of Weightage Value</b>									
0.028	0.122	0.018	0.045	0	0	0	0.057	0.016	0.043

Figure 4 and Table 7 show the road that does not have Road Markings. Therefore, the weightage value for the sub-criteria of Road Marking Paint, Thickness, and Laying will be 0. For the Pavement Edge Failure, the failure does

not exist; therefore, the safety index will be added up with the weightage value of 0.043. Therefore, the final safety index for this road was 0.329. Figure 5 and Table 8 show that the road was in great condition. The weightage value from the criteria and sub-criteria had increased the safety index of the road. The pavement edge failure existed, but it did not affect the safety index, as the weightage value was 0. If the Pavement Edge Failure does not exist, the safety index may be added up with the weightage value of 0.043. In this case, the Pavement Edge Failure had existed; therefore, the weightage value that needed to be added up was 0. However, as the value of the safety index is near to 1, therefore the road may be categorized as a high safety index.



**Figure 5:** Example of Road with Road Marking

**Table 8:** Example of Road Safety Index for Road with Road Marking

Traffic Sign & Signal/ Street Lighting/Pavement Condition	Sight Distance	Sharp Curve	Drainage Provision	Road Marking Paint	Thickness	Laying	Shoulder Width	Quality of Shoulder	Pavement Edge Failure
	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Paved	Exist
<b>Weightage Value</b>									
0.121	0.122	0.018	0.045	0.262	0.058	0.071	0.057	0.016	0
<b>Sum of Weightage Value</b>									
0.121	0.122	0.018	0.045	0.262	0.058	0.071	0.057	0.016	0

## CONCLUSION

The aim of this study is to measure road safety by using an integrated method of Fuzzy-AHP and GIS. Utilizing Spatial-MCDA enables the integration of spatial aspects into the analysis. Spatial-MCDA provides an in-depth understanding of how spatial factors influence differences in road safety. In MCDA, relative weight is assigned to each criterion based on its relevance. In this study, the appropriate weightage value for road safety-related criteria has been determined.

These weighting values reflect the importance of each criterion in influencing road safety outcomes. By analyzing the identified criteria and their relative weights, the evaluation identifies which roadway segments have a high or low safety index. The findings of this study show that most roads in the study area have a high road safety index value, while only a few roads have an average value. This study focused on road infrastructure and related pavement conditions. Based on the analysis, it can be concluded that the road safety index is influenced by the existence of road infrastructure and the condition of road pavement. It is expected that the road safety index found in this study will have important effects on the assessment and future planning of road safety. The novelty of this study resides in its use of Fuzzy-AHP and GIS to measure the road safety index. The use of Fuzzy-AHP in this study allowed for a more comprehensive and precise analysis because it took into consideration all the criteria and expert judgments related to road safety issues. Also, by using GIS, things could be seen from the spatial perspective, which brings more insight into where and what factors specifically are responsible for the differences in road safety that occurred in both areas. By combining these approaches, a better evaluation could be done, which may contribute to the improvement of road safety and make educated choices about how to make improvements to the roads.

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## **SOCIOECONOMIC INFLUENCES AND PEDESTRIAN INFRASTRUCTURE IN PROMOTING ACTIVE TRAVEL TO SCHOOL AMONG PRIMARY SCHOOL CHILDREN**

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### **Abstract**

Walking is considered a physical activity, as it is well-established as a health-enhancing behaviour for children. Opting for active school travel like walking may help increase children's physical activity levels. However, participation in active school travel remains low in many countries. The lack of physical activity among children is a significant global health issue that can lead to an increased risk of non-communicable diseases and poor mental health. A questionnaire survey was conducted among primary school children aged 7 to 12 to study this issue further and gather their perspectives on active school travel. This study investigates the relationship between socioeconomic factors, such as household income, parental education level, and car ownership, and children's decision to engage in active travel to school. Furthermore, the study aims to assess the current state of pedestrian facilities and infrastructure near schools. In addition to the questionnaire survey, the researcher conducted on-site observations to evaluate the availability and condition of pedestrian facilities and infrastructure. The observations also included assessing traffic conditions and potential safety hazards for children who use active transportation to get to school. It is important to note that simply improving pedestrian facilities and infrastructure near schools may not be sufficient to change parental perceptions of traffic safety in the surrounding area.

**Keywords:** Active Travel, Active School Travel, Physical Activity, Walking

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## **INTRODUCTION**

Active School Transportation, briefly known as AST, is defined as walking, cycling, or using other active modes to get to and from school, which is opposed to driving or taking motorised transportation to school (Rothman, Hagel, Howard, Cloutier, Macpherson, Aguirre, & Winters, 2021). Walking is categorised under physical activity as it is well-established as a health-enhancing behaviour for children and adolescents (Uddin, Mandic, & Khan, 2019). Choosing active school travel, such as walking and biking, is conducive to increasing children's physical activity levels (Conference, 2020). The World Health Organisation (WHO) recommends that children and adolescents aged 5 to 7 years do a minimum of 60 minutes of moderate to vigorous-intensity physical activity (MVPA) daily. Only approximately 20% of children and young people in Sweden meet this recommendation, with a concerning downward trend. The decline in physical activity among children has become a public health problem of enormous proportions, and it has been likened to a global inactivity pandemic back in the early 2010s.

Furthermore, there has been a notable decline in children's freedom over the past five decades. In recent decades, most parents have found it challenging to grant their children the independence to walk to and from school on their own. One of the related studies discovered that Active School Commuting (ASC; walking or cycling to or from school) would re-enlighten physical activity by incorporating ASC into adolescents' daily routines (Uddin et al., 2019).

## **LITERATURE REVIEW**

Based on convincing evidence, children who use active transportation are more likely to be physically active than those who rely on passive modes of transport (Lu, Sun, Gou, Liu, & Zhang, 2019; Uddin et al., 2019). Consequently, how children commute to or from school may tremendously impact physical activity rates and health outcomes (Tewahade, Goldstein, Haynie, Iannotti, & Simons Morton, 2019). However, Active School Travel (AST) participation is low in many countries worldwide (Tewahade et al., 2019; Uddin et al., 2019). Children's physical inactivity is a prevalent global health problem that contributes to a higher risk of non-communicable diseases and low mental health status (Hawley, Witten, Hosking, Mackie, & Smith, 2019). In the past 30 years, there has been a substantial decline in physical activity and an increase in the obesity rate among children (Bolkhanian & Reyers, n.d.). One of the reasons for the decrease in physical activity is that the children often prefer to do less physically engaging activities, such as chauffeuring to school. Besides, based on the research undertaken by Faulkner and friends, it was stated that AST can be an essential source of physical activity among schoolchildren, and it has been associated with

higher overall physical activity levels and healthier body weights (Faulkner, Buliung, Flora, & Fusco, 2009).

In encouraging children to practice active school travel, pedestrian catchment areas need to be identified to ensure that the infrastructure provided is following the needs of pedestrians in terms of connectivity, comfort and safety. Therefore, based on the Public Perception Survey on Walking Distances for Daily Activities and the Healthy Walkable City Implementation Guidelines Survey that has been conducted, the average walking distance for an individual is 300 to 400 metres within a time range of 5 to 10 minutes, depending on their age and physical ability (PLANMalaysia, 2017). Table 1 shows the average 5-minute walking distance by age group.

**Table 1:** Average 5-minute Walking Distance by Age Group.

Category	Age	Estimated Distance (meters)	Estimated Time (minutes)
Children	3 to 6 years	100m	Average time: 5 to 10 minutes
	7 to 12 years	400m	
Adults	13 to 59 years	400m	
Senior Citizens	60 and above	180m	
Disabled	Depending on the ability and capabilities of the group		

*Source: PLANMalaysia (2017)*

Referring to Table 1, the estimated distance that needs to be considered by the provider for the children used is between 100m and 400m. This range ensures children safely and comfortably walk to school without excessive fatigue and risk.

In terms of walking distance between home and primary school, PLANMalaysia (2017) has suggested that the ideal distance is within 800 meters, equivalent to a journey of 10 minutes. As walking is an excellent way for children to accumulate daily physical activity, schools should be developed according to the population and catchment area.

Promoting AST can be a promising strategy to increase children's daily physical activity and contribute to their health and development. Nowadays, children and young people must have the opportunity to grow up in an environment that allows them to move freely, accept challenges, gradually expand their range of action, and cultivate their independence. Encouraging active travel among children effectively boosts their daily physical activity levels. It fosters future generations to become active road users, thus enhancing our chances of achieving the climate goals outlined in Agenda 2030.

Recent empirical and experimental research shows that Active School Travel behaviour is complex, with multiple factors interacting at different levels and varying determinants across contexts (Hawley et al., 2019). To unravel this complexity, he says a better understanding of context-specific influences across

socioecological domains is needed. Based on Rahul Raoniar, according to McMillan's framework, parents decide on behalf of the child which mode their children should use (Rahul Raoniar, Trinayan Das, Arunabha Banerjee, 2019). In many previous studies on similar topics, a questionnaire survey was conducted among the parents to understand the decision-making process of mode choice. For this topic of study, the questionnaire survey was distributed among primary school children aged 7 to 12 years old to get their views and perceptions regarding active school travel. This study explores the association between socioeconomic factors, including household income, parents' education level, car ownership, and children's decision to take active school travel. It will also identify the existing condition of pedestrian facilities and infrastructure surrounding the school area.

## **RESEARCH METHODOLOGY**

For the questionnaire survey, it was proposed that the study be carried out in six primary schools in Shah Alam City (Refer to Figure 1). Besides considering the researcher's ease of access to the sample population, the selection of schools was also guided by some visible characteristics of interest, such as areas with similar socioeconomic factors, land use, and convenient location. A school with these visible relevant characteristics was proposed to participate in the study. Only one school was taken to represent each small planning block. To meet the research ethics requirement, the Research Ethics Committee (REC) at UiTM has approved the instrument and protocol used for this study after submitting the application form, questionnaire survey form, parental informed consent form, child assent form, and other information.

The second method of data collection used for this study was a site observational study, where the researcher carried out observations at all schools that participated in the survey. The main objective of site observations is to assess the availability and existing condition of pedestrian facilities and infrastructures near the primary school area. Besides, it evaluated traffic conditions, including vehicle volume, speeds, and behaviours. The third reason for this method was to identify potential safety hazards for children who use active transport to school. Combining these two methods during data collection gives a more comprehensive understanding of the topic of study, thus developing targeted recommendations to enhance safety and accessibility.

## **Limitations**

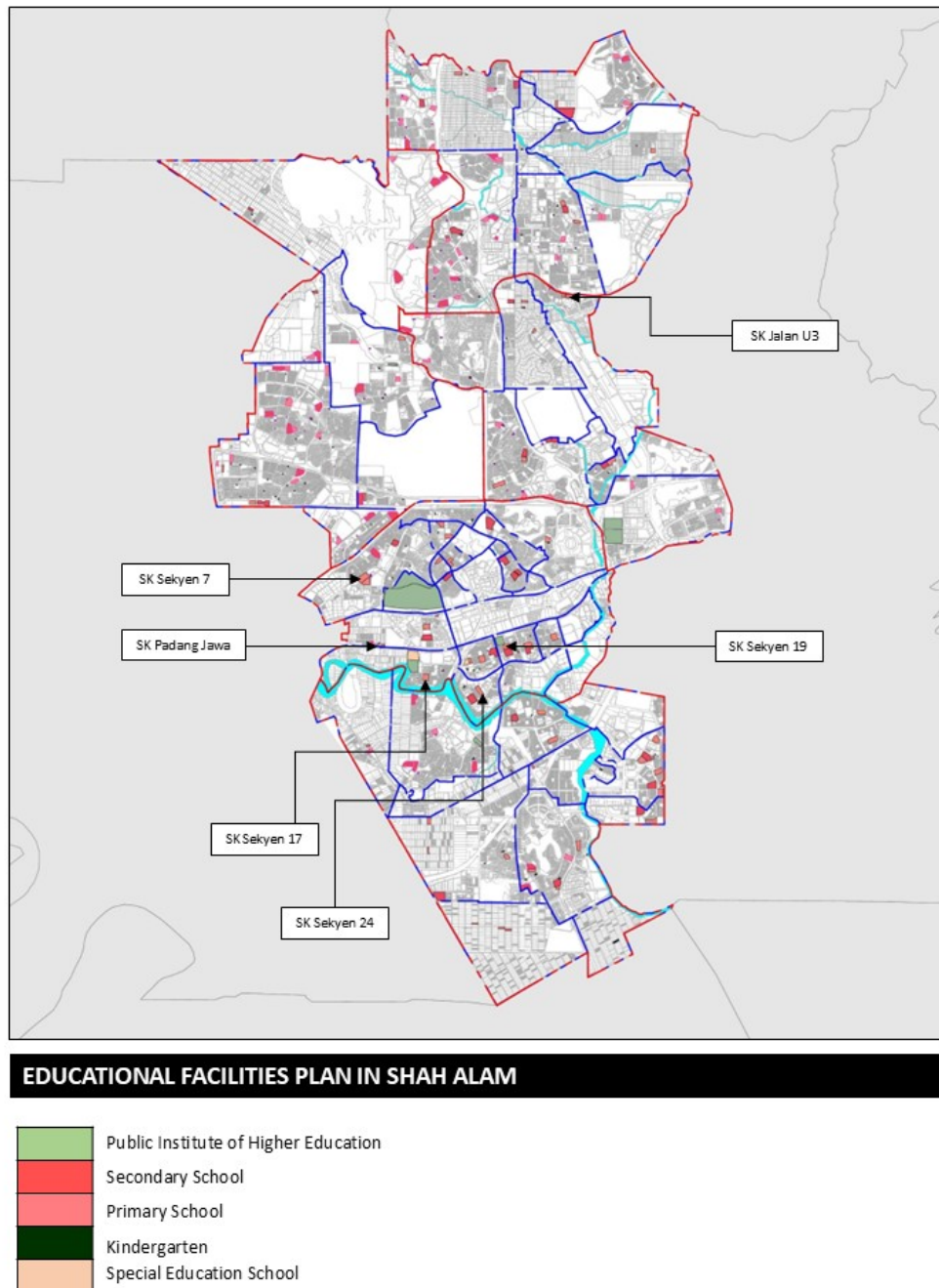
This study used cross-sectional data, which limits the ability to infer causal relationships between socioeconomic factors and children's active school travel. Perhaps for future research, a longitudinal study design would be more appropriate to examine how socioeconomic changes impact children's walking behaviour over time. Besides, this study focused only on physical activity during



the school commute. However, it did not consider the overall physical activity level of the children throughout the day or on non-school days. This is because a more comprehensive evaluation of physical activity would provide a deeper understanding of the contribution of active school travel. Not only that, but this study was also conducted in a specific geographic context, which is in Shah Alam City. The findings may not be directly generalisable to the Malaysian context.

### **Research Sample**

The researcher prepared a list of schools according to the small planning block under Shah Alam City Council. There were five small planning blocks under this local authority area. The selection of primary schools was done primarily through convenience sampling. The total population of primary school children in Shah Alam is 66,508, based on the statistics released by the Ministry of Education (updated on 30th June 2022). Considering the total population is known, the sample size for this study is 381, according to Krejcie and Morgan's method of determining a sample size (1970). Based on the table for determining sample size from a given population, it stated that for a population size of 50,000, the sample size is 381. However, the researcher added 19 more questionnaires (a total of 400) in case any issues occurred during the questionnaire distribution.



**Figure 1.** The location of six schools involved in the survey

### Data Collection Procedure

Data collection was conducted during March and April of the year 2023. The questionnaires (N=400) were distributed to primary schoolchildren aged 7 to 12 who walked to or from school any day of the week. This age range was selected to participate in this study because students at this age level already dare to walk to schools alone or accompanied by friends, parents, or guardians. The respondents also consist of students who walk to school for both morning and afternoon sessions. Those students who were using a vehicle every day were excluded from participating in the study. The survey included five sections, namely student and parent personal information, details of the student's walk to school, pedestrian infrastructure and facilities, and perception of safety aspects while walking to school.

When the students were assembled and ready to participate in the study, the researcher explained its purpose and relevance and then distributed the questionnaire. The respondents were requested to return the questionnaire three days after the questionnaire was distributed. The consent letter from the researcher to parents or guardians was attached to the questionnaire, explaining the objectives and relevance of the study, assuring the respondents of anonymity, and giving them the option of not participating in the study if they wish. Overall survey response was 100% (N=400).

### ANALYSIS AND DISCUSSION

The first analysis focused on the relationship between age level and gender in terms of active travel to school. Table 1 shows that the number of male students (n=204) who walk to or from school is more than that of female students (n=196). The analysis revealed some interesting patterns where, across most age levels, more boys walked to school than girls. They were only 7 and 11 years old, and the number of female students was higher than that of male students. However, it can be seen that the gender gap varied by age level. Overall, it can be concluded that both genders have the same tendency to walk to or from school due to the differences between the number of males and females not being too significant.

**Table 2:** The Relationship between Age Classification and Gender.

Age	Number of Students		Total
	Male	Female	
7 years	4	6	10
8 years	16	10	26
9 years	23	18	41
10 years	51	35	86
11 years	46	78	124
12 years	64	49	113
<b>Total</b>	<b>204</b>	<b>196</b>	<b>400</b>

*Source: Author's Calculation*

Based on Table 1, it can be discovered that the gender disparity widened in the 8 to 10 and 12 years old, where the numbers between male and female students are pretty extensive. This age level is critical when children start gaining more autonomy and independence. However, social norms and safety concerns may limit a female student's ability to walk to school. It was due to puberty and concerns by the parents about the girls' safety in public spaces, which could also contribute to the restriction of girls from participating in school active travel at that level of age.

Some studies on this topic highlight that in a case study of Rasht, Iran, high school girls are less likely to walk than younger girls and boys (Hatamzadeh, Habibian, & Khodaii, 2017). This result suggests that gender roles and societal expectations may influence these behaviours. Furthermore, the findings show that while both genders face barriers to walking, the factors affecting their decisions to walk differ, and girls commonly encounter more significant obstacles.

Looking at Table 1, the findings highlight several aspects, such as gender socialisation, safety concerns, and independence, that shape children's active travel behaviour across all age levels. Thus, based on the findings, more targeted interventions to encourage walking to school may need to be tailored to address the specific barriers faced, especially by female students of different ages. Among initiatives that can be proposed is to engage parents in the form of discussions regarding the benefits of active school travel and ways that can be taken to ensure the girl's safety as an effort to narrow the gender gap as well as encourage more children to participate in active school travel.

**Table 3:** The Relationship between Walking Frequency and Mode of Transportation to School

Frequency of Walking to school in a week	Mode of Transportation to School								Total
	Walking		Cycling		Parent's Vehicle		Public Transport		
	Male	Female	Male	Female	Male	Female	Male	Female	
1-2 times	33	23	0	0	24	15	4	5	104
3-4 times	18	14	2	1	4	10	3	0	52
5 times/everyday	153	159	5	3	18	37	3	7	385
Subtotal	204	196	7	4	46	62	10	12	
Total	400		11		108		22		

*Source: Author's Calculation*

Table 2 presents the crosstabulation results between children's mode of transportation and the frequency of walking to school in a week, separated by gender. For this question, respondents may choose more than one option, as the students may have a mixed mode of transportation to school. Due to this, multiple-answer questions have led to the number of students cycling, riding a parent's vehicle, and using public transport.

Based on Table 2 above, the analysis revealed an apparent relationship between the frequency of walking to school and the primary mode of transportation to school taken by the students. The results show that among schoolchildren who walked to school for five days per week, 312 (153 male and 159 female) out of 400 students used active transportation (walking) as their primary mode. In contrast, 8 (5 male and 3 female) and 65 (18 male and 37 female) cycled and used motorised vehicles. Of schoolchildren who walked to school 3 to 4 days per week, 32 (18 male and 14 female) out of 400 students walked to or from school, while 3 (2 male and 1 female) and 14 (4 male and 10 female) students cycled and used motorised vehicles, respectively. Among those who walked to school 1 to 2 days per week, only 56 students used active transportation (walking), and the remaining 48 used motorised vehicles.

The results suggest that as the frequency of walking to school decreases, the proportion of children using another mode of transportation increases. Here, it can be concluded that those who walked to school more often have a greater tendency to use active modes of transportation than those who walked less frequently. In contrast, for those students who walked to school only 1-2 days per week, the proportion of using active transport to school also dropped. It can be noticed that the remaining students with low walking frequency primarily relied on motorised vehicles such as cars, motorcycles, and public transport like school buses to get to and from school. This situation can be related to the findings of other studies, which highlight that as the distance to school increases, the frequency of walking decreases. At the same time, the proportion of children using passive modes of transportation, such as cars and buses, is increasing (Larsen, Gilliland, Hess, Tucker, Irwin, & He, 2009).

To summarise, this result suggests that the more often children walk to school, the more likely this group is to adopt active transportation as their habitual mode of travel. On the other hand, relying on the motorised mode for school travel does not encourage active travel to school, primarily if school and home are located within a reasonable distance.

**Table 4:** The Relationship between Socioeconomic Factors and Walking Frequency of Children

	Walking Frequency to School in a Week			
	1-2 times	3-4 times	5 (everyday)	Total
<b>Household Income</b>				
No Income	6	2	28	36
B40	43	28	224	295
M40	4	2	49	55
T20	3	0	11	14
<b>Parental Education</b>				
No Formal Education	1	0	5	6
Primary School	1	2	17	20

Secondary School	30	18	130	178
Tertiary Level	16	8	124	148
Postgraduate Level	2	2	11	15
Not Related	6	2	25	33
<b>Car Ownership</b>				
Yes	51	24	281	356
No	5	8	31	44

*Source: Author's Calculation*

The result in Table 3 revealed several key insights on the relationship between socioeconomic factors and the walking frequency of children in a week. The data presented a strong association between household socioeconomic status and the walking frequency to school in a week. Regarding household income, it was discovered that children from lower-income households were significantly more likely to walk to school five days per week. The result contrasts with the higher-income group, which recorded a decline in walking frequency. The pattern result was recorded to be the same for the walking frequency of 1 to 2 times a week for both lower and higher-income groups.

However, the mixed findings of Chi-Square tests indicate uncertainty about the relationship between household income and school walking frequency. The Pearson Chi-Square test (24.394) shows no significant association between these two variables, meaning that household income does not differ significantly in the weekly walking frequency to school. The Likelihood Ratio test also indicates no significant association with a p-value of 0.077.

Table 3 shows a similar pattern for parents' education level whereby, among schoolchildren whose parents had tertiary level as the highest education level, they recorded a higher number of students walking to school five days a week compared to those whose parents have postgraduate level qualifications. These results suggest that the less educated parents place a higher value on active transportation. Thus, responsible authorities may implement awareness programmes in many educational centres to promote the walking culture among individuals for future planning.

The results of the Chi-Square for these two variables also indicate uncertainty. The Pearson Chi-Square test (8.630) shows no significant association between these two variables, meaning that parental education does not differ significantly in the weekly walking frequency to school. The Likelihood Ratio test also displays no significant association with a p-value of 0.487.

Apart from the above, car ownership was also tested to determine whether it influences the walking frequency of schoolchildren. Interestingly, the highest number of children from households that owned a car walked to school five days per week, and children with no vehicles also recorded the highest number of people walking to school every day. This result indicated that the

availability of motorised transport does not discourage children from walking, even for those living near the school area.

Uncertainty is discovered when testing the relationship between car ownership and walking frequency. There is no discernible difference in the frequency of these two variables, as indicated by the results of the Pearson Chi-Square test (7.013). With a p-value of 0.062, the Likelihood Ratio test likewise shows no meaningful connection and is insignificant.

In conclusion, the survey findings presented in the table above highlight the significance of socioeconomic disparities in children's active transportation to school in Shah Alam City. Even though the results obtained contrast when the Chi-Square test was used, these factors must be considered. It is suggested that the responsible authorities address these inequities by targeting infrastructure improvements and educational campaigns. Both recommendations will be crucial to promoting walking and improving the health and safety of all primary schoolchildren.

The second data collection method is a site observational study focusing on the availability and condition of the pedestrian infrastructure, traffic volume, speed, and potential safety hazards in the site area. The following part will summarise key findings from the site observation related to those aspects.

Based on the observation of the researcher, the majority of the roads in front of the school area lacked dedicated sidewalks or footpaths, which forced pedestrians to walk on the road shoulder on the grass. It is the responsibility of responsible authorities to ensure that pedestrian facilities are provided to facilitate schoolchildren's use of the facilities safely. Besides, where sidewalks were present, it can be observed that many were in poor condition, such as having cracks, uneven surfaces, and obstructions such as utility poles and parked vehicles on the sidewalk area. On top of that, the crosswalks were limited without continuity and often located at major intersections, which required children to walk long distances to reach safe crossing points. Regarding supporting facilities, pedestrian signals and signage were inadequate, with many crosswalks lacking clear markings and signage that alerts drivers to pedestrians' presence. The following photos show the existing condition of the site area in terms of pedestrian infrastructure and facilities aspects.



**Figure 2.** The signboard installed away from the main road



**Figure 3.** The traffic light is not working



**Figure 4.** There are no clear markings on the speed hump



**Figure 5.** Pedestrian paths are placed with large trash cans



**Figure 6.** Cracks and uneven surfaces pedestrian path

For the second aspect, traffic conditions, it was noticed that the traffic volumes were high during school arrival and dismissal times. This situation happened due to the mix of cars, buses, and motorcycles on the roads simultaneously, which contributed to the crowdedness. The main road in front of the school area is two ways, which caused severe congestion in front of the school. Also, vehicle speeds often exceed the posted speed limit of 30km/hr, especially on wider roads with no traffic calming measures implemented. Besides, double parking and illegal stopping by parents' vehicles that drop off and pick up their children created congestion and reduced pedestrian visibility.





**Figure 7.** The speed limit in front of school area



**Figure 8.** The situation in front of school area during peak hours

Apart from the above aspects, safety hazards are also among the crucial elements considered in this study. During site observation, there was a lack of separation between pedestrians and vehicles, with no physical barriers or buffers on many roads near the school area. The overgrown vegetation and parked cars along the shoulder of the road obstruct visibility at intersections and crosswalks. On top of that, the inadequate lighting along the streets and pedestrian crossings, especially during early morning and evening hours when children are commuting to and from school, became one of the main problems for pedestrians in terms of safety. It was aggravated by drainage issues, which led to water pooling on the road shoulder and sidewalks, especially during rainy periods.

To sum up, all these findings discovered from the site observational study have highlighted the significant challenges and safety risks faced by children walking to school in the study area. To conclude, the lack of adequate pedestrian infrastructure, high traffic volumes, speeds, and various safety hazards create an environment that is inconducive to active transportation and puts children at risk of traffic crashes or other incidents involving pedestrians.

## CONCLUSION

Based on the findings in the previous sections, it can be concluded that improving the pedestrian facilities and infrastructure provision in the school area is not enough to improve the parental perception of traffic safety in the neighbourhood school area. Despite that, this study may provide an analytical framework to examine how socioeconomic factors and traffic safety may relate to children's behaviour among schoolchildren across different areas. For future research, it is suggested that the researcher focus on people who use passive modes of transportation, as a result assisting in clarifying the transportation needs and preferences, which at the same time may encourage active school travel habits among school children. Most importantly, it will lead to a fairer distribution of resources where pedestrians can fully utilise the installed pedestrian facilities and infrastructures.

## ACKNOWLEDGEMENT

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## DISCLOSURE STATEMENT

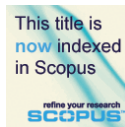
The authors declare that no personal, professional, or financial relationships related to this research that could be construed as potential conflicts of interest.

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## **THE INFLUENCE OF URBAN PARK ON SHAPING THE PERCEPTION OF SOUNDSCAPE: CASE STUDY OF PUTROE PHANG PARK IN BANDACEH, INDONESIA**

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### **Abstract**

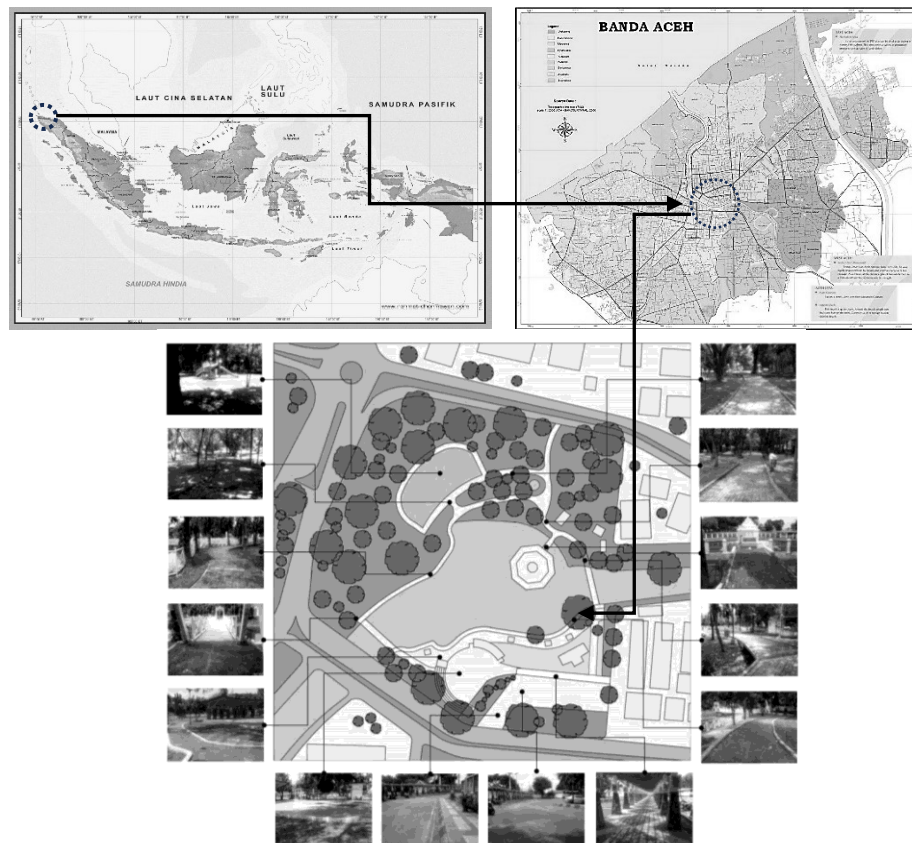
Urban parks play a vital role in enhancing the quality of life in cities by providing serene, healthy natural environments. Among their numerous benefits, urban parks significantly influence the auditory experience of visitors. This study investigates the impact of landscape elements within urban parks on perceived soundscapes, focusing on Putroe Phang Park, one of the largest urban parks in Banda Aceh, Indonesia. Our methodology combines landscape observations, soundwalk data collection, visitor questionnaires, and sound measurements, including Sound Pressure Level (SPL) and Ambisonic recordings. We used a UNI-T UT sound level meter and a Zoom H1N digital audio recorder for data collection. The SPL distribution within the park was visualized using contour maps generated using Surfer software (version 23.3.202). Our findings reveal that while some landscape elements contribute positively to a pleasant soundscape, others, notably traffic noise, detract from the overall experience. However, the park's Leq remained between 58 and 68dB(A), below the upper threshold of 70 dB(A). Our findings suggest that enhancing the diversity and quality of landscape elements can mitigate undesirable sounds and improve the park's auditory environment.

**Keywords:** Landscape Elements, Putroe Phang Park, Banda Aceh, Soundscape, Urban Park

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## INTRODUCTION

Urban parks are an important element of a city, contributing to the creation of a natural, healthy, and pleasant environment (Ahmad et al., 2024, Zuraidi et al., 2022). They also positively impact psychological restoration (Nordh et al., 2011; Ishak et al., 2018; Zhu et al., 2023), focusing on user preferences (Ersoz et al., 2024). The landscape elements of the parks provide sounds that create a comfortable atmosphere and shape visitors' perceptions. These elements also act as barriers to reducing urban traffic noise. A park in the middle of a city provides thermal, visual, and acoustic comfort to the surroundings (Nursaniah et al., 2023, Hakim, 2012). Environmental acoustics in public spaces support self-soothing activities and health therapy, substituting nature outside the city (Buxtona et al, 2021).



**Figure 1:** The location of Putroe Phang Park in Banda Aceh positioned at 5°32'49"N, 95°18'59"E and its surroundings

Environmental acoustics and ecology studies have been widely discussed through soundscape or sonic-environment theories (Sugiarto and Ghani, 2019). However, the implementation of landscape elements, an indicator of the quality of ‘soundscape’ in the built environment, has received less attention. Therefore, this study identifies the influence of landscape elements in urban parks on shaping the perceived soundscape.

Putroe Phang Park, one of the largest urban parks in Banda Aceh, Indonesia (Figure 1), was investigated in this study. Putroe Phang Park features a variety of greenery, including large trees, bird nests, playgrounds, and ponds connected to the city river. The park also features hardscape and softscape elements, allowing for various human activities. As for the sonic environment, human-generated sounds, such as machine noise, tend to dominate over natural sounds like water, birds, and insects. Such noise negatively affects the overall environment (Rehan, 2014).

This study makes a notable contribution to the expanding field of urban park soundscapes and their connection to landscape elements, thus addressing a gap in the research. While much attention has been given to the role of soundscapes in urban environments, less attention has been given to how landscape elements influence the perception of soundscapes. By investigating Putroe Phang Park in Banda Aceh, this research highlights the importance of incorporating natural landscape elements in urban parks to create a more enjoyable and restorative acoustic environment. It demonstrates the ability of these elements to reduce urban noise and improve environmental conditions by enhancing thermal, visual, and acoustic comfort. The study also provides valuable insights for sustainable urban planning, especially regarding how natural sounds can counterbalance the dominance of artificial noise in city parks. Furthermore, it introduces a new perspective on the role of landscape features in shaping soundscapes, which is crucial for improving the well-being of park visitors.

## **LITERATURE REVIEW**

### **Soundscape**

According to Aletta et al. (2019), the concept of ‘soundscape,’ popularized by R.M. Schafer, refers to the acoustic environment and how it is perceived by individuals or society. It emphasizes the balance of sounds in a living environment and is considered an ecological acoustic discipline (Sugiarto and Ghani, 2019). Soundscape research often focuses on urban areas, where diverse and intense sound sources can invoke different perceptions and emotions. The influence of landscape elements on soundscape perception is not fully understood, highlighting the need for further study (Samsyiah et al., 2019).

Soundscape research aims not only to control noise but also to facilitate area reconstruction (Wang, 2003). The key landscape elements influencing soundscape perception in city parks include buildings, vegetation, and open-air conditions. (Syamsiyah et al., 2019). Rehan (2014) compared public spaces and concluded that effective soundscape design could incorporate green walls and green roofs, softer materials, water structures such as fountains, and noise barriers to reduce traffic noise. These studies emphasize the importance of urban park design in shaping soundscape perception.

## **RESEARCH METHODOLOGY**

The research employed a mixed-method approach, specifically the triangulation method, to study soundscapes at Putroe Phang Park, Banda Aceh. With its diverse vegetation and urban noise, this park was investigated to build on previous studies by Afif et al. (2023) and Bilqis et al. (2024), which focused on landscape elements and thermal conditions. The study examined several variables: (1) sound and voices, (2) landscape characteristics, and (3) landscape elements. Observational data were collected using the soundwalk/ sound diary method, where the researcher walked through the park, engaging with the space and its acoustics while recording the sounds and experiences encountered (Syamsiah et al., 2015<sup>\*</sup>, Mitchel, 2019).

Additionally, a questionnaire was conducted to collect data on user perceptions, using the category and soundscape rating scale listed in ISO/TS 12913-2:2018 (Morillas, 2006). Thirty Architecture students from Universitas Syiah Kuala, aged 18 to 22 years (16 males, 14 females; mean age = 20.3 years, SD = 0.92), participated as respondents. All participants were in good health free from medication that could affect hearing. They were asked to participate in soundwalks in the morning between 09:30 and 11:30 and in the afternoon between 16:30 and 18:30. The Participants were divided into two groups: a morning group (n=15) and an afternoon group (n=15).

To assess the measured Sound Pressure Level (SPL), average Leq (1 minute) noise data were collected from 63 points (Figure 2.a). These measurements, taken with a UNI-T UT353 sound level meter (range: 30 dB - 130 dB(A)), resulted in 1,584 samples—792 from the morning and 792 from the afternoon. Noise measurements were conducted during both periods. Voice recordings were captured at 15 sample points (Figure 2.b) using a Zoom H1N handy recorder, which meets the recommended specifications (20Hz to 20kHz range, 44.1 kHz sample rate, 16-24 bit depth). The recorder was set to WAV 96kHz/24-bit format with a gain of 6-7, and various settings, such as the low cut filter, limiter, and Auto-level, were turned off. A furry windscreen was used to minimize wind noise. The AMB method captures low-frequency sounds, such as bird and cricket calls, at representative points after the initial observations.

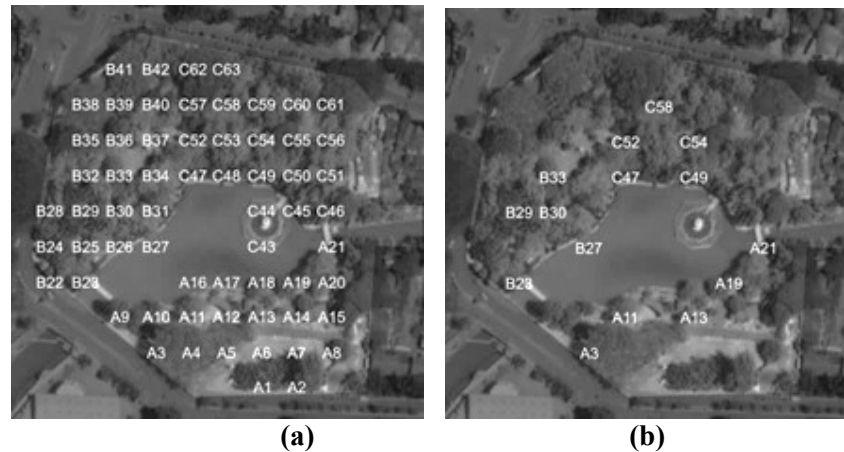


Figure 2: SPL measurement point (a) and ambisonic recording point (b)

## RESULTS AND DISCUSSION

### Putroe Phang Park Overview

Putroe Phang Park is a city park and a green open space that functions as an urban forest in the Baiturrahman sub-district of Banda Aceh City (DISBUDPAR, 2015). It is part of a historical complex, famously known for being built by The Sultan of Aceh (1608-1636) as a refreshing park for his consort, Putri Pahang (Fakhira, 2021). The Park is situated in the heart of downtown Banda Aceh and is surrounded by areas with diverse activities, as shown in Figure 1. To the north, the park faces Sultan Mahmud Syah Street, Simpang Jam, and government office complexes. To the south, it is bordered by Jalan Nyak Adam Kamil 1, which hosts commercial, military, and residential areas. On the west side, the park is bordered by the Krueng Daroy River, the Iskandar Muda Kodam complex, and residential and commercial spaces. The park's eastern side is adjacent to Jalan Teuku Umar, a commercial area of cultural and historical significance.

### Landscape character

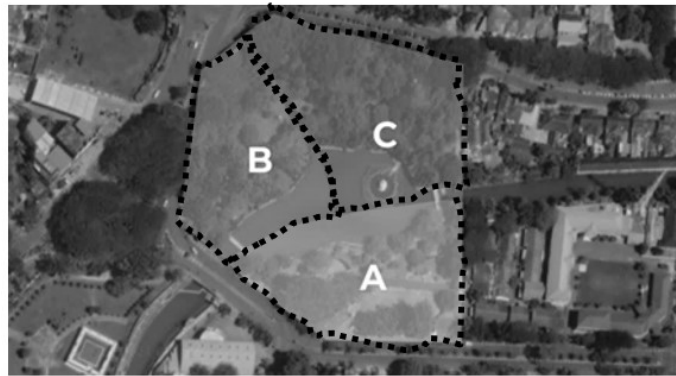
Field observations of Putroe Phang reveal that it functions as an urban forest and follows a two-way typology, as classified by Irwan (2019). The park's vegetation is primarily dominated by tree species such as Tanjung (*Mimusops elengi*) and Asam Jawa (*Tamarinda indica*) alongside grass. The vegetation grows along the shape of the Krueng Daroy River, which divides the park into two. The park experiences tropical weather conditions with high average humidity.

### Landscape elements

Observations at Putroe Phang Park were conducted in three zones: A, B, and C (Figure 3). Zone A includes the amphitheatre, parking lot, and surrounding



spaces. The ground surface comprises cement, gravel, ceramic, paving blocks, and grass mixed with bare soil. The dominant vegetation includes Tamarind, Amboyna wood, Spanish cherry, and Sea Pine trees. Zone B features a landscape dominated by Spanish cherry and Tamarind trees, which provide shade. It includes a rock pool area, designed to resemble a stream that connects to Zone C, and a children's playground covered with grass and shaded by evergreen *Reullia angustifolia* plants. Zone C is adjacent to Zone B and has footpaths made of paving blocks and cement. The area contains a non-functional cement fountain, and the ground is mostly covered with leaves, grass, and ground-cover plants.



**Figure 3:** Observation zones conducted in Putroe Phang Park

### Distribution of Sound and Sound Sources

Figure 4 illustrates the distribution of sounds and noises that shape the soundscape of Putroe Phang Park, as observed during the initial study. **Anthropogenic** sound sources include traffic noise, car horns, and sirens from the highway adjacent to the park.



**Figure 4:** Distribution of sound and sound sources in Putroe Phang Park

In contrast, natural sounds, such as geophony and biophony, also contribute. **Geophony** includes sounds from wind, water, and rustling leaves, while **biophony** refers to sounds produced by squirrels, birds, and insects within the park's landscape elements. Additionally, anthropophonic sounds are present due to visitor activities within the park (Figure 4).

### Observation Data

Observations were conducted during the morning and evening between late 2021 and early 2022. Over a 45-minute observation period across three days, various sounds and their intensities were documented in Putroe Phang Park. Figure 5 presents a graphic model of soundscape perception following the methodology proposed by Heryanto et al. (2021). In Zone A, traffic noise predominated throughout the day, particularly in the afternoon, with some human activity sounds and occasional natural noises like birds and wind. Zone B, located near a busy intersection, experienced significant traffic noise, with minimal natural or human sounds. Zone C, on the other hand, was quieter in the morning, with more natural sounds, offering the most comfort to visitors.

Overall, Zone B was the noisiest, followed by Zone A, while Zone C was the most tranquil. A significant difference in sound intensity was observed between morning and afternoon across all zones. Zone B caused the most discomfort, followed by Zone A, despite the presence of natural sounds. Zone C, with its quiet ambiance, provide the most comfortable experience.

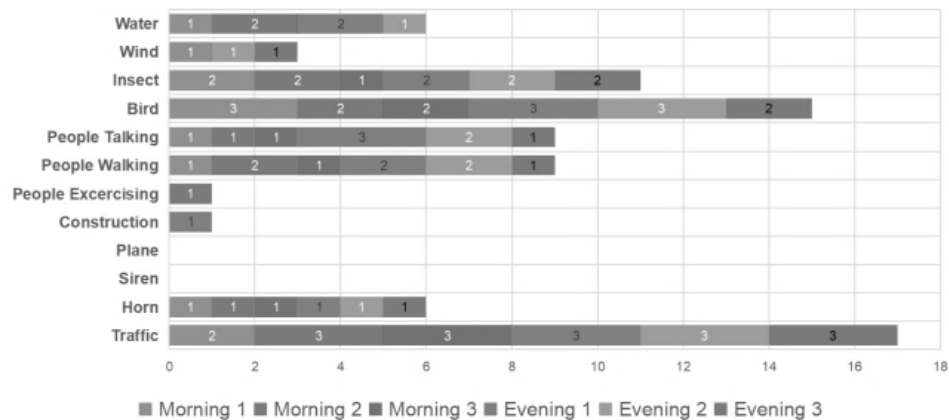
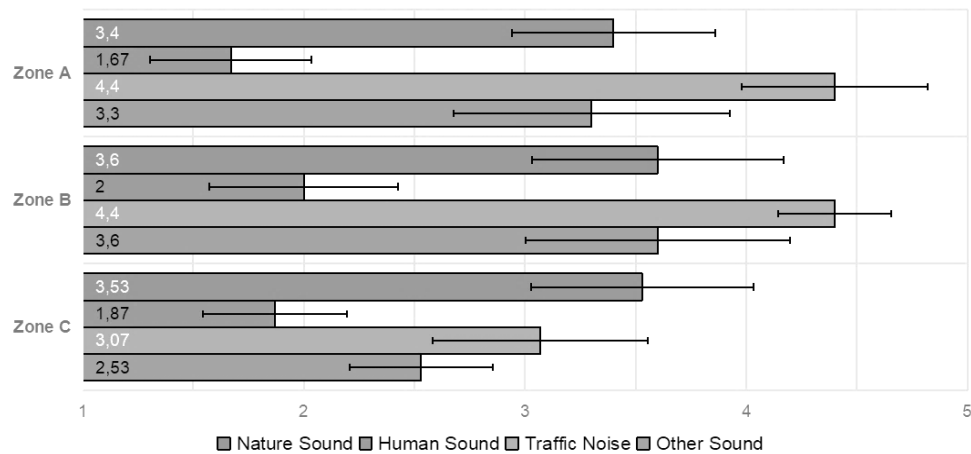


Figure 5: A sample of Sound and voice types observed in Zone A

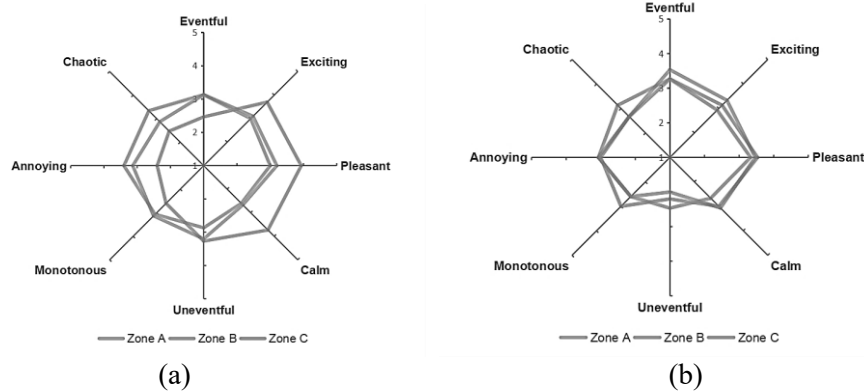
### Soundwalk data and questionnaire

A soundwalk was conducted with thirty participants who walked through Zones A, B, and C, spending approximately 10 minutes listening in each zone under cloudy, rainy conditions. This study revealed that in Zone A, traffic noise was the loudest and significantly more prominent than other sounds. Traffic noise was also dominant in Zone B but more comparable to natural sounds. In Zone C, natural sounds, though slightly quieter than traffic noise, were the most noticeable, while human activity sounds remained minimal due to low visitor numbers (Figure 6).



**Figure 6:** Average values with 95% confidence intervals of the most dominant sound and voices occurring in the morning in Zones A, B and C (first question category)

Figure 7.a illustrates the quality of sound perception in the morning using a radar graph. Zone C was perceived as the most pleasant, comfortable, and calm due to the dominance of natural sounds and minimal traffic noise. In contrast, Zones A and B were perceived as distracting and chaotic, mainly due to higher traffic noise levels. Figure 7.b shows the afternoon perceptions, which were generally more positive across all zones. However, Zone B scored highest for “chaotic” feelings, reflecting the influence of heavy traffic. Zone C scored highest for “pleasant” and “boring” due to a balance of natural sounds and minimal variation. The absence of bird sounds in the afternoon also contributed to more negative perceptions in Zones B and C.

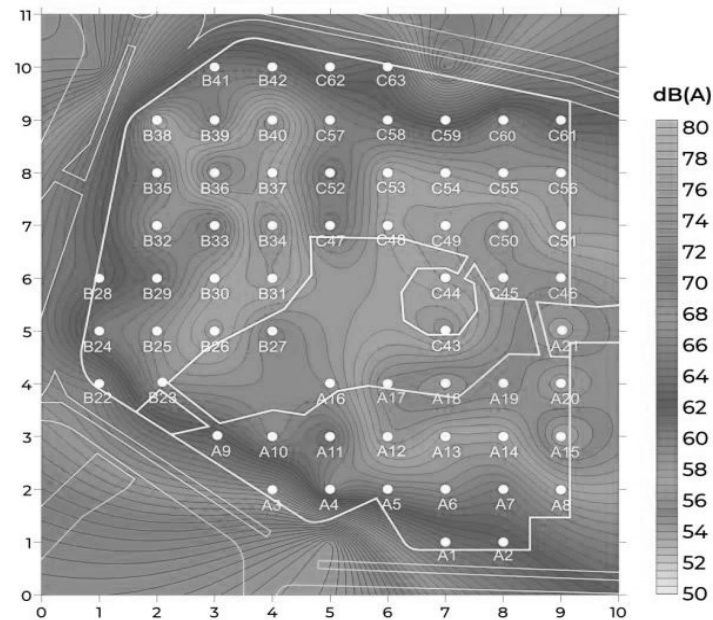


**Figure 7:** Average values of the perceived quality of sounds and noises in the morning (a) and in the afternoon (b) in Zones A, B and C (second question category)

Figure 7.a also shows that in the morning, Zone C received the highest scores for soundscape quality and feasibility, favored for its dominance of natural sounds over traffic noise. Zone B received the lowest scores, with participants reporting being most disturbed by road noise. In the afternoon (Figure 7.b), Zone C again received the highest scores, although not significantly different from Zones A and B. Zone B, despite having more greenery, was less favored due to traffic noise. Zone A was seen as more “exciting” and “calm,” while Zone C was considered the most “pleasant” due to its natural features.

### Leq Measurement

The measurement method collected the average Leq noise data (1 minute) at sixty-three points in Putroe Phang Park in the morning and afternoon. Measurements were also conducted outside the park at three points to compare the average noise levels inside and outside. A total of 1,584 samples were collected, with 792 samples taken in the morning and 792 in the afternoon. Figure 7 shows the average Leq values for both periods.

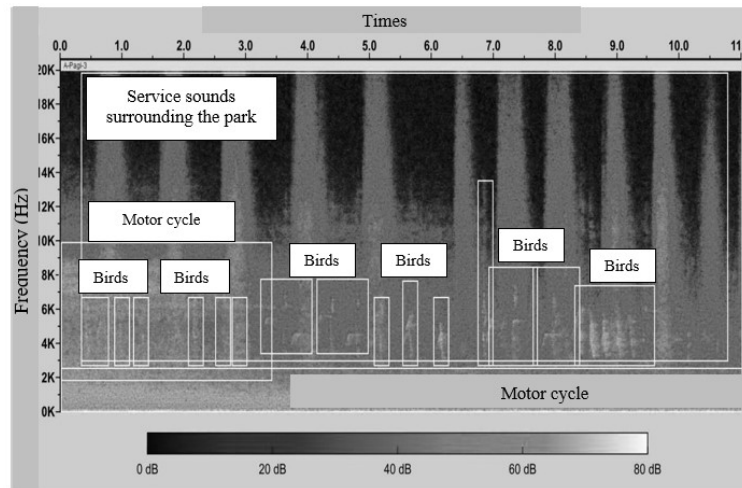


**Figure 8:** Leq values (1 minute) for measurement points in the morning

The measurements were conducted between 09:30 and 11:30 in the morning and between 16.30 and 18.30 in the afternoon. The weather was sunny, and traffic density was normal. No measuring point was recorded for a sound pressure level (SPL) below 50 dB. As shown in Figure 8, the average Leq value in the three zones (A, B, C) during the morning was relatively similar, around 59 dB(A), which exceeds the Indonesian noise standard (Kep-48/menlh/11/1996). However, it remains below the upper threshold of 70 dB and is classified as quiet (Syamsiyah et al., 2020; Suriandjo, 2021).

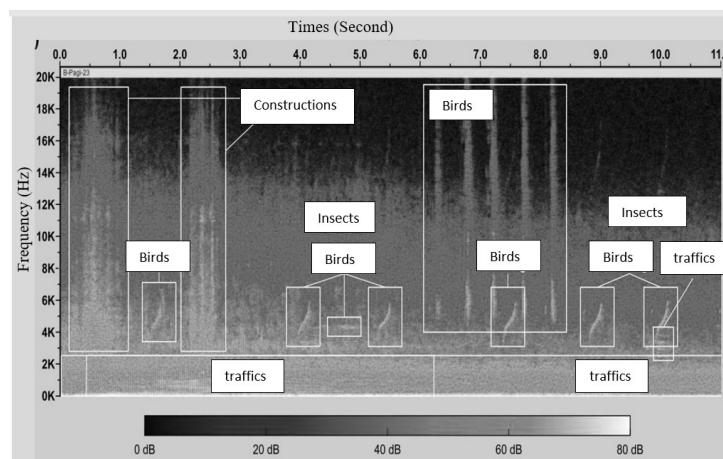
### **Ambispheric Recordings**

Figure 9 shows that in Zone A, on a sunny day, traffic noise dominated the morning and afternoon at 20-2500 Hz with an intensity of 50-80 dB. Bird sounds were observed at points A3, A13, and A19 at 2000-8000 Hz with an intensity of 30-65 dB. Water sounds were prominent only at point A21 near the white bridge, ranging from 2000-18,000 Hz. Morning broom sounds were detected at points A3, A11, and A13, while motorcycle noise at point A3 was noted between 2000-9000 Hz.



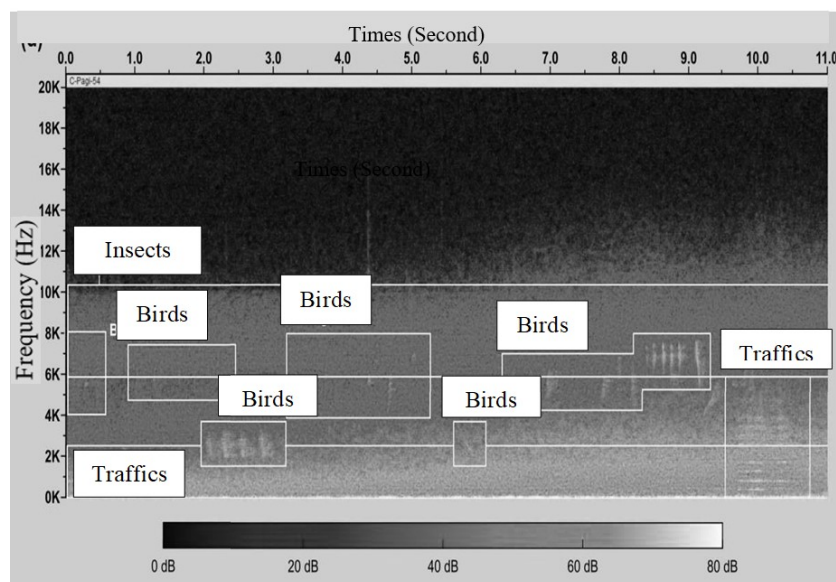
**Figure 9:** Spectrogram of an 11-second ambisonic recording in Zone A

Figure 10 reveals that in Zone B, traffic noise consistently dominated throughout the day. Bird sounds were prominent at points B30 and B33, between 1800-8000 Hz and 30-65 dB, but less intense at points B23 and B27. Insects were heard at points B29 and B33. By the afternoon, bird sounds had diminished, especially at points B23 and B29, with some activity remaining at points B27, B30, and B33. Wind sounds dominated at point B23, while insect sounds persisted at points B29 and B30. Vehicle and horn noise occurred at multiple points, contributing to the overall noise levels.



**Figure 10:** Spectrogram of an 11-second ambisonic recording in Zone B

Figure 11 shows that traffic noise was the primary sound throughout the day in Zone C. Although Bird and insect sounds were present, traffic often overshadowed them. Bird activity was notable at point C58, and insect sounds were strongest at point C49 near the river. Wind rustling through leaves was prominent in tree-covered areas. In the afternoon, bird and insect sounds decreased, while traffic noise remained significant. Additional sounds included vehicle horns, a brief car alarm at point C54, and wind sounds. Key sounds in Zone C included birds, insects, river flow, wind, and traffic. Secondary sounds involved park activities and construction noise. Despite being masked by traffic, insect and water sounds are crucial for preserving the park's natural ambiance.



**Figure 11:** Spectrogram of an 11-second ambisonic recording in Zone C

### Comparative Influence:

- **Traffic Noise:** Traffic noise is the most dominant factor across all zones, particularly in Zone C, where it consistently overshadows natural sounds. In Zone A, traffic is less intrusive than in Zone C but remains a significant part of the soundscape.
- **Natural Sounds:** Zone B showcases a stronger presence of natural elements, like birds and insects, especially in the morning, making it feel more balanced between urban and natural soundscapes than Zones A and C.

- **Human Activity:** Zone A presents more varied human sounds, such as broom noises and motorcycles in the morning, while in Zone B, vehicle horns and other traffic-related sounds dominate human activity noise.

This comparison highlights that, while traffic is a constant disruptive factor, areas with stronger natural sound elements (like birds, insects, and water) help balance the perception of the soundscape, making it feel more connected to the park's natural ambiance. Zone B, in particular, seems to strike the best balance, with bird and insect sounds playing a more significant role, especially in the morning.

## CONCLUSION

The study at Putroe Phang Park reveals that the perception of the soundscape varies across the three zones. Zones A and B were perceived more negatively than Zone C. Visitors rated Zone C's soundscape quality and feasibility significantly higher in the morning due to the dominance of natural sounds. However, by the afternoon, the zones' differences in soundscape quality were less pronounced. Despite Zone C's better performance, the noise levels in all three zones exceeded the standard limit of 50 dB(A) set by regulation 48/menlh/11/1996. The relationship between the park's soundscape and its architectural elements shows that while some features effectively shape the auditory experience, there is room for improvement to enhance the soundscape in a way that better aligns with the park's regional and historical context.

## ACKNOWLEDGEMENT

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## DISCLOSURE STATEMENT AND REFERENCES

The authors declare that there are no conflicts of interest related to this study. All data used in this study were collected and analyzed impartially, and the conclusions drawn are solely based on the findings of the research. The authors are committed to academic integrity and transparency throughout the research process.



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## **THE IMPACT OF AGODI URBAN PARK ON THE SUBJECTIVE WELL-BEING OF ITS VISITORS**

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### **Abstract**

Urban parks, within city centres are green spaces that incorporate natural elements such as grass, flowers, and trees, often featuring wildlife, small zoos, and abiotic components like hills and lakes, whether natural or artificial. These parks form a crucial interface between individuals and nature, contributing to public health, social cohesion, climate improvement, and tourism development. This study investigates the impact of the Agodi Park experience on the subjective well-being of visitors in Ibadan, the second-largest city in Africa. A survey method and a 6-point Likert-type scale were used to gather data on park experiences. Questionnaires were administered to 378 participants, with 350 responses analysed. Descriptive statistics and Spearman correlation analysis was employed. Results showed that 34.6% of respondents strongly agreed that they felt a sense of oneness with nature in the park, 44.3% agreed, 7.1% disagreed, and 11.1% were neutral. The findings indicate a high level of well-being among visitors, with various factors influencing their experience. The study recommends improving park facilities to alleviate pressure on limited resources and suggests further preservation and development of the park's vegetation as a key visitor attraction.

**Keywords:** Urban Parks, wellbeing, subjective wellbeing, experience, and Park use

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## INTRODUCTION

The concept of "contact with nature" encompasses areas that contain elements of living systems, such as plants and animals, across various scales and levels of human involvement, ranging from small urban parks to untouched wilderness. It also includes non-living features, such as sunsets or mountain views. The definition of nature varies depending on the type of contact and how individuals relate to it (Russell et al., 2013).

According to Aziz et al. (2018), an urban park is a public green space designed for recreation and aesthetic purposes in the city. These parks are typically managed by local authorities and often feature lawns for picnicking and informal sports, playgrounds for children, sports facilities, walking and biking paths, landscaped gardens, water features, seating areas, and cultural or recreational facilities such as museums and amphitheaters.

Bhandari et al. (2018) and Mohd & Sahrir (2024) suggest that urban green spaces contribute to the sustainability of cities by providing ecosystem services such as carbon capture, air pollution reduction, biodiversity support, water recharge, and climate regulation. However, the connection between urban nature and human well-being is frequently overlooked, particularly in cities focused on economic growth. A lack of contact with natural spaces has been associated with higher rates of cognitive and physical health issues (Van den Berg, 2017). Additionally, exposure to green spaces facilitates sun exposure, which promotes calcium absorption through the synthesis of vitamin D (Chen et al., 2015).

Urban parks are essential recreational resources, serving millions of people each year. While some parks are highly valued, the quality of parks managed by city authorities can vary. Parks offer numerous benefits, including visual amenities, wildlife conservation, and cultural landmarks. Perceptions of safety and well-being significantly influence how people use these spaces (Cronin-de-Chavez et al., 2019). Hence, Perceptions of safety in urban parks differ based on factors such as gender and crowding. Mak and Jim (2019) found that women tend to be more concerned about safety than men and are more likely to support visible law enforcement. Safety is also influenced by physical features such as vegetation. While open, visible areas may improve security, they can reduce the park's overall attractiveness (Hartabela et al., 2022). Environmental stressors negatively affect human life, leading to aggression, cognitive decline, and reduced well-being. This study investigates the positive impact of urban parks on mental health and overall well-being. Biswas et al. (2022) define well-being as a positive state that goes beyond the absence of pain or discomfort, encompassing the fulfilment of essential needs, a sense of purpose, and the ability to achieve personal goals. Well-being is further enhanced by supportive relationships, inclusive communities, good health, economic security, rewarding work, and a healthy environment (Minh et al., 2023).

## LITERATURE REVIEW

Well-being refers to a state of comfort, health, and happiness, encompassing physical, mental, emotional, and social aspects (Pinto et al., 2017). It is a holistic concept shaped by various factors such as physical and mental health, emotional and social well-being, financial stability, environmental conditions, and a sense of purpose. Rohde et al. (2020) classify well-being into two forms: Subjective Wellbeing (SWB) and Objective Wellbeing (OBW).

**Subjective Wellbeing (SWB)** refers to how individuals perceive and evaluate their lives, including their happiness and life satisfaction, based on personal self-reports.

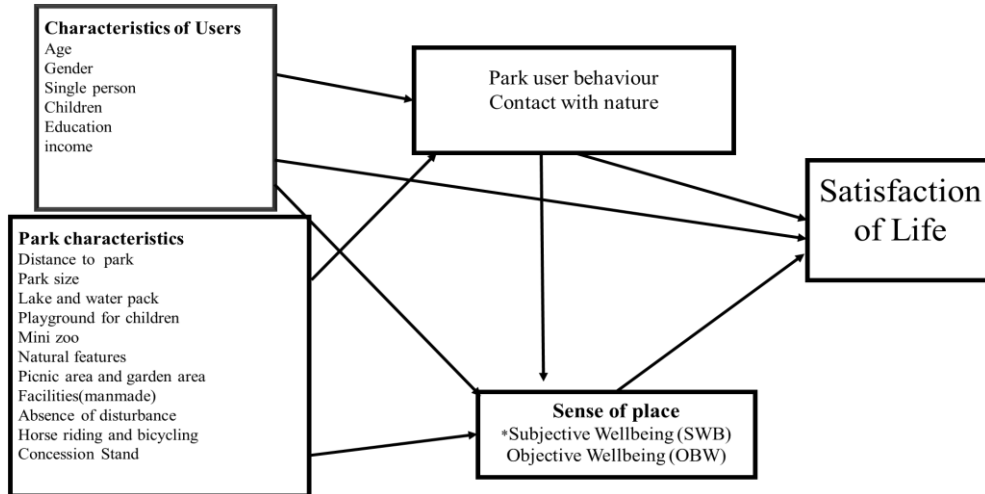
**Objective Wellbeing (OBW)** involves assessing well-being through measurable, external factors that reflect quality of life across various domains, enabling comparisons between individuals and populations.

This study focuses on Subjective Wellbeing (SWB), a significant human concern dating back to the Classic Greeks, who explored concepts like *eudemonia* (human flourishing) and *ataraxia* (inner peace). Interest in SWB has persisted through the ages and is now studied in relation to personality, with numerous meta-analyses conducted on the topic (Abubakar, 2022; Murphy, 2011; Waldron, 2010).

Wapner (2013) underscores the growing scientific interest in the benefits of contact with nature for human well-being. Studies have examined various factors related to park use, including user characteristics, park features, and visitor experiences. For example, Kothencz and Blaschke (2017) explored the correlation between perceived and objective park characteristics in Szeged, Hungary, recommending the integration of both human perceptions and objective indicators. Ayala-Azcárraga et al. (2019) linked perceived green space characteristics to visitor well-being, while Hong et al. (2019) found that the frequency of visits and time spent in urban green spaces positively influenced well-being, though constraints and access issues could negatively impact visit frequency.

Van Dinter et al. (2022) investigated the relationships between personal and park characteristics, park use behaviours, sense of place, and visitors' long-term subjective well-being. Ling Lee et al. (2023) examined the impact of perceived soundscapes in Malaysian parks on visitors' subjective well-being and stress reduction. Similarly, Helen and Praise (2020) assessed tourist satisfaction with park facilities and services, concluding that high-quality tourism services significantly enhance tourist satisfaction.

The reviewed literature provides valuable insights into the relationships between user characteristics, park features, park use, visitor experiences, and well-being, but lacks full integration of these aspects. This study aims to comprehensively test these relationships, employing a conceptual framework (Fig 1) to illustrate these connections.



**Figure 1:** Conceptual framework illustrating the variables and their hypothesised relationships for analysis.

The conceptual framework illustrates that positive park characteristics promote frequent use and foster a strong sense of place, which, in turn, enhances both subjective and objective well-being. Frequent Park use reinforces the sense of place, clarifying the link between park perceptions and well-being.

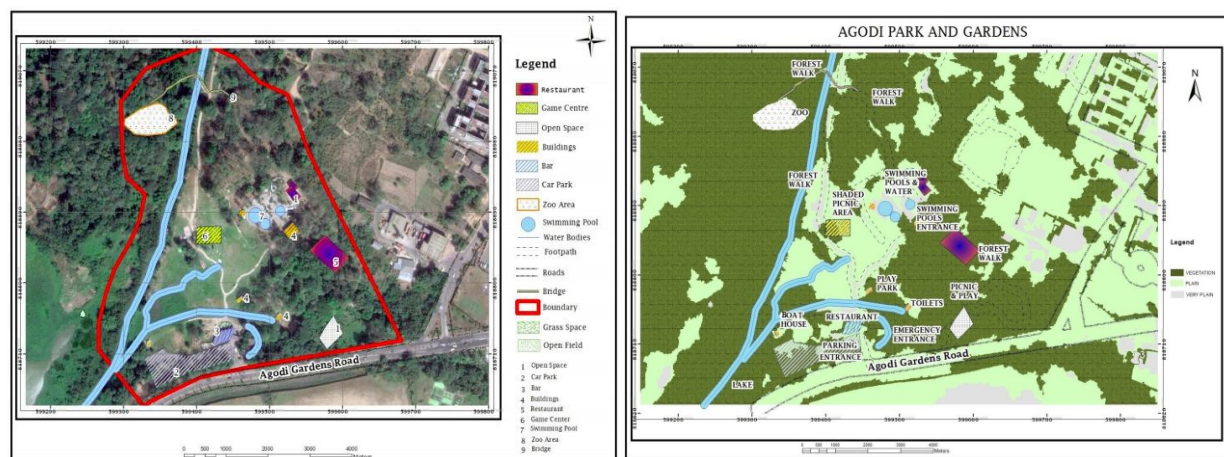
Thus, this study will assess how urban parks, specifically Agodi Park, influence visitors' subjective well-being, with a focus on the role of the sense of place in explaining this effect. Additionally, it will examine how personal characteristics shape well-being and other key variables. Data were collected from visitors to Agodi Park to analyse these relationships, addressing the following research objectives:

1. Examining visitor's experience in Agodi Urban Park.
2. Identifying the factors influencing visitors' experience in Agodi Urban Park.
3. Analysing the relationship between visitors' experience and their subjective well-being in Agodi Park.

### **The Study Area**

The study focuses on Agodi Urban Park in Ibadan, a popular recreational destination located at 7°24'25"N 3°53'57"E. Initially established as the Agodi Zoological and Botanical Gardens in 1967, the park was destroyed by flooding in 1980. It was later renovated by the Oyo State Government and reopened in 2014. Spanning 150 acres, the park features a water park, lake, mini zoo, play areas, picnic spots, gardens, and activities such as horse riding and cycling. A

tranquil retreat, Agodi Park is particularly popular with families during weekends and holidays, offering relaxation and recreation for both children and adults.



**Figure 2:** Geographical Location of the Study Area  
*Source: Authors ,2023*

## MATERIALS AND METHODS

The study was conducted in August 2023 during a festive season at Agodi Gardens. Of the 375 questionnaires administered, 350 were completed and returned. Efforts were made to ensure gender balance in the sample, and respondents were informed of the study's purpose. The survey employed a 6-point Likert-type scale to gather data on park usage and visitor experiences. Data analysis was performed using SPSS v.20, with a significance threshold set at  $p = 0.05$ . Descriptive statistics were applied to the first two objectives, while Spearman correlation analysis was used for the third. All survey questions were administered in English. Responses to the survey statements were rated from Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) to Strongly Agree (SA). The first section evaluated visitors' experiences, including their sense of connection with nature and the effects on their physical and psychological well-being during and after the visit. Sample questions included "I feel a sense of oneness with the nature around me" and "How much do you feel physically/psychologically better than usual?" (Pasanen et al., 2018; Corral-Verdugo et al., 2008).

The next section focused on factors influencing visitors' experiences, such as noise, waste management, crowding, facilities, vegetation, and park administration (Frash Jr et al., 2016). The final section assessed visitors' well-being, with questions like, "Spending time at the park makes me feel relaxed and relieved."



## RESULTS AND DISCUSSION

This study investigates the impact of visits to Agodi Urban Park on the subjective well-being of visitors, emphasising the role of positive leisure experiences in enhancing well-being. It seeks to uncover the outcomes of park visits and the factors influencing these effects. The research reveals several key findings that contribute to a deeper understanding of the relationship between park visits and well-being.

### EXAMINING VISITORS EXPERIENCE IN AGODI URBAN PARK.

#### **I Feel a Sense of Oneness with the Nature Around Me.**

The data presented in Table 1 indicates that 2.85% of respondents strongly disagreed with the statement “I feel a sense of oneness with the nature around me at the park”, while 7.1% disagreed and 11.1% remained neutral. In contrast, 34.6% strongly agreed, and 44.3% agreed with the statement. These results suggest that the majority of park visitors do feel a strong connection with nature during their visit, as illustrated in Plate 1.



**Plate 1:** Vegetation scene depicting oneness with Nature

**Table 1:** Visitors Experience in Agodi Urban Park

S/N	Variable	No of individuals who took part in the survey	Percentage
1	I feel Sense of oneness with the nature around me.		
	Strongly deny	8	2.85%
	Deny	25	7.1%
	Neutral	39	11.1%
	Strongly agree	121	34.6%
	Agree	155	44.3%



2	I Feel Strong and Inspired in the park		
	Strongly deny	6	1.7%
	Deny	15	4.3%
	Neutral	33	9.4%
	Strongly agree	122	34.9%
	Agree	174	49.7%
3	I feel physically better than usual when here.		
	Strongly deny	5	1.4%
	Deny	40	11.4%
	Neutral	101	28.9%
	Strongly agree	86	24.6%
	Agree	118	33.7%
4	I feel psychologically better than usual		
	Strongly deny	9	2.6%
	Deny	42	12%
	Neutral	50	14.3%
	Strongly agree	94	26.9%
	Agree	154	44%

Source: Field Survey, 2023

#### **I Feel Strong and Inspired in the park**

The data in Table 1 reveals that 1.7% of respondents strongly denied feeling strong, attentive, and inspired during their visit, while 4.3% disagreed, and 9.4% remained neutral. In contrast, 34.9% strongly agreed, and 49.7% agreed. This suggests that the majority of park visitors experience a sense of strength, focus, and inspiration while at the park.



**Plate 2:** A zoo located in the park depicting feeling inspired in contact with Nature

#### **I Feel Physically Better Than Usual.**

Based on the data presented in Table 1, 1.4% of respondents strongly denied feeling physically better than usual while at the park, 11.4% disagreed, and 28.9%

remained neutral. In contrast, 24.6% strongly agreed, and 33.7% agreed. This suggests that the majority of park visitors feel physically better than usual during their visit, as illustrated in Plate 3.



**Plate 3:** Footpath walkway in the park

#### **I Feel Psychologically Better Than Usual.**

The data from Table 1 show that 2.6% of respondents strongly disagreed with feeling psychologically better than usual while at the park, 12% disagreed, and 14.3% were neutral. However, 26.9% strongly agreed, and 44% agreed. This indicates that the majority of park visitors experience improved psychological well-being when visiting the park, as illustrated in Plate 4, which highlights the calming presence of the lake within the park.



**Plate 4:** A lake and swimming pool in the park

#### **EXAMINING THE FACTORS AFFECTING VISITORS EXPERIENCE**

The data in Table 2 reveal that noise levels in the park have an insignificant impact on visitors, with 51.4% of respondents completely denying any disturbance from noise. In contrast, the condition of the park's facilities was deemed highly significant, with 50.9% of respondents agreeing that the presence and status of facilities play a crucial role in their experience. Regarding waste management, 36% of park users remained neutral, indicating a relatively

insignificant impact. However, the effect of vegetation was considered highly significant, with 49.1% of visitors agreeing that its presence greatly enhances their park experience. Additionally, 35.1% of respondents acknowledged crowding, often leading to the overuse and deterioration of facilities, as depicted in Plate 5. Furthermore, 49.1% of participants agreed that the park is well-managed by staff. Lastly, data from Table 2 indicate that 46.3% of respondents strongly agreed, and 40% agreed, that improvements to the park's facilities are necessary.



**Plate 5:** Children playing ground

**Table 2:** Factors Affecting Visitors Experience

S/N	Variable	No of individuals who took part in the survey	Percentage
1	Level of noise on the park users		
	Strongly deny	36	10.3%
	Deny	180	51.4%
	Neutral	89	25.4%
	Strongly agree	16	4.6%
	Agree	29	8.3%
2	Effect of facilities in the park		
	Strongly deny	10	2.9%
	Deny	30	8.6%
	Neutral	92	26.3%
	Strongly agree	40	11.4%
	Agree	178	50.9%
3	Waste Management in the park		
	Strongly deny	34	9.7%
	Deny	108	30.9%
	Neutral	126	36%
	Strongly agree	17	4.9%
	Agree	65	18.6%
4	Good vegetation in the park		
	Strongly deny	4	1.1%
	Deny	14	4%
	Neutral	10	2.9%
	Strongly agree	150	42.9%
	Agree	172	49.1%

S/N	Variable	No of individuals who took part in the survey	Percentage
5	Crowdy environment		
	Strongly deny	11	3.1%
	Deny	47	13.4%
	Neutral	93	26.6%
	Strongly agree	76	21.7%
	Agree	123	35.1%
6	Staff management and Ethics		
	Strongly deny	11	3.1%
	Deny	47	13.4%
	Neutral	93	26.6%
	Strongly agree	76	21.7%
	Agree	123	49.1%
7	Facilities improvement		
	Strongly deny	9	2.1%
	Deny	40	3.7%
	Neutral	72	7.9%
	Strongly agree	106	46.3%
	Agree	123	40%

*Source: Field Survey, 2023*

### **RELATIONSHIP BETWEEN VISITORS EXPERIENCE AND THEIR SUBJECTIVE WELLBEING IN AGODI PARK.**

The analysis presented in Table 3 highlights the relationships between visitors' experiences and their subjective well-being at Agodi Urban Park. The correlation between "spending time at the park, which makes visitors feel relaxed and relieved," and subjective well-being yielded a correlation coefficient of 1.000 and a p-value of 0.000, indicating a perfect and highly significant relationship. Similarly, the correlation between "feeling connected to nature" and subjective well-being resulted in a correlation coefficient of 0.621\*\* and a p-value of 0.000, demonstrating high significance. The correlation between "feeling physically better than usual while at the park" and subjective well-being produced a correlation coefficient of 0.255\*\* and a p-value of 0.000, indicating strong significance. Furthermore, the correlation between "feeling energised during their time at the park" and subjective well-being showed a correlation coefficient of 0.138\*\* and a p-value of 0.010, signifying a significant relationship. Lastly, the correlation between "spending time at the park keeping visitors conscious and awakened" and subjective well-being yielded a correlation coefficient of 0.359\*\* and a p-value of 0.000, confirming a highly significant relationship.

**Table 3:** Correlation analysis between Visitors experience and their Subjective Wellbeing in Agodi Park.

S/N	User's experience.	Spearman correlation Co-efficient	Subjective wellbeing(P-value)
1	Spending time at the park makes me feel relaxed and relieved.	1.000	0.000
2	Being here makes me feel connected to the nature around me.	0.621	0.000
3	I feel physically better than usual when I am here	0.255	0.000
4	My time here keeps me energized	0.138	0.010
5	Spending time here keeps me conscious and awakened	0.359	0.000

Note, that  $P < 0.05$  is moderately significant and  $P < 0.01$  is significant while  $P < 0.001$  is highly significant.

Source: Field Survey, 2023

### KEY CONTRIBUTION OF THE RESEARCH TO THE FIELD OF URBAN PLANNING.

The study will enhance understanding of the impact of public spaces on well-being, highlighting both social and psychological benefits. The study will inform evidence-based planning and policy formulation to promote the integration of green space in urban development. Similarly, Long-term urban sustainability improves quality of life, making cities more liveable and attractive for residents. Community participation and engagement in urban park planning and management foster a sense of ownership and responsibility. Economic benefits include attracting tourists to urban parks, generating revenue, and boosting local economies.

### CONCLUSION AND RECOMMENDATION

This study demonstrates that visiting urban parks significantly enhances human well-being, especially during periods when daily activities, environmental stressors, work-related pressures, noise, and overcrowding negatively impact quality of life at both individual and regional levels.

Although park facilities are available, high visitor numbers strain these amenities, diminishing the park's overall quality. To address this, the study recommends expanding facility offerings rather than limiting visitor access. Participants expressed mixed feelings about waste management and sanitation; therefore, enhancing waste management practices – such as increasing bin availability, promptly removing litter, and improving maintenance culture – is essential.

The park's vegetation, including its flora, fauna, and natural features like lakes and hills, serves as a key attraction. Preservation and enhancement of

this vegetation are vital for fostering connections with nature. The study finds the vegetation to be in good condition, with respondents underscoring its importance in nurturing this connection.

### **DECLARATION OF COMPETING INTEREST**

The Authors declare that they have no known competing financial interest or personal relationship that could have appeared to influence the work reported in this article.

### **DATA AVAILABILITY STATEMENT**

The data for this research was drive from questionnaire administered to visitors who visit the park during festive period in August 2023.

### **ACKNOWLEDGEMENT**

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## **ANALYZING LOCATIONS OF OUTDOOR ADVERTISEMENT DISPLAY BY USING FUZZY-AHP AND GIS**

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### **Abstract**

City councils generate revenue through fees for advertising display structures within their various council districts. However, there is yet a map that depicts the area where the advertisement display structure is permitted to be constructed. The city councils often need to refer to a manual book containing the guidelines in textual form, which may make it difficult to directly assess the location of the application to install an advertising display. Therefore, this study was conducted to spatialize the guidelines and analyse the suitable area for installing outdoor advertisement displays. Experts' choice was used to obtain the weightage for the main and sub-criteria, which was calculated using the Fuzzy-AHP method and then used to derive the GIS suitability index model indicating suitable and not suitable areas. Findings revealed that within the tested study area, 94% of the area is suitable, while 6% of it is not. Based on on-site verification, the model is proven to be reliable since the unsuitable area does not comply with the criteria. Hence, a visualization map was created to act as a spatialized guideline, which the experts also agree that the suitability map could help them make decisions efficiently, thus leading to smarter planning for the future.

**Keywords:** fuzzy-ahp, gis, mcda, index model, outdoor advertisement display

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## **INTRODUCTION**

Advertising is a promotional tool used to introduce, encourage, or draw public attention to goods, services, persons, or entities. Companies or individuals must obtain approval from local authorities to establish an advertisement, as per the Outdoor Advertising Board Planning Guidelines Number 2 of 2009. Malaysia's Majlis Perbandaran Petaling Jaya and Majlis Perbandaran Kuantan have built a GIS system to display Outdoor Advertisement Display (OAD) locations. However, this system only displays the current position without further analysis.

It would be better if the City Council could swiftly approve an application by viewing the created map and identifying the area where an advertisement display structure is acceptable or permitted. Wakil et al. (2021) and Haidu et al. (2009) suggested that GIS could be an efficient method for determining the prospective placement of OAD based on preset criteria, making it easier to achieve order and harmony between OAD and the surrounding environment. GIS can help visualize customer locations by analyzing demographic information and psychographic, purchasing, and spending characteristics for accurate customer segmentation. It is also suggested that GIS and marketing can be integrated into market planning and decision-making, leading to the development of innovative marketing tactics.

OAD is a popular offline advertising method that targets the target market while they are not at home. The Town and Country Planning Department and the Malaysian Highways Authority have released guidelines for outdoor billboard placement in Malaysia. These guidelines address various types of displays, such as Free-Standing Billboards, Spectacular Gantry, Rooftop Advertisement, and Building Wrap. However, local governments generate revenue through fees and rental of advertising display structures. There is no map or inventory of suitable locations for advertising displays, making it difficult to recommend suitable sites and prevent unlawful displays that could be life-threatening and negatively impact drivers.

Thus, the aim of this study is to derive spatial-based guidelines, which are in the form of a map showing the suitability for installation of OAD. The study used Fuzzy-AHP to derive the weightage of the criteria for installation of OAD and GIS to develop a suitability index model for OAD, which actually depicts the manual guidelines by the city council.

## **LITERATURE REVIEW**

### **Outdoor Advertisement Display**

OAD aims to become a medium of communication for the advertising industry while also contributing to the development of a contemporary urban environment in addition to integrating with urban systems like transportation, architecture, and greening to create a space and improve the visual interface of a city (Molitor et al., 2020; Sadeghi et al., 2019; Tang et al., 2019).

As cities grow and the economy gets better, the advertisement industry grows rapidly. However, extreme urban visual pollution and deterioration of the socio-physical living environment have occurred due to the unmanaged placement, size, position, structure, and content of OAD in Malaysian metropolitan centers. This can be seen through an article published by the Majoriti, with the title of “Papan Iklan Usang, Tak Ikut Spesifikasi Bahayakan Pengguna Lebuhraya” [Old Advertisement Board, Did Not Follow Specification Endangering Highway User], stated that a lot of unsupervised billboards were seen to be harmful towards the road users (Hussain, 2022). The Majoriti conducted a survey of the Klang Valley and discovered that there are numerous billboards that do not adhere to standards and have not been maintained for an extended period. Hence, it is necessary to follow the general guidelines for the advertisement display.

Road safety plays a major role in establishing OAD. Driver inattention and distraction are recognized as two of the most critical factors for road safety worldwide (Arevalo-Tamara et al., 2022; Oviedo-Trespalacios et al., 2019). Distracted driving includes dividing attention between the primary task, such as driving, and a non-driving-related secondary task, such as talking on a cell phone or reading roadside advertisements. A consistent finding in the literature is that the presence of roadside advertising seems to be correlated with road crashes (Hinton et al., 2022; Vrkljan & Jeleč, 2021; Wu et al., 2021; Brome et al., 2021). Uncontrolled advertisements are causing visual intrusion and block important traffic signs from motorists and pedestrians, thus causing unavoidable accidents. Hence, it is suggested that all commercial signs should be completely avoided at intersections or nearby. In conclusion, all advertising displays must be placed carefully inside the safe zone and must not obstruct the view of drivers.

### **GIS-MCDA in Site Suitability Analysis for Outdoor Advertisement Displays**

Based on Belton and Stewart in 2002, MCDA can be defined as a method to explore decisions that take multiple factors into consideration. For approximately 20 years, MCDA methods have been used for spatial problems by coupling them with GIS (Malczewski & Rinner, 2015). MCDA emerged out of and as a response to single-criterion optimization approaches, namely linear programming. These were established during World War II and refined in the early days of the Operations Research discipline of corporate management in both contexts without addressing secondary effects that need numerous criteria.

MCDA contains multiple approaches. Analytical Hierarchical Process (AHP) and Analytical Network Process (ANP) are two common techniques used in MCDA (Elhosni & Faiz, 2021). AHP is one of the most comprehensive methods of multicriteria decision analysis (Saaty, 2008), while ANP is an extension and generalization of AHP. Both methods are based on the principles of decomposition, comparative judgment, and synthesis of priorities. The main

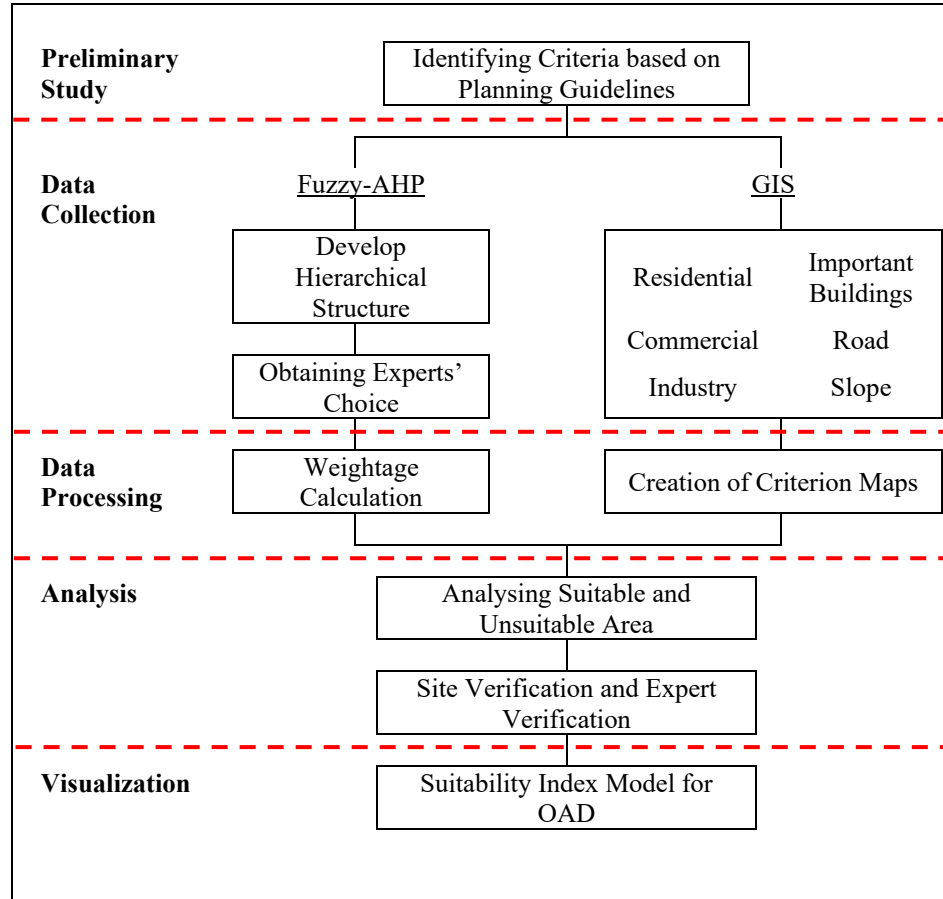
principle of comparative judgment requires assessment between elements in a given hierarchical structure with respect to their parent in the next-higher level (Malczewski & Rinner, 2015).

Site suitability modeling plays a crucial role in various fields, such as urban planning, environmental management, and resource allocation. GIS-MCDA methods are frequently used for analyzing and assessing potential site locations (Zaki et al., 2023; Mabahwi & Nakamura, 2024; Nor et al., 2024). Site suitability modeling involves combining various parameters using a weighted linear combination or other aggregation methods to create a composite index. Weight is given to each criterion that reflects how important it is in the decision-making process. Index models allow for the analysis of many decision-making scenarios and offer a more thorough examination. However, the careful selection, weighting, and normalization of criteria necessary for index models can be very time-consuming.

GIS-MCDA integrates the spatial dimension into the decision-making process by considering the spatial relationships and interactions among criteria and site locations. It utilizes geospatial data and GIS to facilitate advanced spatial modeling and analysis. GIS-MCDA techniques, such as AHP, Fuzzy Logic, and OWA, enhance the accuracy and reliability of site suitability assessments. These techniques can help in decision-making that produces quality results.

## **RESEARCH METHODOLOGY**

This study was conducted in five (5) stages: preliminary study, data acquisition, data processing, data analysis, and visualization, as depicted in Figure 1. The first stage, preliminary study, involved literature review and software training. The second stage involved data collection, which consisted of two (2) parts: Fuzzy-AHP and GIS. The Fuzzy-AHP part involved primary data collection to obtain experts' choice of criteria weightage, while the GIS part used secondary data collection to obtain spatial data representing the criteria from various sources. The third stage is data processing, which involves calculating the weightage using a Fuzzy-AHP pairwise comparison matrix and spatial data editing. Then, Weighted Overlay Analysis combined the weightage calculated and spatial data to derive site suitability indexes. Then, the next stage is analysis, where the locations were analyzed to determine high and low suitability areas. Site verification was conducted to verify the results. The final stage is visualization, where a map visualizing the suitability index was created to aid in planning new OAD locations that comply with guidelines.



**Figure 1:** Methodology Framework

### Selection of Criteria for Site Suitability Analysis of Outdoor Advertisement Display

This study used criteria based on the guidelines by MPSJ (2020), KKR (2020), and PLANMalaysia (2015) as the basis. There are many criteria to be considered when it comes to site suitability analysis, but for this study, three (3) main criteria are highlighted: public safety, public comfort, and environmental quality. Each of these criteria has a sub-criteria that represents them on the ground. These sub-criteria were identified as the geographic features that were suitable for representing the criteria. Table 1 depicts the selected criteria and sub-criteria for the Site Suitability Analysis of OAD that is adapted from the guidelines mentioned earlier.

**Table 1: Main Criteria and Sub-Criteria**

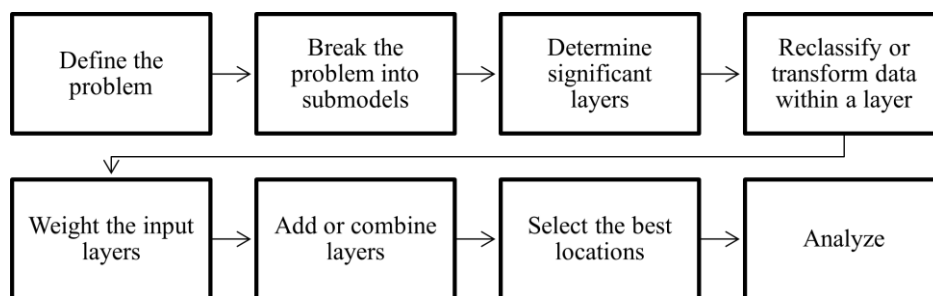
Criteria	Sub-Criteria
Public Safety	Road Distance
	Road User's Driving Visibility
	Emergency Road Accessibility
Public Comfort	Pedestrian Walk
	Residential Area
	Distance From Each OAD
Environment Quality	Intersection
	Important Buildings
	Heritage Buildings

### Calculating Weightage Using Fuzzy-AHP

After obtaining the Expert's Choice through a pairwise comparison matrix, the weightage for each criterion and their sub-criteria were computed. As this study uses Fuzzy-AHP, the pairwise comparison is in the form of linguistic variables. After the calculation is completed, the weightage of the criteria has been determined. Each criterion will be assigned to a weightage of normalized weights. Then, all the values that have been calculated will be inserted in GIS software to do a Site Suitability Analysis. Each criterion will also be assigned to each layer.

### Suitability Index Modelling for Outdoor Advertisement Display

The Suitability Index Model is a method for creating an integrated analysis by applying a single scale of values to varied and distinct sources. Suitability index modeling determines the optimal or most ideal locations for a particular phenomenon. Hence, the suitability index modeling was chosen to determine the site's suitability for OAD. Figure 2 shows the steps to perform the suitability index modeling, which integrates Fuzzy-AHP.



**Figure 2: Steps to Perform Suitability Index Modelling**

The first step for suitability index modeling was to define the problems. The problem that occurred in this study was to determine the suitable area for outdoor advertisement display according to the existing guidelines. All the main and sub-criteria were determined by analyzing the past guidelines.

The second step was to break the problem into sub-models. This was because most suitability modeling problems were mostly complex. It is better to break them down to achieve clear and organized methods for solving the problems. The sub-models can be divided according to the criteria.

Next, the significant layers were determined. The attributes or layers that affect each layer need to be identified. Each factor captures and describes a component of the phenomenon being defined by the sub-model. Each factor contributes to the objectives of the sub-model, and each sub-model contributes to the objectives of the overall model. As a result, the index model should incorporate all factors that contribute to defining the phenomena. For example, since the Outdoor Advertisement Display needs to be 50m away from a major road a certain distance, the buffer was run to create the distance of the buffer.

Reclassification or transformation of data within the layer is important because different numbers of systems cannot be directly combined effectively. Before the layers can be added to the model, they must be reclassified or changed to a common ratio scale due to the potentially diverse ranges of values and different types of numbering systems that each input layer may possess. Hence, all the sub-criteria were reclassified into two (2) classes: one (1) was not suitable, and two (2) was suitable.

The next stage was assigning weight to the input layer. Some factors may be more crucial to the overall objective than others. If this is the case, the factors can be weighted according to their significance before being combined. These weights were obtained through the Fuzzy-AHP method. In the suitability index model, it is desirable to establish the link between all input factors to discover areas that satisfy the model's objectives. Figure 3.6 and Figure 3.7 show how the weightage was incorporated into the index model for this study to derive the suitability index model for OAD.

## **ANALYSIS AND DISCUSSION**

This section discusses the results of the site suitability modeling for the OAD. This section includes an evaluation of the weightage of the main criteria and sub-criteria used in the analysis, as well as the results on the site suitability modeling for the OAD, which is divided into two (2) categories of Suitable and Unsuitable. The location of existing OAD was analyzed based on the suitability map.

### **Weightage of Criteria and Subcriteria**

This section summarizes the weightage for each criterion and sub-criteria by using Fuzzy-AHP techniques. The final weightage for each criterion was

determined by experts who are academic and industry experts. A total of five (5) experts answered the pairwise comparison given. Then, all the calculations were done to compute the final weightage. Table 2 depicts the weightage for criteria and sub-criteria.

**Table 2:** Weightage for Sub-Criteria

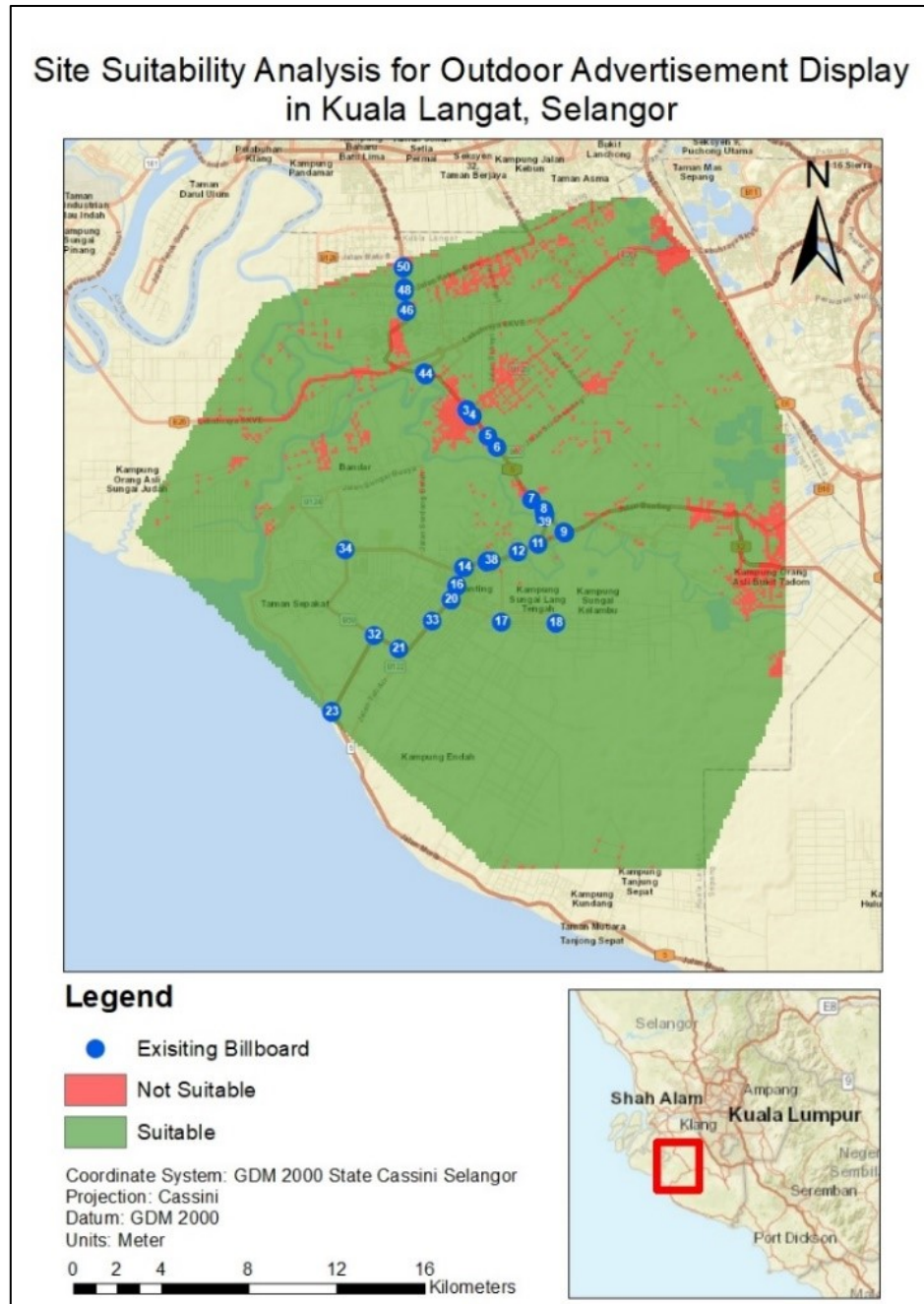
Main Criteria	Weightage	Sub-Criteria	Weightage	Priorities	Rank
Public Safety	0.606	Road Distance	0.116	0.070	6
		Road User's Driving Visibility	0.644	0.390	1
		Emergency Road Accessibility	0.240	0.145	2
Public Comfort	0.166	Pedestrian Walk	0.288	0.048	8
		Residential Area	0.484	0.080	4
		Distance From Each OAD	0.228	0.038	9
Environment Quality	0.228	Intersection	0.246	0.056	7
		Heritage Building	0.427	0.097	3
		Important Building	0.327	0.075	5

In finding site suitability for OAD, public safety should be prioritized as the most important criterion, followed by environmental quality and public comfort as secondary and tertiary factors, respectively. Public safety is vital, as OAD should not endanger the public's safety. A thorough examination of the environment's quality is also required to verify that the display has no negative impact on its surroundings. Finally, public comfort should be considered to ensure that the display does not cause inconvenience or discomfort to the public. By prioritizing these criteria in the site, the suitability study, OAD may be placed in suitable locations that serve their purpose while also protecting the safety and well-being of the public.

#### **Suitability Index for Outdoor Advertisement Display**

The Suitability Map classifies the suitable sites for OAD into two (2) categories: Suitable and Not Suitable area. As can be seen from Figure 3, the suitable areas are mostly away from the city and located around village areas. The areas that were suitable were around Kampung Endah, Kampung Sungai Lang Tengah, and Kampung Sungai Kelambu. This can happen because the area might have a flatland area. On the other hand, the unsuitable areas are mostly near the city.








**Figure 3:** Site Suitability Map for OAD

The site's suitability has been verified in two (2) different methods. First, the referenced locations of the existing OADs were determined. This aids in determining the validity of the proposed Fuzzy-AHP and GIS-based site selection methodology. The Kuala Langat, Selangor region was examined for site validity. The analysis was conducted using the established guidelines. Second, it is also possible to account for the justification of an expert. The verification was performed via an interview. The expert was from the city council. Table 3 shows the Unsuitable OAD in the research area. A total of seven (7) out of 41 OADs had been identified in unsuitable areas and not adhering to the guidelines.

**Table 3: Site Verification for Unsuitable OADs**

Characteristics	Areas
OAD was too close to the main road	 <p style="text-align: center;">Jalan Kampung Jenjarom</p>
OAD was close to the residential area	 <p style="text-align: center;">Jalan Klang Banting</p>
OAD was close to the main road	 <p style="text-align: center;">Jalan Klang Banting</p>

### **Comparison of GIS-based Suitability Map of OAD with Existing Manual or Guidelines based on Verification by Interview with Expert**

An expert from the city council was interviewed regarding this comparison. The Suitability Map of OAD was shown to the expert so that he could make a comparison with the existing manual or guidelines. Several questions were asked, such as whether the suitable locations comply with the guidelines and whether having the map would help them. In addition, other questions were asked about whether it is possible to replace the traditional manual book with spatialized guidelines.

Based on the interview, the expert agreed that a GIS-based Suitability Map provides a lot of advantages over the existing manual or guidelines. When having a map of site suitability will make the process of evaluating site suitability easier compared to solely relying on guidelines. While guidelines provide general recommendations and criteria for site suitability, a map can visually represent the distribution of different criteria spatially and help identify areas that meet specific criteria more efficiently.

A map gives a visual picture of the physical environment as well as the distribution of significant factors that affect a site's suitability. It is a visual representation of various elements, such as roads, buildings, pedestrian walks, and many others. For instance, since the OAD must be established within 30m of the residential area, the map can show where it is located.

A suitability map can also provide simplicity and clarity. Maps are an easy-to-understand and visually appealing representation of complex data. Rather than going through the long guidelines, users can quickly comprehend the suitability map. It facilitates effective communication among project team members and simplifies the decision-making process.

Site suitability analysis often involves considering multiple criteria simultaneously. By overlaying different data layers on a map, various factors can be assessed by interacting spatially. For example, the layers of roads, contours, important buildings, and residential areas can be combined to create a suitability map. Plus, the criteria can be adjusted and modified easily. By changing the weighting of the different criteria, the impact on site suitability can immediately be visualized. This flexibility enables the exploration of different scenarios and the comparison of alternative options efficiently.

In conclusion, based on the interview with an expert from the city council, having a site suitability map would be helpful to them. Nonetheless, it is essential to note that guidelines continue to play an important part in the site suitability analysis. This is because authorities still use the guidelines as references as the guidelines contain more details in terms of the regulations that need to be followed. Maps are useful instruments for visualizing and analyzing data, but guidelines provide the knowledge and expertise required for correctly interpreting the data. The development of the suitability map should be guided by

guidelines that specify the requirements, criteria, and standard procedures. Therefore, a combination of both guidelines and a map-based analysis approach can be the most effective way to evaluate site suitability.

## CONCLUSION

In conclusion, the results of this study have determined and analyzed the site suitability index for OAD using Fuzzy-AHP and GIS in Kuala Langat, Selangor area. The Fuzzy-AHP allowed for incorporating subjective judgments and uncertainty in the decision-making process, while GIS provided the necessary spatial data analysis capabilities. A final map was created that depicts the area where the OAD is suitable and not suitable to be established. The development of the suitability index model for OAD successfully proved the potential of GIS in spatializing the traditional manual or guidelines that are written in a book. Hopefully, the map can aid the city council in decision-making for new OADs, collecting revenue from the OAD, and monitoring illegal OADs.

Future studies should expand the study area to other local authorities in Selangor to support the state's Smart State vision. This would automatically enable the legal and ethical placement of OAD, saving time and energy. Local authorities can identify and rank suitable locations for OAD, track their effectiveness, and make necessary amendments. Regularly updating spatial and attribute data and conducting field or on-site surveys are essential for accurate representation of visibility and accessibility.

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## **THE IMPACT OF LANDSCAPE NARRATIVE FEATURES IN CHINESE URBAN HERITAGE PARKS ON VISITOR SATISFACTION IN FUYONG CITY, ANHUI PROVINCE, CHINA**

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### **Abstract**

In recent years, the number of Chinese visitors in urban heritage parks has been growing, fuelling the rapid development of the heritage site tourism sector. This study explores how landscape narrative features influence visitors' satisfaction in urban heritage parks to bridge the gap between theoretical and practical research in this field. Taking the visitors of Yingzhou West Lake in Fuyang City, Anhui Province, China, as the research object, a questionnaire survey was used to collect data, verify the influence of landscape narrative features on visitors' satisfaction, and analyse its mechanism of action. The study constructed a mechanism model of landscape narrative features affecting visitors' satisfaction and classified the features into three dimensions: physical space, narrative space, and heritage space. The results show that such features significantly positively affect visitors' satisfaction, and enhancing landscape narrative features can effectively improve visitors' satisfaction. This study provides important theoretical support for sustainable tourism development in urban heritage parks and proposes practical ideas for tourism management and design practices in heritage sites.

**Keywords:** urban heritage parks, landscape narrative features, visitors' satisfaction, sustainable tourism

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## INTRODUCTION

Historical and cultural heritage is a region's heritage and spiritual civilization that usually has an innate cultural and emotional connection with the inhabitants, giving them a sense of identity and belonging (Feng, Chiou, & Wang, 2021). As forms of historical and cultural heritage, urban heritage parks enhance a country's national self-confidence and have educational significance (Bischoff & Meckl, 2008; Hadiullina, Nugumanova, Bagautdinova, & Averiyarov, 2013). The primary distinction between historical cultural parks and other parks lies in their gradual development alongside urban growth, with landscape design elements deeply intertwined with local history and culture. Moreover, most urban heritage parks in China are built around historical and cultural relics, serving as new tourist destinations. They are places for people to relax, learn, and preserve traditional Chinese culture. Tourists can obtain local historical information and gain cultural knowledge, which is of great educational significance (Yu, Li, & Ji, 2001).

According to AECOM (2018), a global leader in urban planning and engineering, developing urban heritage parks should prioritize integrating historical and cultural elements into modern urban contexts. Their report highlights strategies such as the proportion of historical and cultural theme parks will increase rapidly due to China's deep cultural heritage (AECOM, 2018). The proportion increased from 12% in 2012 to 20% in 2018, and by 2025, the proportion is expected to account for as much as 28%. In recent years, the visibility of China's historical and cultural heritage has been growing. Chinese tourists' needs and demands for historical and cultural experiences are increasing daily. Due to the uniqueness of heritage site tourism, tourists' preferences are influenced by individual characteristics, which has led to a limited number of relevant studies (Huete-Alcocer, López-Ruiz, & Grigorescu, 2019). More specifically, there are relatively few empirical studies on visitors' satisfaction in heritage site tourism (Gidey & Sharma, 2017). Higher visitor satisfaction means that the quality of the experience in the tourism area meets the needs of tourists, which is an important factor in the sustainable development of tourism in urban heritage parks (Wiwattanakantanga & To-ima, 2014).

This study attempts to fill this research gap by examining the relationship between the landscape narrative features of urban heritage parks and visitors' satisfaction with heritage sites. By constructing a mechanism model of the impact of these features on visitors' satisfaction, it divides the features into three dimensions: physical space, narrative space, and heritage space. It systematically analyses the effect of each dimension on visitors' satisfaction and explores strategies to enhance the landscape narrative features to improve visitors' satisfaction. The results not only provide theoretical support for the sustainable development of tourism in urban heritage parks in China, but also



offer practical guidance for the optimization of tourism management and the design of heritage sites. They also further promote the coordinated development of tourism and cultural protection in heritage sites, which is of great theoretical value and practical significance.

## **LITERATURE REVIEW**

### **Landscape narrative features of urban heritage parks**

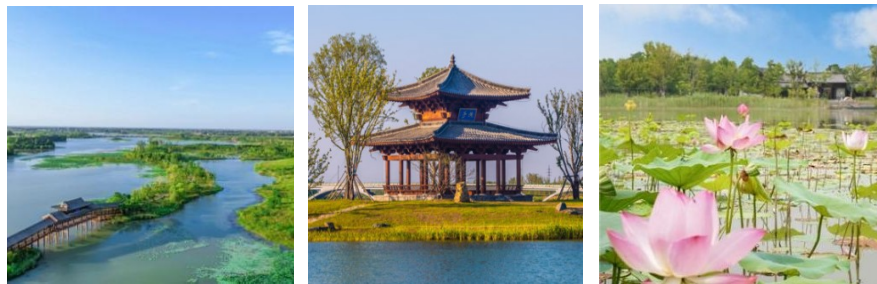
Previous research has taken landscape narrative as a way of interpreting the meaning of a place by incorporating stories and historical elements of the local past (Potteiger & Purinton, 1998), aiming to convey local identity, historical events, and stories (Dzegede, 2000). In other words, landscape narrative is how designers use tangible and intangible elements of the landscape to give meaning to places (Valois & Paradis, 2010). Historical landscapes presented through narrative techniques can trigger multiple interpretations and enhance the connection between local time, people, and places. Landscape narratives also represent public spaces with historical significance (Davis, 2022). As local historical archetypes in modern spaces, historic landscapes present a microcosm of history, and this presentation embodies spatial narratives (Garnier, 2015). Historic landscapes are therefore established as historic cultural heritage. Understanding the landscape narrative of historical cultural heritage helps in recognizing and interpreting historical cultural heritage landscapes (Li, 2020; Lin, 2023).

Urban heritage parks, as unique spaces that integrate cultural heritage and natural landscapes, have become an important focus in urban development and tourism research. Classical Chinese Garden elements, including water bodies, rockeries, plants, and garden architecture, serve as key components in shaping the aesthetic and cultural identity of these parks (Wang, 2022). These elements not only embody historical and cultural narratives but also contribute to the visitors' sensory experiences and emotional engagement. Previous studies have highlighted the significance of such features in enhancing the appeal and functionality of urban heritage parks, making them valuable assets for cultural preservation and tourism development.

Based on classical Chinese garden principles, this study categorizes the landscape narrative features of urban heritage parks into three dimensions: physical space, narrative space, and heritage space. Physical space serves as the structural foundation, encompassing tangible elements such as mountains, water, plants, and architecture, which form the visual and spatial framework of the park (Zhuang & Chen, 2022). Narrative space refers to the stories, legends, and historical events associated with the park, offering layers of meaning that resonate with visitors. Finally, heritage space focuses on the cultural and historical significance embedded within the physical and narrative aspects, emphasizing the

preservation and transmission of cultural values. Together, these dimensions create a comprehensive framework for understanding how urban heritage parks convey cultural narratives, enhance visitor engagement, and contribute to overall satisfaction.

Taking Yingzhou West Lake as an example, the physical space of the park is composed of two categories: natural landscape resources and man-made resources. Natural resources include lakes, rivers, and wetlands, which reflect the harmonious relationship between humans and nature. Man-made resources, such as pavilions, bridges, and historical buildings, incorporate traditional Chinese architectural aesthetics and cultural symbolism. By analyzing these elements, it becomes evident how they contribute to the park's historical and cultural connotations while enhancing the visitors' immersive experience. Figure 1 illustrates the distribution of natural and human resources within the physical space of Yingzhou West Lake, providing a visual representation of its landscape narrative features.



**Figure 1:** The physical space of Yingzhou West Lake.

*Source: Yingzhou West Lake Official Website*

Narrative space is the core element of landscape narrative and integrates history and culture into the experience of urban heritage parks through the design of themes, narrative structure and rhythm, and artistic conception (Li, 2020). Visitor's experience in the narrative space must be immersive and historical, achieved through thematic associations and spatial interpretation (Jiang, 2021). Taking Yingzhou West Lake as an example, the design of the narrative space focuses on the setting of narrative themes (e.g., the culture of the West Lake and the story of poems), the logical arrangement of narrative structure (e.g., the planning of tour routes and stopover nodes), and the expression of artistic conception (e.g., the design of borrowed scenery and cultural symbols). Through the combination of scenes and themes, these narrative techniques enable visitors to feel the interplay of history and culture more deeply (as shown in Figure 2).

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**Figure 2:** The narrative space of Yingzhou West Lake.  
*Source: Yingzhou West Lake Official Website*

Finally, the heritage space is the most culturally significant part of the landscape narrative, centred on local memories, folklore activities, and ceremonial events, reflecting lifestyles and cultural practices passed down from generation to generation (Niglio, 2014). By participating in local folk culture activities, tourists can experience authentic historical and cultural themes and enhance their sense of identity with the local culture, promoting the preservation and inheritance of urban heritage parks (Feng et al., 2021). In Yingzhou West Lake, the heritage space is expressed as a combination of local traditional folk activities and educational significance. Visitors experience the living inheritance of culture through participation in folk festivals, local operas, and traditional craft demonstrations. The heritage space also popularizes local history and cultural knowledge through cultural exhibitions and interactive projects (as shown in Figure 3). These designs contribute to realizing cultural and educational functions, further enriching visitors' experience and enhancing satisfaction.



**Figure 3:** The narrative space of Yingzhou West Lake.  
*Source: Yingzhou West Lake Official Website*

This study explores the landscape narrative features of urban heritage parks and how they influence visitors' satisfaction through systematic analyses of physical space, narrative space, and heritage space, so as to provide theoretical support and practical guidance for the sustainable development of urban heritage parks.

### **Visitors' Satisfaction**

Visitors' satisfaction affects their willingness to revisit and recommend a destination (Huh, 2002). Complete tourist satisfaction is a basic requirement for any destination and can be defined as the customer's overall evaluation of the services received versus the services expected (López Guzmán, Pérez Gálvez, & Muñoz-Fernández, 2018). Visitors' satisfaction is important, because it predicts the future behaviour of tourists (Medina-Viruel, López-Guzmán, Gálvez, & Jara-Alba, 2019) and is also a way to assess the effects of the destination and sustainable development. Overall satisfaction is therefore relevant to the summary assessment of destination quality in tourism.

Landscape narratives have a significant impact on visitors' satisfaction by preserving cultural heritage, promoting traditional values, and providing an authentic tourism experience (Fan, Isa, & Mohamed, 2024), and they are a key factor in maintaining tourism sustainability in urban heritage parks (Popescu, Nita, & Iordache, 2020). Landscape narrative features of urban heritage parks provide tourists with high-quality experiences that positively influence visitors' satisfaction and help maintain the sustainability of tourism in urban heritage parks (Asmelash & Kumar, 2019). By analysing how landscape narrative features of urban heritage parks affect visitors' satisfaction, this study provides a useful addition to the sustainability of tourism in urban heritage parks. This paper's second research objective is to evaluate how landscape narrative features of urban heritage parks positively impact visitors' satisfaction (Chew, Zainol, & Goh, 2024).

In recent years, landscape narratives have evolved to provide visitors with an experience of immersion through narrative devices centred around specific themes and to seek a balance between education and entertainment to enhance visitors' identification with local cultures (Potteiger & Purinton, 1998). This kind of themed design also raises the controversy of authenticity versus commercialization, however. Some studies have pointed out that theme parks may weaken historical authenticity by focusing too much on attracting tourists, thus affecting visitors' experience (Davis, 2022); others argue that the combination of heritage preservation and tourism development can be achieved by modernizing narrative innovation to increase visitors' satisfaction while conveying cultural values (Garnier, 2015). In urban heritage parks, the question of how such a 'narrative' design can balance cultural preservation and heritage

authenticity while meeting visitors' needs and improving visitors' satisfaction remains an important issue to be addressed (Niglio, 2014). This study aims to provide theoretical support and practical guidance for the conservation and management of heritage sites by exploring the impact of landscape narratives on visitors' satisfaction in urban heritage parks and clarifying their role in enhancing the tourism experience, promoting cultural dissemination, and achieving sustainable development.

## **RESEARCH METHODOLOGY**

This study examines an urban heritage park in Yingzhou West Lake, Fuyang City, Anhui Province, China, focusing on the impact of its landscape narrative features on visitors' satisfaction. To fully understand tourists' views and feelings, opinions and feedback were collected from visitors to Yingzhou West Lake through a questionnaire survey.

The landscape narrative features scale was used to measure the three dimensions of physical space (PS), narrative space (NS), and heritage space (HS), with a Cronbach's alpha value of .91 for PS, .94 for NS, and .909 for HS. For the measurement of PS, the scale developed by Wang (2022) and Huang and Yao (2023) was used as a reference. It consists of five measurement items divided into two parts: two items on natural resources and three items on man-made sources. For the measurement of NS, the scale designed for Tao and Rodloytuk (2023) study was divided into three parts, including seven questions: one item on the narrative theme, five items on narrative structure and rhythm, and one item on the artistic context. For the measurement of HS, the scale designed by Feng, Chiou et al. (2021) was used, which consists of two sections with six items: five for folk culture activities and one for educational significance. In this study, these scales were integrated to comprehensively assess the performance of the dimensions of landscape narrative features in urban heritage parks and their impact on visitors' experience.

**Demographic variables.** Previous research has found that visitors' satisfaction is affected by the number of visits, gender, age, education, income, and place of residence (Kim & Thapa, 2018). To test the relationship between the key variables and increase the research's external effect, therefore, this paper selects number of visits, gender, age, education, income, and place of residence as control variables.

The researcher personally conducted a questionnaire survey of tourists at the West Lake of Yingzhou on September 16, 17, 23, and 24, 2023. Because minors' mental development is not mature enough to understand the questionnaire, the participants were tourists over 18 years old. A total of 380 questionnaires were distributed, and 340 questionnaires were retrieved. These

were then screened, resulting in 322 valid questionnaires by removing those with omitted questions. The effective recovery rate reached 94.47%.

This study is dedicated to the in-depth investigation of an urban heritage park located in Yingzhou West Lake, Fuyang City, Anhui Province, China, focusing on the impact of its landscape narrative features on visitors' satisfaction. To fully understand tourists' views and feelings, we plan to collect opinions and feedback from visitors to the Yingzhou West Lake through a questionnaire survey. Therefore, the questionnaire data for this study will be collected mainly from tourists to the Yingzhou West Lake.

## ANALYSIS AND DISCUSSION

According to the results of the questionnaire (Table 1), first-time tourists accounted for 44.86% of the total, those visiting two to four times accounted for 38.89%, and those visiting more than five times accounted for 16.26%. The ages of the participants were distributed as follows: 25–30-year-olds accounted for 33.33% of the total, 31–40-year-olds 32.10%, 19–24-year-olds 24.69%, 41–50-year-olds 7.41%, and over 50-year-olds 2.47%. Regarding education, 55.76% of the tourists had a bachelor's degree, 15.02% had a college degree, 12.55% were in high school, 8.64% were in postgraduate studies or above, and 8.02% were in junior high school or below. In terms of income, 42.18% had a monthly income of RMB 2,001–5,000, followed by 30.86% with a monthly income of RMB 5,001–10,000, 17.28% with a monthly income of less than RMB 2,000, and 9.68% with a monthly income of more than RMB 10,000. Regarding the current residence, 65.43% were from within Fuyang City, 22.63% were from outside Fuyang City, and 11.93% were from other provinces and cities. These statistics show that the visitor group is young, highly educated, middle-income, and mainly local tourists. These characteristics provide an important background for the subsequent analysis of visitors' satisfaction.

**Table 1:** Distribution of basic characteristics of the valid sample.

Title	Option	Frequency	Percentage (%)	Cumulative Percentage (%)
Times	1st	218	44.86	44.86
	2-4 times	189	38.89	83.74
	5 times or more	79	16.26	100.00
Gender	Male	221	45.47	45.47
	Female	265	54.53	100.00
Age	19-24 years old	120	24.69	24.69
	25-30 years old	162	33.33	58.02

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	31-40 years old	156	32.10	90.12
	41-50 years old	36	7.41	97.53
	Above 50 years old	12	2.47	100.00
Education	Junior high school and below	39	8.02	8.02
	High school, junior college, technical school	61	12.55	20.58
	College	73	15.02	35.60
	Undergraduate	271	55.76	91.36
	Graduate school and above	42	8.64	100.00
Income	Less than 2000	84	17.28	17.28
	2001-5000	205	42.18	59.47
	5001-10000	150	30.86	90.33
	More than 10000	47	9.68	99.79
Residence	Within Fuyang City	318	65.43	65.43
	Outside Fuyang City	110	22.63	88.07
	Other provinces and cities	58	11.93	100.00
	Total	486	100.0	100.0

The validation factor analysis results showed a good fit of the model (as shown in Table 2). For example, CMIN/DF = 1.319, GFI = 0.917, CFI = 0.985, and RMSEA = 0.026, which suggests that the research model explains the data well and is suitable for further analysis (as shown in Table 2).

**Table 2:** Results of validation factor analysis.

Model Fit Indicators	Statistical value	Standard value	Statistical results
CMIN/DF	1.319	1-3	Statistical value greater than 1 and less than 3
RMR	0.023	0.05	Statistical value lower than the minimum standard value, goodness of fit
GFI	0.917	$\geq 0.9$	Statistical value is higher than the minimum standard value, goodness of fit
AGFI	0.905	$\geq 0.9$	Statistical value higher than the minimum standard value, goodness of fit
NFI	0.941	$\geq 0.9$	Statistical value is higher than the minimum standard value, goodness of fit
IFI	0.985	$\geq 0.9$	Statistic is higher than the minimum standard value, goodness of fit
TLI	0.984	$\geq 0.9$	Statistic is higher than the minimum standard value, goodness of fit

Model Fit Indicators	Statistical value	Standard value	Statistical results
CFI	0.985	$\geq 0.9$	Statistical value higher than the minimum standard value, goodness of fit
RMSEA	0.026	$\leq 0.08$	Statistical value higher than the minimum standard value, goodness of fit

Correlation analysis showed that all three dimensions of landscape narrative features (PS, NS, and HS) were positively correlated with visitors' satisfaction (as shown in Table 3). The correlation coefficients between PS and visitors' satisfaction were .517, NS .575, and HS .649. This indicated that HS had the most significant effect on visitors' satisfaction, followed by NS, while PS had a relatively small effect.

**Table 3:** Variable correlation analysis, mean and standard deviation.

	M	SD	VS	PS	NS	HS
VS	3.188	0.717	1			
PS	3.328	0.818	0.517**	1		
NS	3.423	0.829	0.575**	0.556**	1	
HS	3.726	0.760	0.649**	0.558**	0.580**	1

\*  $p < 0.05$  \*\*  $p < 0.01$

The results of the AMOS path analysis further validated these findings. Among the paths of influence of the dimensions of landscape narrative features on visitors' satisfaction, HS has the highest standardized coefficient (.333,  $p < .001$ ), indicating that it has the strongest positive effect on visitors' satisfaction; NS has a standardized coefficient of .129 ( $p < .001$ ), which also has a significant positive effect; and PS has a lower standardized coefficient (.013,  $p > 0.05$ ), with no significant effect on visitors' satisfaction.

**Table 4:** Main effects test coefficients

Latent variable	Observed variables	Standardization factor	<i>t</i>	<i>p</i>
VS	PS	0.013	0.044	0.238
VS	NS	0.129	0.042	2.42
VS	HS	0.333	0.055	5.563

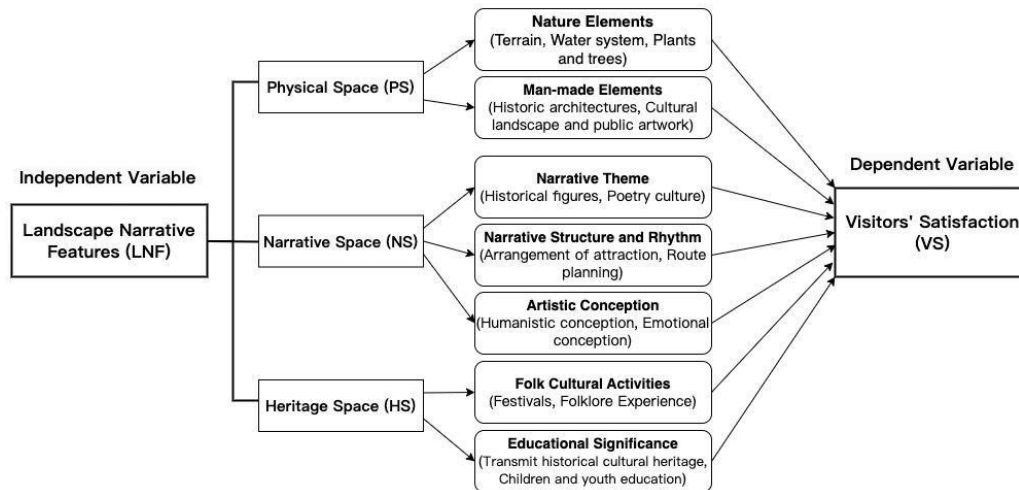
The findings indicate that the three dimensions of landscape narrative features affect visitors' satisfaction differently. The positive effect of HS is the most significant, which suggests that visitors' satisfaction and identification with heritage parks can be substantially enhanced by designing landscape elements that can convey local memories, folklore activities, and cultural and educational



significance. The positive effect of NS reflects the importance of thematic design in enhancing visitors' experience of immersion, for example, through the combination of narrative themes, narrative structure, and artistic conception, so that visitors can feel the deep connection between culture and history. In contrast, although fundamental, PS has a weaker direct effect on visitors' satisfaction and may act more indirectly through other dimensions.

The findings provide the following insights for the design and management of urban heritage parks. First, enhancing the cultural connotation of heritage spaces, such as organizing folklore activities and adding cultural interactive projects, can significantly enhance visitors' experience. Second, through the optimal design of narrative spaces, such as emphasizing narrative themes and artistic conception shaping, visitors' emotional involvement and immersion can be enhanced. Lastly, the design of physical spaces should be closely integrated with narrative and heritage dimensions to better serve the presentation of the overall landscape narrative. Overall, this positive correlation provides theoretical support for research and practice, emphasizing the feasibility and necessity of using landscape narrative features to enhance visitors' satisfaction in urban heritage parks.

The three dimensions of the landscape narrative complement each other to build a complete narrative system. The HS enhances visitors' sense of cultural identity and protection through the display of local memories, folk activities, and cultural education; the NS provides visitors' experience through theme design, narrative structure planning, and artistic conception; and the PS shows the local environment and cultural characteristics through the combination of natural and man-made landscapes, providing visual and sensory support for the overall narrative. The interaction of the three dimensions effectively enhances the cultural experience and visitors' satisfaction with the urban heritage park. The final model of this study is shown in Figure 4, providing a clear representation of the core framework and key elements.



**Figure 4:** Model Illustrating the Influence of Landscape Narrative Features on Visitor Satisfaction.

## CONCLUSION

Taking Yingzhou West Lake urban heritage park as a case study, this study explores how landscape narrative features (including PS, NS, and HS) influence visitors' satisfaction. The positive influence of HS on visitors' satisfaction was most significant, indicating that the landscape design of local memory, folklore activities, and cultural education can significantly enhance visitors' cultural identity. NS provides visitors with an immersion experience and further enhances emotional resonance through narrative themes, structural design, and artistic conception. As the basis of landscape narrative, PS has a weaker direct influence. Moreover, combining narrative and heritage dimensions indirectly contributes to visitors' satisfaction.

The results of this study not only fill the research gap related to visitors' satisfaction in urban heritage parks, but also provide a theoretical basis for the balance between cultural conservation and tourism development. The study emphasizes the importance of landscape narrative features in the sustainable development of urban heritage parks, which can achieve the goal of cultural dissemination and optimizing visitors' experience. Through empirical analysis, this study provides practical guidance for the design optimization and management enhancement of future urban heritage parks.

Based on the findings of this study, the following recommendations can be put forward. First, managers of urban heritage parks should further excavate and enrich the cultural connotation of the HS and enhance visitors' sense of identity and participation in local culture by organizing folklore activities and

cultural exhibitions and increasing interactive experiences. Second, in the design of the NS, attention should be paid to integrating the narrative theme and artistic conception to create a more immersive cultural scene, thus enhancing visitors' experience and emotional resonance. In addition, optimization of the PS should be closely integrated with the narrative and heritage dimensions to achieve the coordination and unity of the overall landscape narrative. This is the first study to systematically analyse the specific impact of the three dimensions of landscape narrative features on visitors' satisfaction, and it therefore provides important theoretical support and practical references for urban heritage parks in the areas of cultural value enhancement, visitors' experience optimization, and sustainable development and provides a new direction and a reference framework for future research.

## ACKNOWLEDGMENT AND ETHICAL STATEMENT

This study was conducted independently without external funding, relying on personal resources while adhering to ethical standards. The data were publicly available or self-collected without special permission, complying with the University of Malaya's ethical requirements.

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## **DOCUMENTING THE CULTURAL CEREMONIES OF ORANG ASLI PAHANG**

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### **Abstract**

The Orang Asli Pahang celebrate their heritage with vibrant ceremonies embodying the spirit of community, culture, and nature. This study aims to develop a digital documentation strategy to archive the cultural ceremonies of the Orang Asli Pahang in a cultural repository. This will preserve and enhance access to this cultural information, filling gaps in collective memory and improving documentation of lesser-known communal ceremonies to help revive the cultural heritage. Purpose: The primary objectives of this paper are (i) to document the cultural ceremonies of Orang Asli Pahang, and (ii) to assign themes to the cultural ceremonies widely applicable to all tribes of the Orang Asli in Pahang. Method: Qualitative research method is employed to explore, document and thematize the cultural ceremonies of Orang Asli Pahang. Such methods include content analysis, semi-structured interviews, and thematic analysis. Findings: There exists a rich tapestry of cultural ceremonies that interrelate with other domains of cultural heritage. These cultural ceremonies are commonly motivated by marital celebrations, ancestral honorations, supernatural phenomena, and occasional communal feasts. Concerning all tribes of Orang Asli Pahang, the cultural ceremonies are thematized under rite of passage-related, ancestor-related, supernatural-related, and communal feast-related. The findings also highlighted the urgency to digitally document the Orang Asli Pahang's cultural ceremonies. Respondents remember individual rites of passage but struggle to recall communal ceremonies involving feasts, ancestors, and the supernatural.

**Keywords:** Intangible Cultural Heritage, Cultural Ceremonies, Orang Asli Pahang

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## **INTRODUCTION**

This paper aims to develop a digital documentation strategy to archive the cultural ceremonies of the Orang Asli Pahang. This effort seeks to fill gaps in the collective memory by identifying existing traditions and improving the documentation of lesser-known communal ceremonies, ensuring the preservation and revival of the heritage. The study significantly contributes to the ongoing investigation into the field of Intangible Cultural Heritage [ICH], with a specific focus on the cultural ceremonies the Orang Asli in Pahang.

In pursuit of documenting and assigning the metadata for the repository of cultural ceremonies, the primary objectives of this paper are outlined below:

- i. To document the cultural ceremonies of Orang Asli Pahang,
- ii. To assign themes to the cultural ceremonies widely applicable to all tribes of the Orang Asli in Pahang

## **CULTURAL CEREMONY METADATA AND THEMES**

Cultural ceremonies are categorized under the third of domain of UNESCO's Convention for the Safeguarding of the ICH. The third domain refers to the Social Practices, Rituals, and Festive Events. However, the manifestation of any particular ICH is not confined to a single domain. Often times the completion of a single cultural manifestation involves multiple ICH domains (Abu Bakar, et al., 2014; Lazaro Ortiz, S., & Jimenez de Madariaga, 2022)

Museums and heritage institutions often use many forms of repositories to document and oversee cultural heritages materials and items. Metadata is crucial for the operation of a cultural repository since it facilitates the organisation and discovery of cultural materials, ensures consistent standardisation, offers contextual information, and enables preservation and management. This process expedites accessibility and interoperability across various cultural manifestation archives. Metadata refers to the information that explains and provides context to a certain data (Monova-Zheleva, et al., 2020). For instance, the metadata pertaining to a certain cultural manifestation may include the title of the manifestation, its location, the participants, and the materials involved.

The crucial metadata for cultural ceremonies includes (i) the incorporation of ICH domains and (ii) the identification of themes, which refers the underlying motives behind the ceremony's manifestation. The incorporation of ICH domains refers to the categorizing the cultural ceremony according to the domain outlined by UNESCO's Convention for the Safeguarding of the ICH, guaranteeing that they are classified within the established framework. The identification of themes focusses on the fundamental causes that define each cultural ceremony. This can include marital celebration and seasonal changes.

Thematizing the intricacies of the cultural ceremonies help recognize the underlying motives, interrelationships with other domains of ICH and other specifics involved the ceremonies.

### **UNDERSTANDING CULTURAL CEREMONY**

According to UNESCO (2003), cultural ceremonies are categorized under the third domain out of the five domains of ICH. Cultural ceremonies are a prominent cultural manifestation, encompassing customs, social practices, and collective festivities transmitted over successive generations. These activities frequently function as forums for cultural interchange, promoting a feeling of identity and unity among the participants. Tume (2021) highlights that ceremonies provide a platform for the expression of many ethnicities and cultural solidarity, particularly by presenting and immersing oneself in a unique culture.

For Selkani (2018), a ceremony can occur regularly or less frequently than once a year, while Dadman and Madani (2021) describe a ceremony as a customary yearly celebration. Drawing upon previous studies, Hjalager & Kwiatkowski (2018) define ceremonies under five distinct characteristics:

- i. Ceremonies have a finite duration, with a clearly defined beginning and end;
- ii. Ceremonies are restricted to a particular place;
- iii. Ceremonies are organized events with predetermined goals, themes, and schedules that follow recognisable structures, although they may include some spontaneous elements;
- iv. Ceremonies bring together multiple activities in mutually beneficial relationships; and, lastly,
- v. Ceremonies are inclusive and welcoming, allowing anyone to participate.

Cultural ceremonies showcase diverse ICH manifestation and expressions. Religious rituals, rites of passage, and family events like births, marriages, and funerals are among them. They also include socio-political practises including loyalty oaths, customary law, and community amusement. Cultural ceremonies can also include family, settlement, and seasonal rituals. Other cultural manifestations found within these ceremonies such as cultural expressions, including gestures, recitations, music, and attire, enrich enhance the cultural ceremonies. Parades and symbolic gestures, like animal sacrifice, rituals feature, and culturally important cuisines augment their significance (Lazaro Ortiz, S., & Jimenez de Madariaga, 2022).

The cultural ceremony among Orang Asli is a timeless tradition deeply interwoven with their cultural, spiritual, and social fabric. Their distinctive languages, knowledge systems, beliefs, and vital expertise in strategies for sustainable management of natural resources distinguish them from other parts



of national communities. Orang Asli expresses cultural identity, tradition, and solidarity through their lively cultural ceremonies. Originating in ancestral traditions and sacred cosmologies, these celebrations resonate with the rhythms of nature. They signal seasonal changes, abundant harvests, and deep spiritual ties (Goh & Teh, 2022; Zuhairi, Rosnon, & Shaari, 2020; Ghani et al., 2020).

## **THEMES OF CULTURAL CEREMONY**

Four themes of cultural ceremonies emerged from prior research, centred around rites of passage, communal feasts, ancestors, and the supernatural. The development of the interview's questions and the thematic analysis of the interview data both incorporated these themes.

### **Rite of Passage-Related Ceremonies**

The rite of passage-related ceremonies are fundamental to Orang Asli cultural traditions and social structure. *Adat* is the term for Orang Asli's customs and tradition. For Orang Asli Jahut's marital ceremony, only the relatives of the engaged parties are invited to weddings, though at times, neighbours are allowed to attend as well. Crucially, at marriage celebration, Orang Asli upholds their beliefs and adhere to their *adat*. The wedding ceremony is guided by the *adat* leaders, who diligently follow the customs and traditions governing the union between a man and a woman (Adam & Yusop, 2020).

### **Communal Feast-Related Ceremonies**

Communal feast-related ceremonies tend to occur during seasonal months, usually just after the harvest of crops, such as rice or other forest produced. The ceremony of *Menjulung Tahun* (New Years) is one of the joyous celebrations that function as a ceremonial gratitude for a bountiful harvest and a time for communal feast for Orang Asli Semelai. Additionally, a noteworthy tradition of Orang Asli Semai is offering sacrifice chickens, flowers, and unhusked rice to the rice spirit to placate the land spirits for a successful crop (Shaari et al., 2024).

### **Ancestor-Related Ceremonies**

The ancestral-related ceremonies comprise of ceremonies or rituals specifically designed to pay homage and remember forebears and their customs. Orang Asli Temuan celebrate *Hari Moyang* (Ancestors' Day) to request protection, forgiveness, and blessings from their ancestral spirits to ensure a more promising future. This celebration functions as a prominent cultural indicator, strengthening connections to one's ancestors and safeguarding customary rituals throughout the community (Linggang, Wirunsakunphiban & Nusen, 2024; Mahfuz, 2023)

### Supernatural-Related Ceremonies

Orang Asli Pahang believe in supernatural entities, with *Sewang* being one of the most notable. A ceremonial rite called *Sewang*, functions as a singing séance with the goal of forging a strong connection between their spirituality and paranormal beings. Deeply ingrained in their cultural legacy, this ceremonial practice allows spiritual communication and asks the supernatural realm for blessings, protection, and guidance. *Sewang* maintains spiritual continuity and cultural identity by preserving their ancestors' traditions (Chan & Saidon, 2017).

### METHODOLOGY

This study conducted qualitative research, in particular a thematic literature review driven by the objective formulated, followed by content and thematic analyses to establish existing findings. Multiple resources were utilized, such as books, journals, reports, academic publications, community documentation and scholarly articles on Orang Asli Pahang. The initial findings helped to shape the creation of interview questions and an organization that enabled smooth discourse during the interview sessions with different Orang Asli tribes.

Guided by key themes and sub-themes identified in the initial findings, the semi-structured interview aimed to explore and document the cultural ceremonies of Orang Asli Pahang. The semi-structured interviews were conducted primarily with community leaders, known as *Tok Batin*, or, if they were unavailable, with key representatives of the targeted communities (refer to Table 1). The interviews were audio-recorded and later transcribed for further analysis. The analysis was principally focused on identifying the names of the ceremonies, the involvement of ICH domains, and assigning suitable themes to the cultural ceremonies (refer to Figure 1).

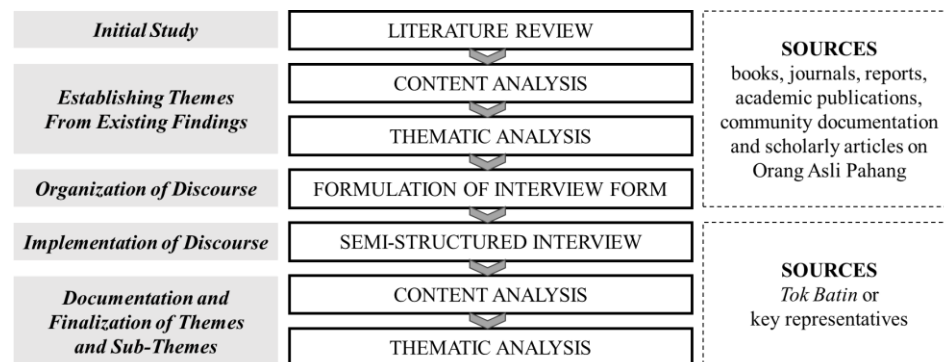


Figure 1: Flowchart of Fieldwork Approach

**Table 1:** Targeted Community for Semi-Structured Interviews

Targeted Community	Daerah	Tribes
Kampung Kuala Atok	Jerantut	Bateq
Kampung Sungai Pian	Temerloh	Jah Hut
Kampung Kuala Enggang	Temerloh	Che Wong
Kampung Sungai Rening	Cameron Highlands	Semai
Kampung Kuala Boh	Cameron Highlands	Semai
Kampung Sungai Tiang	Jerantut	Semoq Beri
Kampung Pelawan	Bera	Semelai
Kampung Sungai Bot	Bentong	Temuan
Kampung Gumum	Pekan	Jakun

## FINDINGS

The first part of this section indicates the summary of findings from the semi-structured interviews. The following part shows an example of how the findings are organized in the designated metadata.

The cultural ceremonies of Orang Asli Pahang are essentially communal events, typically involving families and neighbours. *Adat*, their cultural customs, underpin these ceremonies. Following *Adat*, led by the *Tok Batin* and backed by other community leaders, is vital and violators are punished. Table 2, Table 3, Table 4 and Table 5 shows the summary of findings of the third ICH domains, Social Practices, Rituals, and Festive Events gathered from the interview conducted. The supporting domain of Oral Traditions and Expressions (1), Performing Arts (2), Knowledge & Practices (4) and Traditional Craftsmanship (5) are also indicated.

**Table 2:** Rite of Passage-Related Ceremonies

Tribes	Description	ICH	
Orang Asli Bateq	Marriages in the communities occur without any exchange of money. If both parties agree, they proceed with a small celebration. Before the wedding, the village head seeks approval from both families. After the marriage, the house that was built by the formerly single bride is completed with walls. Most parts of the house are constructed by the wife.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli Che Wong	<i>Merisik</i> is a preliminary step where a man proposes to a woman, allowing both families to acquaint themselves. If the woman's family agrees, they move to engagement, pledging marriage. The wedding follows with customs and rituals to invoke blessings, with community support and advice being integral to maintaining family harmony.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli Semoq Beri	Engagement takes place once an agreement has been reached between both parties. Typically, engagements involve the exchange of gifts such as toys, animals, or other valuable items.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4

	Marital ceremony involves the extended family and the local community.	<input checked="" type="checkbox"/>	5
Orang Asli Semelai	Ceremonies are held at the <i>Rumah Adat</i> led by the Village Headman with support from elders and community leaders. Only the <i>Tok Batin</i> officiates marriages, with customs requiring everyone to sit on traditional mats. Festivities begin with the groom's exit from the house to traditional music. While dowries are not customary, the groom presents a <i>mas kahwin</i> valued at RM 22.50, with additional RM 0.50 for the Village Headman, and RM 8.00 for widows. Gifts include betel leaves, makeup, clothes, and jewellery, accompanied by a betel nut set. Guests cannot take or reduce items from it. Following vows, celebrants enjoy music and palm wine, banana, or sugarcane-based drinks.	<input checked="" type="checkbox"/>	1
		<input checked="" type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Table 2: Rite of Passage-Related Ceremonies (continued)			
Tribe	Description	ICH	
Orang Asli Jah Hut	During proposal, the man's side sends a needle and thread in a woven container made of <i>mengkuang</i> to the woman's side. If the woman does not accept the man, she will pierce the needle into the thread and return it to the man as a sign of agreement. The engagement involves sending items such two identical rings, handkerchiefs, and RM100. Since gold rings are ostentatious and taboo, they are rarely used. The man sends these items to the woman, who reciprocates with a woven container. Traditions has been modernized where money or rice are now exchanged. Tribal leader descendants expect more than RM50, unlike ordinary member. Usually, the paternal uncle officiates the wedding. Absent paternal uncles are represented by heirs. Without paternal uncles, heirs, or younger siblings, elder brothers can act as guardians as a last resort. The village's <i>Dewan Adat</i> will host the wedding. The welcoming ceremony for the bride and groom is also held among the tribe.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli Semai	Marriage among the tribe usually occurs at a young age, around 17 or 18 years old. The importance of respecting traditions is emphasized, such as the prohibition for the bride and groom to leave their villages before the wedding. Weddings in village are celebrated on a large scale, with over a thousand attendees at each ceremony. The celebrations can last from morning until the next morning and include traditional dances and other forms of entertainment. Marriages in village also involves discussions with family and village leaders, followed by religious procedures overseen by a religious officer. Equal distribution of dowry is emphasised, considering the groom's financial capacity. There are financial compensations involved if divorce, with the amount depending on the fault of each party. Remarriage also entails financial obligations, including a fee for entering the spouse's house.	<input checked="" type="checkbox"/>	1
		<input checked="" type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5

Orang Asli Jakun	The tribe have two types of engagements: ordinary and <i>Timun Setudung</i> . Regular engagements are long due to financial constraints, while <i>Timun Setudung</i> engagements are shorter due to financial flexibility. Engagement items include betel leaves, betel nuts, and clothing. Weddings are held at <i>Dewan Adat</i> and officiated by the Tok Batin. Most tribe members marry inter-tribally. Wedding ceremonies follow traditional Orang Asli or Malay-style solemnizations. Divorce penalties range from RM 30 to RM 40, with higher penalties imposed today to discourage divorce. <i>Adat</i> institution members work together to ensure successful wedding ceremonies.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5

Table 3: Communal Feast-Related Ceremonies

Tribe	Description	ICH	
Orang Asli Semai	The tribe celebrate the rice harvesting ceremony. They hold a feast on the first day of rice harvesting. The harvesting day is a busy day as most of them engage in activities such as fishing, hunting, gathering vegetables, harvesting, and pounding rice.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli Semelai	The <i>Menjulong Tahun</i> celebration is held in conjunction with rice harvesting activities, where relatives, siblings, and neighbours are invited to process harvested rice together by winnowing and pounding the rice. The processed rice is then cooked and enjoyed together with the attending relatives, siblings, and neighbours who helped in the process.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input type="checkbox"/>	5

Table 4: Ancestor-Related Ceremonies

Tribe	Description	ICH	
Orang Asli Temuan	<i>Hari Moyang</i> or known as <i>Aik Muyang</i> is a ritual and prayer held at the graveyard site to honor the spirits believed to have safeguarded the safety and provided blessings to the current generation. <i>Hari Moyang</i> is celebrated from December to January on different dates depending on the settlement groups. Activities include cleaning the graves of ancestors and serving various food and drinks to the spirits of the ancestors.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli Semai	<i>Hari Genggulang</i> is a traditional ritual celebrated between December and February for community safety and well-being. The ritual has evolved throughout time and place. A shaman or <i>Bomoh</i> casts a <i>Cenagoh</i> spell to their ancestors to start the event. In a specially constructed <i>Balai</i> , the <i>Bomoh</i> will execute the rite. Woven <i>serdang</i> leaves, <i>mengkuang</i> forest, flowers, and others beautify the <i>Balai</i> . The left and right bowls in front of the <i>Balai</i> contain an ancestral feast of glutinous rice, <i>Wajik Periong</i> , and chilled and bleeding chicken eggs. After the <i>Balai</i> ritual, the <i>Tok Pawang</i> binds the taboo. The ritual culminates	<input checked="" type="checkbox"/>	1
		<input checked="" type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5

	with each resident hosting a feast for the public. Indigenous or <i>Modek</i> dancers and music in half the sites make the celebration more exciting.		
Orang Asli	They believe in ancestral spirits as everyday companions. The spirituality of their culture shapes their outlook and behaviours.	<input checked="" type="checkbox"/>	1
Semoq Beri	They believe their ancestors' spirits guard, advise, and assist them. This religious system influences their customs, ceremonies, and social interactions by fostering deep regard for their ancestry.	<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input type="checkbox"/>	5

**Table 5: Supernatural-Related Ceremonies**

Tribe	Description	ICH	
Orang Asli	During the Chinese New Year holidays, they participate in a <i>Berlacang</i> activity. Offering beef and poultry among other meals to the river as a form of devotion is the ritual's practice.	<input checked="" type="checkbox"/>	1
		<input type="checkbox"/>	2
Jakun	After releasing adorned sculptures or tiny boats into the river, the meal is devoured while taking a bath. Worship and disaster protection for the village's residents are the two main goals. The <i>Tok Batin</i> is in charge of organizing and carrying out the planning process. It is forbidden to visit at this time because of the possibility that <i>hantu</i> or ghosts may accompany the guests.	<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli	A ritual called <i>Berjarom</i> is performed to appease spirits and is conducted at spiritually significant locations such as large rocks, caves, banyan trees, fig trees, and so on. During the ritual day, they impart protective knowledge to selected individuals, while on the following night, the knowledge is passed down to the new shaman.	<input checked="" type="checkbox"/>	1
Jakun		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input type="checkbox"/>	5
Orang Asli	The <i>Tum Yap</i> ceremony or blood sacrifice ceremony appeases the anger of <i>Gobar</i> (a supernatural being). <i>Tum</i> (water) and <i>Yap</i> (blood) ceremony involves disposing of blood taken from the tibia bone, mixed with rainwater or river water. During the ritual, phrases such as "Go! Go!" or "stop" must be uttered.	<input checked="" type="checkbox"/>	1
Bateq	Anyone who violates the <i>lawad</i> must perform the <i>Tum Yap</i> ceremony. Typically, participants come in groups rather than individually. If the perpetrator is absent during the ceremony, a replacement must be chosen from witnesses.	<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input checked="" type="checkbox"/>	5
Orang Asli	The tribe believes deeply in <i>Jujuh Semengot</i> , which refers to the seven spirits that hold significant spiritual and cultural importance. This folklore is passed down orally from one generation to the next, serving to educate about the tribe's spiritual beliefs, values, and traditions.	<input checked="" type="checkbox"/>	1
Semelai		<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4
		<input type="checkbox"/>	5
Orang Asli	The tribe performs a singing séance called <i>Nopoh Bukau</i> to cure or communicate with supernatural spirits specifically the <i>Bi Asal</i> and <i>Bi Hali</i> , who greatly affect fertility and abundance.	<input checked="" type="checkbox"/>	1
Che Wong	The spirits thought to have come from deep inside the Earth,	<input type="checkbox"/>	2
		<input checked="" type="checkbox"/>	4

live in nature and help plants thrive. The ritual is conducted in complete darkness, typically after sunset, without any other light sources to allow the supernatural to enter the location. The two nights ceremony includes entertainment, relaxation, songs about fruit and animals. Although it is usually performed indoors, it can also be conducted outdoors, with close family and friends invited to participate.	<input type="checkbox"/>	5
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The gathered data is expected to be entered based on the metadata into the cultural repository database as follows.

**Table 6:** Example of Data Input

Metadata	Input
Name	Marital Custom: Engagement
Tribe	Orang Asli Semoq Beri
Location	Kampung Sungai Tiang, Jerantut
ICH Manifestation	Cultural Ceremony
ICH Theme	Rite of Passage-Related Ceremonies
ICH Domain	Social Practices, Rituals, and Festive Events
Supporting ICH Domains	<input checked="" type="checkbox"/> Oral Traditions and Expressions (as vehicle) <input type="checkbox"/> Performing Arts <input checked="" type="checkbox"/> Knowledge & Practices (Nature & Universe) <input checked="" type="checkbox"/> Traditional Craftsmanship
Description	Engagement takes place once an agreement has been reached between both parties. Typically, engagements involve the exchange of gifts such as toys, animals, or other valuable items. Marital ceremony involves the extended family and the local community.
Source	Tok Batin
Keywords	Gifts Exchange

	RITE OF PASSAGE	COMMUNAL FEAST	ANCESTOR	SUPERNATURAL
BATEQ	<i>House Construction</i>	-	-	<i>Tum Yap</i>
JAH HUT	<i>Needle &amp; Thread in Woven Container</i>	-	-	-
CHE WONG	<i>Merisik</i>	-	-	<i>Nopoh Bukau</i>
SEMAI	<i>All-Day Celebration</i>	<i>Harvest Ceremony</i>	<i>Hari Genggulang</i>	-
SEMOQ BERI	<i>Gifts Exchange</i>	-	<i>Spiritual Companionship</i>	-
SEMELAI	<i>Mas Kahwin</i>	<i>Menjulung Tahun</i>	-	<i>Jujuh Semengot</i>
TEMUAN	<i>Within-Tribe Union</i>	-	<i>Hari Moyang</i>	-
JAKUN	<i>Timun Setudung</i>	-	-	<i>Berlancang, Berjarom</i>

**Figure 2:** Tabulated Keywords of Cultural Ceremony based on Tribe and ICH Themes

The interview findings show how much the respondents were able to recall with respect to their cultural ceremonies. Following the transcription process, thematic analysis was conducted to assign codes and themes to the interview data. The themes of cultural ceremonies are found to be centred on rites of passage, communal feasts, ancestors, and the supernatural. The thematic findings also indicated a strong interweaving of the cultural ceremonies with other domains of ICH, implying that the comprehensiveness of a cultural ceremony is heavily dependent on the protection of other ICH domains.

The findings underscore the urgent need to safeguard the cultural ceremonies of the Orang Asli Pahang via digital documentation in an established cultural repository. The respondents can identify rites of passage ceremonies, which are highly individualized. However, they struggle to recall ceremonies centred around communal feasts, ancestors, and the supernatural, which are deeply collective and involve the broader community.

Cultural ceremonies serve as symbols of the tribe's common expressions, encapsulating its beliefs, customs, and overall identity. The ceremonies provide a medium to transmit social conventions, spiritual beliefs, and ancestors' knowledge from one generation to the next, acting as essential ties to their past. They are essential to maintaining a strong connection with their ancestral lands and the environment, promoting community cohesiveness, and protecting indigenous languages. Safeguarding these ceremonies is crucial for the Orang Asli Pahang's continued cultural existence as well as for raising public knowledge and appreciation of their rich cultural heritage.



## CONCLUSION

The two objectives of this study are to document the cultural ceremonies of the Orang Asli in Pahang and to assign themes to these ceremonies that are broadly applicable to all tribes of the Orang Asli Pahang. The process of documenting the cultural ceremonies commenced with the establishment of existing findings, which facilitated the formulation of interview questions and the creation of an organisation that could effectively execute the ceremonies at the various locations of the targeted respondents.

The findings show that the respondents can recall rites of passage ceremonies but struggle with communal feasts, ancestor, and supernatural events. Thematic analysis revealed these themes and their interconnection with other ICH domains, stressing the need for comprehensive protection. The findings highlight the urgency of digitally documenting Orang Asli Pahang's cultural ceremonies. These ceremonies are essential for transmitting social practices, spiritual beliefs, and ancestral knowledge, preserving community cohesion, and protecting indigenous languages. Safeguarding the cultural ceremony is crucial for the tribe's cultural continuity and public awareness of their heritage.

## ACKNOWLEDGEMENT

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## **TRANSFORMATION OF CORAL REEF ECOTOURISM THROUGH THE DEVELOPMENT OF SUPPORTING INFRASTRUCTURE AT BIG KELAGIAN ISLAND INDONESIA**

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### **Abstract**

Coral reefs play a crucial role as habitats where marine life can thrive and seek sustenance, as well as serving as attractive tourist destinations. The research aims to analyse the suitability of tourism and the carrying capacity of ecotourism on Kelagian Besar Island, Indonesia, along with its supporting infrastructure. The research method utilizes an analysis of tourism suitability and area carrying capacity for snorkelling and diving tourism, as well as observing the supporting infrastructure. The analysis resulted in an average suitability rating for snorkelling and diving tourism at 51.38% and 51.63%, respectively, across 7 stations, with a carrying capacity of 1395 and 3187 individuals per day for snorkelling and diving. Field observations revealed that the island's infrastructure is relatively adequate but still requires further improvement and development. To maximize the potential of the area, coral reef transplantation could be undertaken to enhance and maintain tourism suitability on the island. In conclusion, the overall tourism suitability analysis falls into the category of not suitable (S3), with a carrying capacity of 4,582 individuals per day for snorkelling and diving tourism, indicating the need for improving the quality of coral reefs and their supporting infrastructure for ecotourism management on the island.

**Keywords:** Coral reefs, Diving, Snorkelling, Kelagian Besar Island, Supporting Infrastructure

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## **INTRODUCTION**

Coral reefs are ecosystems that play a significant role in the underwater environment (Elise et al., 2019; Xu & Zhao, 2014; Hoegh-guldberg et al., 2017). Ecologically, coral reefs serve as habitats where fish can survive and feed (Berkström et al., 2012). Additionally, the underwater beauty with its diverse marine life such as anemones, algae, and fish around the coral reefs can be a stunning tourist attraction for activities like snorkelling and diving.

Snorkelling and diving tourism are among the most popular preferences for marine tourism in coral reef ecosystems (Shokri & Mohammadi, 2021; Lamb et al., 2014). Maximizing tourism empowerment can enhance the economic growth of the local community and support regional revenue (Xu et al., 2009). Therefore, good planning is necessary, one of which involves conducting an analysis of the Tourism Suitability Index (TSI) and the Area Carrying Capacity (ACC) (Romano et al., 2015). This analysis is useful to determine whether the area meets the criteria to be a suitable tourist destination.

The suitability value of tourism in an area can be assessed through spatial mapping obtained by analyzing satellite imagery data (Jokar et al., 2021). However, its accuracy may differ from actual field conditions. Without accurate planning and mapping, human activities such as tourism and coastal development will have a negative impact on coral reef ecosystems (Silveira et al., 2021). Therefore, data in the form of information on coral reef distribution and further research on Kelagian Besar Island are needed.

Perhaps research on the analysis of tourism suitability and area carrying capacity has been conducted on this island before, but this study incorporates variables that were not previously included, specifically regarding supporting infrastructure as an output. The aim of this research is to analyze the suitability of tourism and ecotourism carrying capacity on Pulau Kelagian Besar along with its supporting infrastructure. Therefore, this study is expected to yield new findings (novelty) and serve as a reference for ecotourism development on the island.

## **RESEARCH METHODOLOGY**

### **Research Study**

This research is a field study conducted on Kelagian Besar Island, specifically in the Padang Cermin District, Pesawaran Regency, Indonesia. The research was spread across 7 locations where data collection was carried out at each station [See Figure 1].

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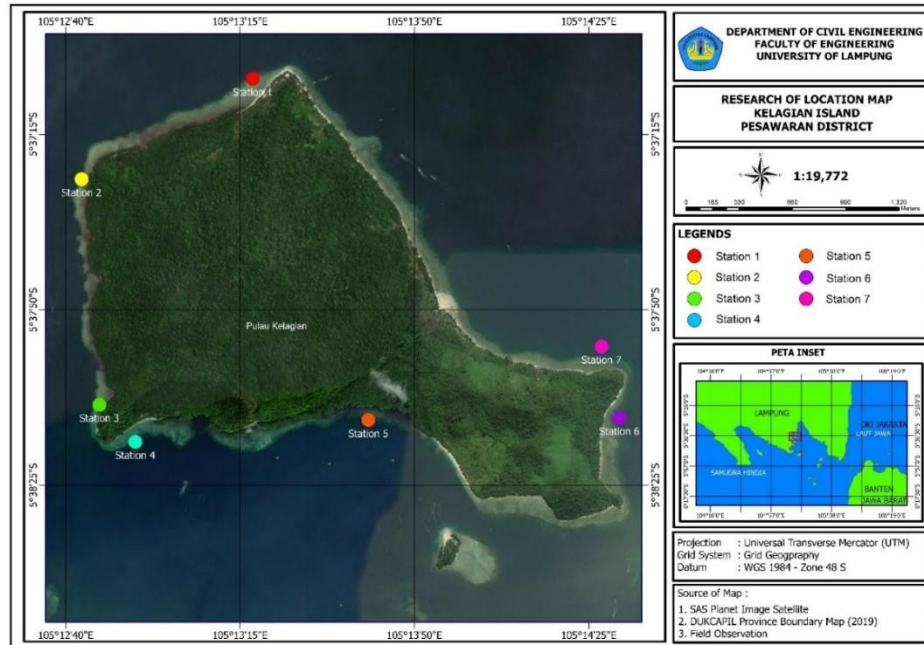


Figure 1: Research Location Map

### Research Instruments

This research utilized a series of tools and materials, including:

- An underwater camera for underwater photography.
- A Garmin 64s GPS for accurate location recording.
- A roll meter for distance measurement.
- A Secchi disk to determine water clarity.
- SCUBA diving equipment for diving.
- Bottles and ropes for measuring current speed.

### Tourism Suitability Data Collection Process

The analysis of the TSI diving category is based on 7 parameters, and the analysis of the TSI diving category is based on 6 parameters. The steps taken to obtain snorkelling and diving IKW data are as follows:

- Water Clarity Data Collection: This is done using a device called a Secchi disk. The device is lowered into the sea, and observations are made to see at what depth the device is no longer visible from the surface.

- b) Water Depth Measurement: This is carried out using a roll meter, which is submerged to the sea floor, and the depth is then measured.
- c) Current Speed Data: This data is collected using a bottle and a string placed on the water's surface. Observations and measurements are made to determine how far the bottle is carried by the current over a certain period.
- d) Coral Cover Data: This is obtained using the Line Intercept Transect (LIT) method. This method involves laying a 50-meter transect line without intervals.
- e) Coral Fish Species Identification: This is done simultaneously with coral cover data collection. Coral fish species data are obtained by directly observing the fish.
- f) Lifeform Types: These are identified concurrently with the collection of coral fish species and coral cover data along the transect line.

#### **Carrying Capacity Data Capture Process**

The ACC data is obtained from the coral reef distribution area at each location on Kelagian Besar Island, derived from Citra Satelit Sentinel 2A.

#### **Interview With Local Community**

The interview aims to observe something whose truth is being sought (Bondi, 2014). The data collection through interviews was conducted to understand the ecology, number of visitors, supporting infrastructure, and the legality of the local tourism management.

#### **Observation Of Supporting Infrastructure**

Infrastructure is a system consisting of facilities or services that are integral to human life and serve to meet basic human needs, such as economic and social requirements (Tzoulas et al., 2007). The observed infrastructure includes the existing facilities and the access road leading to Kelagian Besar Island.

#### **Tourism Suitability Assessments**

The process of analyzing the tourism suitability index is a comprehensive assessment of the suitability of a tourist area for two types of activities, snorkelling and diving (Romadhon et al., 2014). The suitability assessment for snorkelling employs 7 parameters, while for diving tourism, it utilizes 6 parameters is the formula used to determine the tourism suitability index (Shokri & Mohammadi, 2021):

$$TSI = \sum (N_i / N_{maks}) \times 100\%$$

**Description:**

TSI : Tourism Suitability Index  
Ni : Value of i-th parameter (weight x score)  
Nmax : Maximum value of a tourism category

The assessment on each criterion of suitability is determined based on the object's impact on the attractiveness of tourism. The greater the object's impact, the higher the parameter value assigned in (Shokri & Mohammadi, 2021).

The research is conducted by observing the existing parameters, to determine whether the collected data yields appropriate results or not. The parameters for assessing the suitability of diving ecotourism can be evaluated based on six parameters: coral reef depth, lifeform types, water clarity, coral species, coral community coverage, and current velocity. Meanwhile, parameters for assessing the suitability of snorkelling ecotourism can be calculated based on seven parameters: lifeform types, coral species, coral community coverage, coral reef width, water clarity, current velocity, and coral reef depth. Suitability for tourism classes is categorized as unsuitable with a score of <50%, conditionally suitable with a score of 50-75%, and suitable with a score of 75-100%. Data analysis is conducted after the data collection and processing process is completed.

**Tourism Carrying Capacity**

Area Carrying Capacity (ACC) is the maximum limit that a tourist area can sustain over a certain period without causing negative impacts on the ecosystem, both for humans and wildlife (Yusoh et al., 2023; Mohamad & Marzuki, 2018). By limiting the level of tourist visits within a specific timeframe, tourism management can be effectively carried out, ensuring that recreational activities can be enjoyed without harming the preservation of nature (Filza Nadilla Utari et al., 2023). The following is the formula used to determine the carrying capacity of the area (Shokri & Mohammadi, 2021):

$$ACC = K \times \frac{Lp}{Lt} \times \frac{Wt}{Wp} \quad (2)$$

**Description:**

ACC = Area Carrying Capacity  
Lt = The area size for a specific category  
LP = The area/unit length of area that can be utilized  
Wp = The duration utilized by visitors for each specific activity  
Wt = The duration allocated by the area for daily tourism activities  
K = The ecological capability of visitors per unit Area

### **Tourism Infrastructure Analysis**

With the presence of sufficient supporting facilities, visitors are expected to feel more comfortable and secure while engaging in tourist activities. However, in the development of such infrastructure, it is necessary to consider the preservation of the ecosystem in the area (Mamirkulova et al., 2020). Therefore, the development of tourist attractions can be conducted sustainably, yielding positive benefits for visitors while still considering the protection and preservation of the natural environment (See Yulianda et al, 2019).

### **Integration Of Coral Reef Tourism Development**

In the initial stage of information gathering, methods such as observation and mapping, documentation, functional object description, and aesthetic governance of coral reef ecotourism are utilized. This study employs comparative analysis, particularly focusing on ecotourism-supporting infrastructure. Based on this, infrastructure principles for coral reef ecotourism are hypothesized. These findings will serve as the foundation for the author to recommend further masterplan planning regarding the governance of coral reef ecotourism on Kelagian Besar Island.

## **RESULTS AND DISCUSSION**

### **Tourism Suitability Index**

Based on research conducted in the field, data on the suitability of snorkelling and diving tourism were obtained. The data obtained for snorkelling and diving categories are shown in the table below [See Table 1 and See Table 2].

The coral cover measurements on the island range from 23.3% to 87.6%. Location 1 has a coral cover percentage of 73.3%, location 2 has 87.6%, location 3 has 85.4%, location 4 has 23.3%, location 5 has 56.4%, location 6 has 54.6%, and station 7 has a coral cover percentage of 50.88%. The total identification results indicate the presence of 6-8 types of lifeforms, namely Coral Massive (CM), Coral Mushroom (CMR), Coral Foliose (CF), Coral Branching (CB), Coral Submassive (CS), Coral Millepora (CML), Acropora Branching (ACB), and Coral Encrusting (CE), which provide a captivating and beautiful sight for visitors.



**Table 1:** The Recapitulation of Snorkelling Activity Transaction Data

Indicator	station						
	1	2	3	4	5	6	7
Water brightness (%)	100	100	100	49.42	85	100	100
Coral cover (%)	73.3	87.6	85.4	23.3	56.4	54.6	50.88
Lifeform types	6	7	7	8	6	6	8
Reef fish species	11	8	12	8	9	10	10
Current speed (cm/s)	10.1	7.2	13.3	7.6	8.2	5.2	4
Coral Depth (m)	6.5	5.6	4.5	4	5.5	9	6
Width of coral beds (m)	43	15	15	7	50	45	12

**Table 2:** The Recapitulation of Diving Activity Transaction Data

Indicator	station						
	1	2	3	4	5	6	7
Water brightness (%)	100	100	100	49.42	85	100	100
Coral cover (%)	73.3	87.6	85.4	23.3	56.4	54.6	50.88
Lifeform types	6	7	7	8	6	6	8
Reef fish species	11	8	12	8	9	10	10
Current speed (cm/s)	10.1	7.2	13.3	7.6	8.2	5.2	4
Coral Depth (m)	6.5	5.6	4.5	4	5.5	9	6

The results contained in the summary table of transect data allow for the assessment of the Suitability Index for Tourism for snorkelling and diving activities [See Table 3 and see Table 4].

Analysis of the suitability of snorkelling category tourism in the waters of Kelagian Besar Island states the results with the category of unsuitable (S3) and diving category tourism with the category of conditionally suitable (S2.). The range of snorkelling IKW values obtained is between 28.07% - 77.19% and diving IKW range between 29.6-81.5%.

### Area Carrying Capacity

The carrying capacity of an area is beneficial for regulating the number of visitors to a specific area within a certain period of time. To determine the carrying capacity value for snorkelling and diving categories, the area of tourism that can be utilized (Lp) is required [See Table 5].

**Table 3:** The Calculation of TSI Snorkelling Category

Parameter	Weight	Station						
		1	2	3	4	5	6	7
Water brightness (%)	5	5	15	15	5	5	5	5
Coral cover (%)	5	10	15	15	0	10	10	10
Lifeform types	3	3	6	6	6	3	3	6
Reef fish species	3	3	0	3	0	0	3	3
Current speed (cm/s)	1	3	3	3	3	3	3	3
Coral depth (m)	1	1	2	2	2	2	1	1
Width of coral beds (m)	1	1	0	0	0	1	1	0
N max	19	26	41	44	16	24	26	28
Percentage (%)		45.6	71.9	77.2	28.1	42.1	45.6	49.1
Category		S3	S2	S1	S3	S3	S3	S3

**Table 4:** The Calculation of TSI Diving Category

Parameter	Weight	Station						
		1	2	3	4	5	6	7
Water brightness (%)	5	5	15	15	5	5	5	5
Coral cover (%)	5	10	15	15	0	10	10	10
Lifeform types	3	3	6	6	6	3	3	6
Reef fish species	3	3	0	3	0	0	3	3
Current speed (cm/s)	1	3	3	3	3	3	3	3
Coral depth (m)	1	3	2	2	2	2	3	1
N max	19	27	41	44	16	23	27	28
Percentage (%)		50	75.9	81.5	29.6	42.6	50.0	51.9
Category		S2	S1	S1	S3	S3	S2	S2

Description:

Nmax :  $\sum$  (weight x score)

TSI: S1 : Suitable (75-100%)

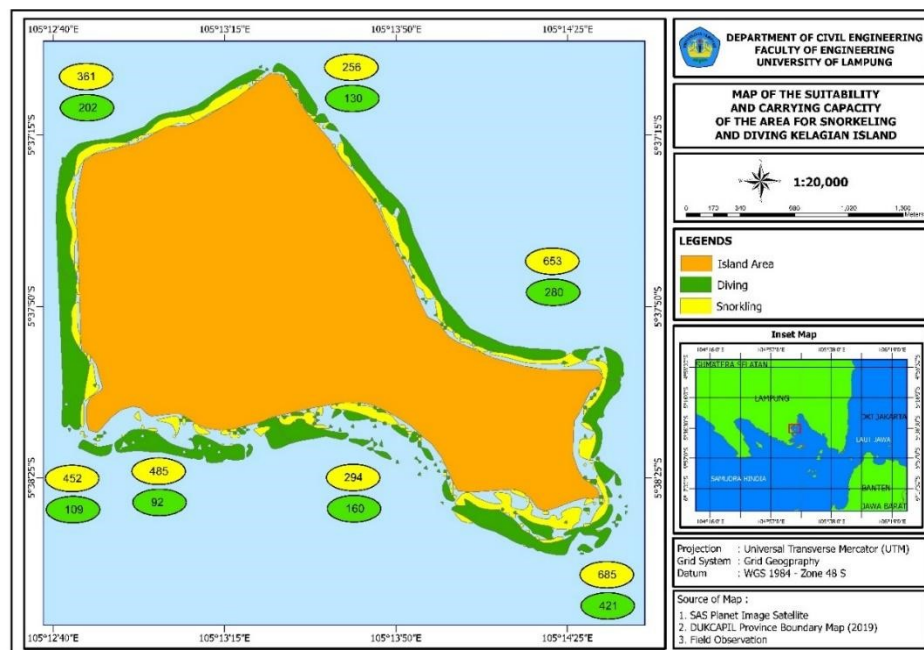
S2 : Conditonal Suitable (50-<75%))

S3 : Not Suitable (<50%)

**Table 5:** The Calculation of The Area/Length Unit of The Region That Can Be Utilized (Lp)

Tourism	K	The vast expanse of recreational activities (km <sup>2</sup> )							Lt	Wt	Wp
		1	2	3	4	5	6	7			
Diving	2	64.0	90.3	113.1	121.3	73.6	171.2	163.4	2000	8	2
Snorkelling	1	32.6	50.4	27.2	23.0	40.1	105.4	70.0	500	6	3

The area available for diving tourism covers 796,755 m<sup>2</sup>, while for snorkelling tourism it is 358,636 m<sup>2</sup>. The assessment of the carrying capacity of the snorkelling and diving areas can be seen in. Figure 2.



**Figure 2:** The Map of TSI And AAC On Kelagian Besar Island

The analysis of carrying capacity in the Kelagian Besar Island for snorkelling tourism reveals a maximum capacity of 256-685 people per day, whereas for diving tourism it is 92-421 people per day. These data are obtained from 7 stations, and the distribution map of maximum visitor capacity at each station can be seen in Figure 2.

Consequently, it is expected that the management can more effectively plan necessary actions to enhance tourists' experiences while preserving the environment.

### **Snorkelling and Diving Ecotourism Analysis**

The analysis of the area's carrying capacity indicates that the coral reef area in Pulau Kelagian Besar reaches 114.54 hectares, predominantly featuring fringing coral. The diverse marine life, such as various types of fish and coral, serves as the main attraction for tourists visiting the island. This information is documented in a book discussing the impact of snorkelling routes on the coral reef. To enhance tourists' comfort, it's necessary to have a variety of coral types on Pulau Kelagian Besar, emphasizing the importance of coral diversity to enrich the tourists' experience. With this variety, tourists are more inclined to engage in snorkelling and diving activities.

From observations conducted at the 7 Stations listed in Figure 1, snorkelling and diving sites are present at all of these Stations. The highest coral cover percentage was recorded at Station 2, reaching 87.6%. Details regarding this coral cover can be found in Tables 4 and 5. Overall, the coral cover on this island is considered good, although there are two Stations showing signs of coral reef damage, namely Station 4. The lowest coral cover percentage was recorded at Station 4, reaching only 23.30%, which is attributed to a lack of regular maintenance. To maximize the potential in this area, it is recommended to conduct coral reef transplantation to enhance coral cover. This step will help preserve and enhance the suitability of coral reef ecotourism on Kelagian Besar Island.

The suitability analysis for snorkelling and diving activities, the ecotourism suitability index of the coral reefs on Kelagian Besar Island is classified as "not suitable" (S3). In comparison with similar research on Marsegu Island, Maluku, which utilized a similar analysis, the results indicate a Tourism Suitability Index (TSI) of 74.79% along the coast of Marsegu Island, categorized as "Suitable" (S1). This is due to a more optimal percentage of coral cover, visibility, and current speed in that area. The carrying capacity for diving and snorkelling activities on Kelagian Besar Island is 4582 people per day. Compared to the carrying capacity on Marsegu Island, Maluku, which has an area of 1023 hectares, its capacity reaches 4092 people per day. Therefore, as input for management, education is needed for visitors and local communities regarding snorkelling and diving activities to ensure the coral reef ecosystem remains intact and undamaged.

### **Supporting Infrastructure for Coral Reef Ecotourism**

Based on direct field observations, the availability of supporting infrastructure can be seen in Table 10. The table indicates that the availability of infrastructure on Pulau Kelagian Besar is not evenly distributed. Given this condition, development of management should be undertaken to ensure the existing facilities are adequate.

The supporting infrastructure on this island is already quite good, but it still requires improvement and development, such as the lack of adequate resorts or accommodation, souvenir shops, and the absence of diving equipment rental facilities, which means visitors interested in snorkelling or diving need to bring their own diving gear.

### **Marine Ecotourism Development**

According to the assessment of the tourism suitability index on Kelagian Island, it indicates that it falls into the category of not suitable (S3). This is due to the lack of coral fish species and the small number of live corals, resulting in a very low tourism suitability score. By collaborating with management or government, it is hoped that the potential of tourism on this island can be enhanced and the tourism industry, especially marine ecotourism, can be developed.

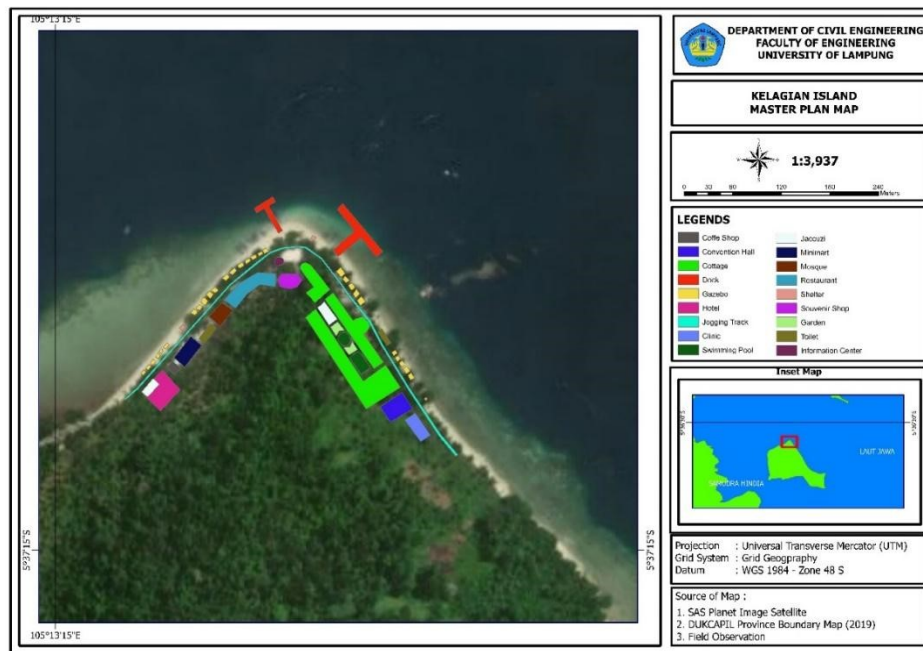
There are several efforts that can be made to develop marine ecotourism activities, including:

- a. Conducting coral reef transplantation and maintaining the quality of the underwater ecosystem aimed at increasing the tourism suitability index, especially regarding coral fish species and the number of life forms.
- b. Improving the management of supporting infrastructure to make visitors more comfortable to engage in tourism activities (Wijaya, 2016). Some examples include providing diving equipment rental facilities, improving road access to tourist stations, and providing public facilities such as toilets, prayer rooms, and accommodations.
- c. Promoting environmentally friendly marine tourism on social media. This promotion includes information about tourist attractions on the island, availability of transport boats, and professional guides to minimize environmental damage and ensure the safety of tourists.

### **Marine Ecotourism Integration Planning**

The development planning of ecotourism on this island is reviewed based on accessibility and amenities. After observation, the results obtained are in the form of fairly good infrastructure conditions, but improvements and development are still needed for the existing infrastructure on the island. Recommendations for infrastructure development planning need to be made before creating a master

plan so that the results obtained can increase the number of tourists to Kelagian Besar Island [See Figure 3].



**Figure 3:** Masterplan Kelagian Besar Island

The picture illustrates that the development of infrastructure facilities can be centralized in the northern part of the island, aiming to preserve the island's environment so that tourists can still visit and explore the island without harming the environment. It is hoped that the recommendations from the existing infrastructure will serve as a reference or consideration for tourism management or relevant authorities, thereby fostering the continuous improvement of ecotourism on the island, both economically and socially.

## CONCLUSION

The conclusion is that the overall suitability analysis of tourism falls into the category of not suitable (S3), and the carrying capacity of the area for snorkelling and diving tourism is 4582 people per day. Therefore, there is a need to improve the quality of coral reefs, as well as the supporting infrastructure for ecotourism management on the island.

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## **DIFFERENTIATION OF TOURISM PERFORMANCE IN RURAL AREAS: CASE STUDY OF DESA LESTARI, MALAYSIA AND DESA MANDIRI, INDONESIA**

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### **Abstract**

Rural tourism in Southeast Asia have leveraged the potential of rural tourism through a community-based approach by initiating a village-owned enterprise to strengthen the village economy based on the unique village's characteristics. However, despite the importance of rural tourism, considerable differences in economic performance happened among villages. It raised a question of how rural tourism performance varies between villages and what factors determine the variation. Thus, this paper aims to examine the differentiation of tourism performance in rural areas between Desa Lestari in Malaysia and Desa Mandiri in Indonesia. A quantitative method was employed using a structured interview involving tourism-related stakeholders to understand the diverse potential and dynamic of rural tourism. The findings highlighted that village-owned enterprises in both countries have successfully boosted the village economy by optimising the village's potentials, managed by the local community and supported by the government's initiatives. Regarding factors of rural tourism performance, Ponggok Village demonstrates a strong linkage between tourism performance with cultural and environmental dimensions, While Peruas Village strongly links tourism performance with economic and social dimensions. Hence, this research serves as a reference in understanding the success factors in rural tourism performance in Southeast Asia.

**Keywords:** Rural Tourism, Rural Planning, Rural Economy, Community Based Tourism, Village-Owned Enterprise

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## INTRODUCTION

The tourism industry in Southeast Asia, particularly in Malaysia and Indonesia, has experienced significant growth in recent years, with a notable focus on rural tourism development (Trupp & Dolezal, 2020). Both countries have recognised the potential of tourism as a key driver in rural development and regional imbalances intervention. In addition, the growth of rural tourism in Southeast Asia was partly due to the increased demand from tourists seeking the experience of the natural environment and the cultural heritage preserved by local folks.

In Malaysia, the tourism sector has emerged as a major catalyst for economic growth, contributing to a substantial socioeconomic enhancement for the rural community and village development (Puah et al., 2018). Similarly, Indonesia has identified tourism as a promising path for future rural development, with a diverse portfolio of rural destinations offering the potential for sustainable business performance (Amiruddin et al., 2022). However, the differentiation of tourism performance between rural areas in these two countries remains an important area of investigation. One key factor to consider is the role of local communities in shaping the trajectory of rural tourism development.

Previous research has highlighted the significance of community perceptions and attitudes towards the environmental impact of tourism, which can significantly influence the sustainability of rural tourism initiatives (Lo et al., 2014; Yusoff et al., 2024). Furthermore, the quality of the relationship between local stakeholders and tourism operators has been identified as a crucial element in fostering sustainable rural tourism (Quaranta et al., 2016). Another important factor is the development of dynamic capabilities within rural tourism enterprises, enabling them to adapt to changing market conditions and maintain sustainable business performance over the long term (Streimikiene et al., 2021).

The positioning of Desa Lestari in Malaysia and Desa Mandiri in Indonesia in the context of rural tourism has a diverse potential between regions and villages despite the crucial differences and the dynamics in rural tourism performance. Hence, it raised a question of how rural tourism performance varies between Desa Lestari and Desa Mandiri and what factors determine the variation of these rural tourism villages. Therefore, this paper aims to examine the differentiation of tourism performance in rural areas using a case study approach between Desa Lestari in Malaysia and Desa Mandiri in Indonesia.

## LITERATURE REVIEW

### ***Rural Tourism Development in Southeast Asia***

The growth of rural tourism in Southeast Asia has become an increasingly prevalent economic and social phenomenon in recent decades. The region's diverse landscapes, rich cultural heritage, and picturesque rural communities have attracted domestic and international tourists seeking authentic experiences

(Hitchcock et al., 2018). As a result, rural tourism has emerged as a promising pathway for economic development and community revitalisation across Southeast Asia, offering entrepreneurial opportunities for the populations and fostering a more sustainable balance between people and the environment.

The economic benefits of rural tourism have been well-documented, with practitioners reporting increased income, higher profit margins, and greater opportunities to sell agricultural products or craft items (Garrod et al., 2006; Fons et al., 2011). Additionally, rural tourism development enhances the viability and living standards of rural communities, as the populations actively participate in and benefit from the growth of the tourism industry. Importantly, the rise of rural tourism in Southeast Asia has also prompted a rethinking of the region's approach to natural resource management, moving away from a narrow focus on agricultural exploitation towards a more holistic and sustainable model that values the preservation of local ecosystems and cultural identity.

#### ***Rural Tourism Development in Malaysia's Desa Lestari Programme***

The Ministry of Rural and Regional Development Malaysia (KKDW) is responsible for developing rural areas by improving the economic status of rural communities (Rashid et al., 2023). A programme known as Desa Lestari was established in 2013 where currently 165 villages have been selected under the village-owned enterprise. Through various economic projects, this programme has succeeded in revitalising rural villages and improving the living standard of rural communities by implementing agrotourism and ecotourism development projects. This programme has been a significant driver of rural tourism development, providing a platform for communities to showcase their unique cultural and environmental assets (Hassan & Abdul Rahman, 2023). Through this initiative, the Malaysian government has sought to empower rural communities, improving their economic circumstances while safeguarding the natural landscapes and traditions that define their way of life. This programme has been particularly successful in Sarawak, where tourism has become the second-largest contributor to the state's economy (Sheng & Potter, 2023).

An exemplary of this programme, Peruas Village ecotourism homestay programme in Pahang has successfully created an authentic “nature-based experience” rooted in the local culture to offer visitors (Rashid et al., 2019). Through this programme, community members have actively participated in hosting guests, sharing their traditions, and managing the environmental resources that underpin the region's appeal. Recognising the importance of stakeholder engagement, KKDW has prioritised the involvement of local communities in planning and implementing rural tourism initiatives. This approach empowered communities to take ownership of their development, ensuring that tourism activities align with their values and traditions.

### ***Rural Tourism Development in Indonesia's Desa Mandiri Programme***

Rural tourism in Indonesia has been intertwined with the participatory planning and community engagement agenda since the 1998 National Reform. The involvement of local populations plays a crucial role in ensuring the sustainability and long-term success of tourism initiatives (Fahmi et al., 2017). One of the main pillars of rural tourism in Indonesia is the community-based tourism (CBT). This approach emphasises community participation in various tourism activity dimensions from planning, management, operations, and monitoring-evaluation (Permana & Harsanto, 2020). The Indonesian government has realised the CBT in the form of the Desa Mandiri programme. This programme was launched in the late 1990s and aligned with the popular flagship project of promoting 100 Tourism Villages (Darsono et al., 2023). This programme highlights potential and highly-resourced villages across the country as key rural tourism destinations that are expected to be the engine of tourism growth in Indonesia.

It's involves upgrading infrastructure, improving accessibility, and providing training and support to local communities with the aim in establishing the tourism hubs in remote areas that can attract both domestic and international tourists whilst ensuring that the local communities benefit economically and socially (Wahyuningtyas et al., 2019). This programme emphasised the role of community ownership in tourism projects, from running homestays to offering guided tours, organising cultural events, and selling local products, with planners and government-only acted as educator and facilitator (Permana & Harsanto, 2020). In addition, the participated village through the village-owned enterprise able to collaborate with national and local government as they provide supporting educational and networking side-projects, which include promoting these villages through national and international marketing campaigns, capacity-building programmes, housing and infrastructure revitalisation, and cooperative training.

### ***Theoretical Perspective on Rural Tourism Performance Differentiation***

Rural tourism has been recognised as an essential driver for economic development in many developing countries, including Indonesia and Malaysia (Trupp & Dolezal, 2020). This sector generates income and employment for local communities and promotes the preservation of natural resources and cultural heritage. However, the performance of rural tourism varies across different regions, and understanding the factors contributing to this differentiation is crucial for policymakers and rural-related stakeholders. The dynamic capabilities framework is a theoretical perspective that can shed light on this concern.

Dynamic capabilities refer to a village-owned enterprise's ability to reconfigure and renew its resources and capabilities in response to changing market demands and environmental conditions (Shrestha & L'Espoir Decosta, 2023). This theory emphasises the importance of a village-owned enterprise's

ability to sense, seize, and reconfigure its resources to maintain a competitive advantage in a dynamic environment with the significant interplay of five development dimensions namely economic, social, human, cultural and environmental. In the context of rural tourism, the dynamic capabilities framework suggests that the performance of rural tourism destinations is influenced by the ability of local stakeholders, to sense changes in market trends, seize new opportunities, and reconfigure their resources and capabilities to meet the evolving needs of tourists. This may involve the development of innovative tourism products and services, the enhancement of destination infrastructure and amenities, the strengthening of local supply chains, and the implementation of effective destination management and marketing strategies.

### ***Factors Impacting Rural Tourism Performance***

Rural tourism has emerged as a prominent focus of scholarly inquiry, with researchers seeking to unravel the intricate dynamics that underpin its performance as a catalyst for community development; at the heart of this discourse lies an exploration of the complex interplay between various forms of dimension such as economic, social, human, cultural, and environmental, and their collective influence on the vitality of rural tourism ventures. As rural communities grapple with the challenges of globalisation, demographic shifts, and environmental pressures, understanding the nuanced relationships between these capitals has become increasingly crucial for policymakers, planners, and industry stakeholders invested in fostering sustainable and equitable rural tourism outcomes. A robust body of empirical evidence has emerged, illuminating the multifaceted nature of rural tourism performance through the lens of dimension interdependence with the justification of factors and indicators (Table 1).

The economic dimension underpinning rural tourism ventures represents a critical determinant of their success, as it encapsulates the financial resources, government assistance, and asset ownership necessary to develop and maintain viable tourism products and services (Quaranta et al., 2016; Yusoff et al., 2024). Equally important is the availability of financing resources, whether through government assistance, individual investment, or community-driven initiatives, which can enable rural entrepreneurs to establish or expand their tourism enterprises. Given the pivotal role of the human dimension in shaping the outcomes of rural tourism, it encompasses the indicators of education, local knowledge, skills, and capabilities of the youth generation as a key factor that can profoundly influence the performance and success of rural tourism initiatives (Ivona, 2021). These human dimension factors can directly shape the ability of rural communities to actively participate in tourism-related activities, leverage tourism opportunities to generate economic benefits and ensure the sustainability of tourism initiatives.

**Table 1:** Dimensions, Factors and Indicators Influencing Rural Tourism Performance

Factor	Indicator	References
<b>Economic Dimension</b>		
Assistance from Government	Financial grant obtained	Quaranta et al. (2016);
	Physical development project	Rashid et al. (2023)
Financial Resources	Self-financial funding used	Puah et al. (2018); Rosalina et al. (2023)
Asset Ownership	Number of asset ownership related to tourism activities	Yusoff et al. (2024)
<b>Human Dimension</b>		
Young Generation	Involvement of the young generation in tourism	Rashid et al. (2023)
Education Level	Villagers with a tourism educational background	Saxena et al. (2007)
Local Knowledge	Villagers with local knowledge practised in tourism	Ivona (2021)
Skill Set	Level of management skill in tourism activities	Rosalina et al. (2023)
<b>Social Dimension</b>		
Cooperation	Community involvement in social organisation	Ramaano (2023)
Social Organisation Activeness	Programme/activity related to tourism	Rashid et al. (2023);
	Villager's involvement in tourism activities/ programmes	Shrestha & L'Espoir Decosta (2023)
Leadership	Community's acceptance of the village leader	Lo et al. (2014)
<b>Cultural Dimension</b>		
Intangible Cultural Practices	Intangible cultural practices in tourism activities	Tiberghien et al. (2017);
	Marketing promotion of intangible cultural practices	Ivona (2021)
Tangible Cultural Assets	Tangible cultural assets involved in tourism activities	Amiruddin et al. (2022);
	Marketing promotion of tangible cultural assets	Rosalina et al. (2023)
<b>Environmental Dimension</b>		
Natural Resources	Natural resources attraction location	Ramaano (2023)
Man-Made Resources	Man-made resources attraction location	Garrod et al. (2006);
		Rosalina et al. (2023)
Infrastructures and Facilities	Provision of tourism-related infrastructures	Garrod et al. (2006);
	Tourism-related infrastructure maintenance	Castanho et al. (2021)
Accessibility	Accessibility of transportation mode to the village	Rashid et al. (2023)

Scholarly work consistently emphasises the critical role of the social dimension in underpinning the success of rural tourism initiatives ultimately hinges on the willingness and engagement of the local community (Lo et al., 2014; Ramaano, 2023). It was influenced by a complex interplay of factors, including the social dimension- the cooperation, togetherness, social activeness and leadership that facilitate collaboration and collective action within a community, resulting in rural tourism initiatives' performance. As rural communities have sought to leverage their unique cultural assets to attract visitors and spur the success of rural tourism ventures, the pivotal role of a community's cultural capital is the tangible and intangible cultural resources that shape the local identity and experience (Tiberghien et al., 2017).

The rural tourism industry has been recognised as a key driver of rural economic development through the important role of environmental assets that can provide a comparative advantage (Garrod et al., 2006). Rural areas often possess unique natural landscapes and diverse ecosystems that can captivate

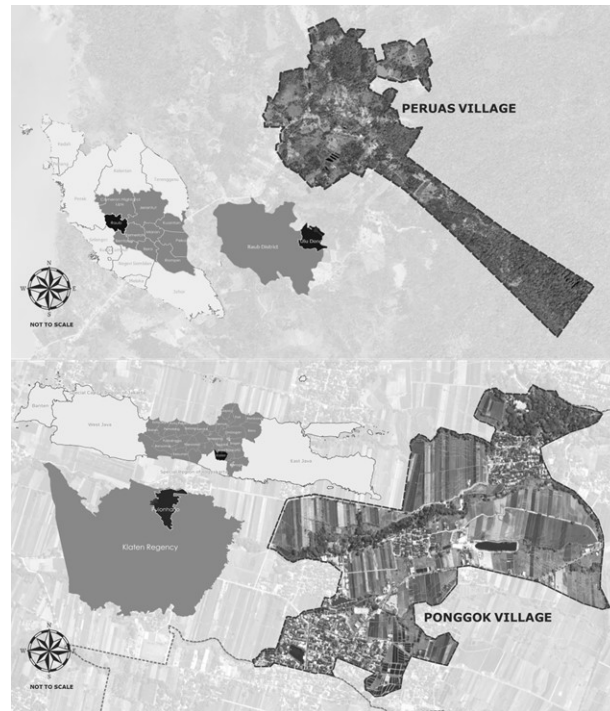
visitors with a sense of rejuvenation and eventually shape the resilience of rural tourism destinations. Environmental factors in rural tourism destinations, such as natural and man-made resources, infrastructure completeness, and accessibility, have become pivotal in attracting visitors and ensuring the long-term sustainability of these tourism activities (Rashid et al., 2023).

## RESEARCH METHODOLOGY

### *Case Study of Desa Lestari, Malaysia and Desa Mandiri, Indonesia*

Peruas Village is one of the traditional villages in Malaysia that has achieved a *Desa Lestari* award from the Ministry of Rural Development Malaysia in 2018. This village has existed since 1890 and it is located in Ulu Dong Sub-district in Raub District, Pahang, 35 kilometres away from Raub city centre and 120 kilometres away from Kuala Lumpur (Figure 1). The main economic activities are commodity-based agriculture and ecotourism where it covers an area of 478.3 hectares with the main land use consisting of agriculture and nature such as rivers and forests. The village is rich in natural resources such as rafflesia flowers, forest reserves, waterfall and river and still maintains cultural activities. The establishment of Koperasi Homestay Kampung Peruas Raub Berhad in 2010 has successfully transformed this village into a vibrant ecotourism village that offers an authentic “nature-based experience” with the local culture experienced to visitors from and major cities like Kuala Lumpur. With the exploitation of attractive natural resources, this village has been selected as one of the villages in Malaysia achieving the *Desa Lestari* programme in 2018.

Ponggok Village is one of the tourist villages in Indonesia that has reached the status of an *Desa Mandiri* in 2016. This village began to make efforts through the utilisation of village potential. It is in Polanharjo District, Klaten Regency, 26 kilometres away from Solo city centre and 95 kilometres away from Semarang, the administrative centre for Central Java (Figure 1). This village covers an area of 77.0 hectares with the main land use consisting of food-based agriculture, housing settlement and natural water resources. It is rich in natural resources, including well-preserved natural spring water. The potential of spring water sources in Ponggok Village has been managed into umbul or water pools as water tourism attractions. Hence, the main economic activities are water tourism. The Ponggok tourism village is managed by Badan Usaha Milik Desa (BUMDes) Tirta Mandiri Ponggok, and Pokdarwis (Tourism Awareness Group) and successfully transformed the village’s economy with profitable revenue. Currently, this village has the highest village income generation among all the BUMDes in Indonesia.



**Figure 1:** Location of Peruas Village, Malaysia and Ponggok Village, Indonesia  
*Source: Author (2024)*

### ***Method of Data Collection and Analysis***

A quantitative method was employed as the research approach in collecting and analysing quantitative and qualitative data related to tourism-related stakeholders within these villages. This method can assist researchers in gaining a complete picture context of the diverse potential of rural tourism and the differences and dynamics in rural tourism performance between case studies of Malaysia and Indonesia. This method involved an ideal sample size using purposive sampling which only related to the research context such as the tourism-related key stakeholders. The relevant samples involved are hospitality and accommodation, attraction operators, village-owned enterprises, food operators, and transportation operators as interviewees using the structured interview method.

Through the interviews with different tourism-related key stakeholders in Malaysia and Indonesia case studies, the researchers performed a quantitative method analysis using mean score analysis and Analysis of Variance (ANOVA) in analysing the significance level of factors and indicators in rural tourism performance and evaluating the differentiation of rural tourism performance among the case studies. This analysis interpreted the transcript's data collection and synthesised the common themes of rural tourism performance.



## FINDINGS AND DISCUSSION

### ***Background of Rural Tourism Case Study in Indonesia and Malaysia***

The case study of Peruas Village, Malaysia and Ponggok Village, Indonesia has shown how the concept of village-owned enterprises in both countries has strengthened the village economy and development based on the needs and potential of the villages through the establishment of village business institutions managed by the local community and supported by the government's initiatives (Table 2). Based on these case studies, it has indicated that the concept of village-owned enterprises can be the main wheel of economic drivers in the villages. For example, Peruas Village established their village-owned enterprise in 2010 with their focal business is community and private-driven hospitality and accommodation initiatives to support their eco-tourism activities. Meanwhile, Ponggok Village established their village-owned enterprise in 2002 with their focal business is the eco-tourism industry through a wide range of water activities with the support of community-driven accommodation and retail businesses.

**Table 2:** Current Background of Rural Tourism Case Studies

Background	Details	Case Study	
		Peruas Village	Ponggok Village
Tourism Entity	Village-owned Enterprise	Koperasi Homestay Kampung Peruas Raub Berhad	BUMDes Tirta Mandiri Ponggok
	Hospitality and Accommodation	Community and private-driven: Homestay, Resort and Chalet	Community and private-driven: Homestay and Resort
	Food Business	Private-driven small food stall	Community-driven food stall
	Attraction Place	Eco-tourism through forest and water activities	Eco-tourism through water activities
	Transportation	NA	Private transportation business
Tourist	Number of Tourists per Year	25,000-30,000 people	60,000-70,000 people
Recognition	Local Bodies	Federal Government Ministry and State Government	Central Government Ministry and Provincial Government
	International Bodies	Asean Rural Sustainable Tourism Standard (Gastonomy)	NA
Income Generation	Total Average per Year (USD)	USD 150,000 - 200,000	USD 600,000 - 650,000
Young Generation	Tourism Involvement	81% youth involvement	84% youth involvement
Resources	Natural	Waterfall, River and Forest	Watershed, River and Paddy Field
	Man-Made	River Pool	Water Pool and Fishing Centre

Source: Research Fieldwork (2024)

In terms of the resource availability for both villages, they shared almost similar natural and man-made attractions like water elements to be utilised as eco-tourism activities. These eco-tourism attractions were operated and managed by the youth generation within their villages with more than 80 per cent involvement of the young generation. Most of them are involved under the

village-owned enterprise for example, youth in Peruas Village are engaged in hospitality and accommodation, while youth in Ponggok Village are involved in attraction places and activities. Based on the village's tourist data, Ponggok Village received more visitors and tourists per year which is 60,000-70,000 people, while Peruas Village only received 25,000 to 30,000 people in the year 2023. The income generation per year from the rural tourism industry in Ponggok Village which generated around USD 600,000 to 650,000 is slightly lower compared to the Peruas Village which generated approximately USD 150,000 to 200,000 per year in 2023.

***Factors Impacting Differentiation of Rural Tourism Performance***

The study revealed that both Peruas Village (7.98) and Ponggok Village (8.06) generally indicated a high level of rural tourism performance (Table 3). The findings highlighted that both villages have differences in rural tourism performance with certain strengths and weaknesses linked to their context. Ponggok Village demonstrates a strong linkage between tourism performance and cultural and environmental dimensions. Ponggok Village excels in promoting intangible cultural practices and involving the community in tourism-related activities, reflecting its commitment to preserving local traditions whilst fostering active community participation and local engagement in various tourism attractions. In addition, Ponggok Village also indicated a well-performed in leveraging natural and man-made attractions as important factors, as well as maintaining tourism-related infrastructures based upon self-organised practices.

Meanwhile, Peruas Village showed strong linkages between tourism performance with economic and social dimensions. Peruas Village is good in terms of active government assistance and financial resources in developing their ecotourism products and supporting activities through the village-owned enterprise initiated by the community called Koperasi Homestay Kampung Peruas Raub Berhad. Their ability to convince Malaysia's government agencies to help them financially as well as invest in the tourism-related infrastructures and physical development projects in this village has shown good results in terms of the number of visitors/tourists domestically and internationally as well the income generated from these rural tourism activities. Peruas Village also excels in several indicators in the social dimension in terms of social organisation activeness in conducting tourism activities and the community's acceptance of the village leader or local champion which influenced the smoothness of village decision-making processes on the implementation of any related rural tourism.

**Table 3:** Analysis of Factors Impacting Differentiation of Rural Tourism Performance

Factor	Indicator	Performance Level (Mean)		ANOVA (F-test)
		Peruas Village	Ponggok Village	
Economic Dimension				
Assistance from Government	Financial grant obtained	9.44	7.13	0.000*
	Physical development project	9.56	6.38	0.000*
Financial Resources	Self-financial funding used	9.56	8.63	0.001*
Asset Ownership	Number of asset ownership related to tourism activities	9.11	8.00	0.002*
Human Dimension				
Young Generation	Involvement of the young generation in tourism	8.11	8.38	0.163
Education Level	Villagers with a tourism educational background	7.78	7.50	0.446
Local Knowledge	Villagers with local knowledge practised in tourism	9.22	9.13	0.350
Skill Set	Level of management skill in tourism activities	7.78	9.00	0.117
Social Dimension				
Cooperation	Community involvement in social organisation	6.67	7.13	0.226
Social Organisation Activeness	Programme/activity related to tourism	8.11	8.63	0.007*
	Villager's involvement in tourism activities/ programmes	7.56	8.75	0.022*
Leadership	Community's acceptance of the village leader	9.67	9.13	0.044*
Cultural Dimension				
Intangible Cultural Practices	Intangible cultural practices in tourism activities	5.67	7.88	0.008*
	Marketing promotion of intangible cultural practices	4.67	8.50	0.076
Tangible Cultural Assets	Tangible cultural assets involved in tourism activities	8.89	5.50	0.000*
	Marketing promotion of tangible cultural assets	6.67	4.38	0.346
Environmental Dimension				
Natural Resources	Natural resources attraction location	7.67	9.63	0.003*
Man-Made Resources	Man-made resources attraction location	7.78	8.88	0.021*
Infrastructures and Facilities	Provision of tourism-related infrastructures	7.67	9.38	0.000*
	Tourism-related infrastructure maintenance	7.67	8.63	0.004*
Accessibility	Acessibility of transportation mode to the village	8.22	8.75	0.051
Overall Rural Tourism Performance		7.98	8.06	0.001*

\*Significant value at 0.05

Ponggok Village faced a slight deficiency in the economic dimension compared to Peruas Village. For instance, the finding shows that Ponggok Village has a lower perception of the relationship between tourism performance and securing government assistance for physical development projects and asset ownership. This situation is widely caused by unstable government policy and various complicated bureaucratic processes that limit many rural actors to secure opportunities at the local level easily. The common practice of the government's effort to distribute its financial support centred to particular places considered

more popular and attractive for markets also creates disconnection to certain potential areas that have been long overlooked. Despite this, the village demonstrates effective self-financial funding, indicating resilience and self-sufficiency, although vulnerable and unstable. The village's ability to fund its tourism initiatives helped to compensate for the lack of external government support but limits its potential for larger-scale infrastructure development and expansion.

Meanwhile, Peruas Village faced a slight deficit in terms of cultural dimension compared to Ponggok Village. For instance, the finding shows that Peruas Village has a lower perception of the relationship between tourism performance and marketing promotion of both intangible and tangible cultural assets and practices. This situation is widely caused by a low awareness level of digital marketing and promotion importance through mass media and social media by the tourism operators, especially from the hospitality and accommodation entities.

The findings regarding Ponggok Village's strengths and weaknesses in rural tourism performance reflect broader trends in Indonesia's rural and community-based tourism landscape. Ponggok Village has become a successful model of a tourism village due to its ability to capitalise on its unique cultural and environmental assets. However, like many rural tourism initiatives in Indonesia, Ponggok Village faces challenges in certain economic dimensions, particularly in securing government assistance for physical development projects and maximising asset ownership. This situation is a common problem for Indonesia because the nation has to take care of many villages under relatively dynamic and constantly changing policy frameworks. As a result, many programmes come as partial, unsustainable, and not reaching all potential village targets.

The findings regarding Peruas Village's strengths and weaknesses in rural tourism performance reflect rural transformation initiatives to make rural areas attractive and profitable through community-based rural tourism. Implementing high economic impact projects like the homestay programme and water recreation park have successfully transformed this village into a vibrant ecotourism village with proper government assistance, and financial resources. Although several challenges such as inadequacy support of community involvement and inadequate marketing promotion of intangible cultural practices and tangible cultural assets faced by this village may hinder the progress of the rural tourism development, yet they managed to offer an authentic “nature-based experience” with the local Malay culture experienced for the tourists in Malaysia.

In summary, the case study of Ponggok Village highlighted the need for a more integrated approach to all the rural tourism dimensions for rural tourism development in Central Java and Indonesia as a whole. While cultural and environmental dimensions have proven to be key drivers of success for

Indonesia's tourism villages, economic sustainability remains a critical challenge. In comparison, Peruas Village underlined the focal point of community reinforcement, effective marketing strategies, and resource attraction diversity as key approaches for the resilience of rural tourism in Malaysia. Therefore, with stronger partnerships between local communities, governments, and private sector actors, Malaysia and Indonesia villages can build a more robust and sustainable model for rural tourism that supports economic development and the preservation of cultural and environmental resources.

## **CONCLUSION**

In conclusion, the Malaysian and Indonesian governments have prioritised rural tourism in their development agendas by recognising its differential potential to catalyse economic growth, alleviate poverty, and preserve cultural traditions. This paper presents a comparative analysis of the tourism performance in two distinct rural communities in Malaysia and Indonesia, in which the critical factors that drive their differential success are delineated.

The case of Peruas Village illustrates the hallmarks of an effective rural tourism programme under the village-owned enterprise where it manifests strong linkages between tourism performance with economic and social dimensions. The importance of active government involvement, and social organisation activeness were the key differential success factors for rural tourism development of Peruas Village. In contrast, the case of Ponggok Village suggests a unique trajectory, where the transformation of the rural tourism industry has transformed the existing rural economic structure into distinct tourism products by demonstrating strong linkages between tourism performance and cultural and environmental dimensions. The importance of active community participation and local engagement in the intangible cultural practices and natural resources abundance were the key differential success factors for the rural tourism development of Ponggok Village.

Indeed, the local communities' positive perceptions of rural tourism's dimension of social coherence, government support, cultural uniqueness and environmental abundance have been instrumental in sustaining the sector's growth in Southeast Asia, specifically in Malaysia and Indonesia. The outcomes observed in these case studies underscore the importance of tailoring rural tourism performances to each community's unique economic, social, human, cultural, and environmental dimensions, rather than adopting a one-size-fits-all approach.

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## DISCLOSURE STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare absence of conflicting interests with the funders.

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## **THE AUTHENTICITY OF INTANGIBLE CULTURAL HERITAGE MODEL BASED ON TOURISM TERMINATE INTENTION**

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### **Abstract**

Recent studies have extensively examined the motivation of tourism intention related to the authenticity of intangible cultural heritage (ICH), but however, the factors influencing tourism termination intention are still poorly understood. This study proposes an integrated research model of the ICH tourism termination intention. The model is constructed based on the theoretical perspectives of the (Expectation Confirmation Theory) ECT and (Landscape Perception Theory) LPT. The objectives of this study are to investigate the factors and mechanisms influencing the termination of tourism intention. This study adopted the quantitative method and analysed 311 questionnaires using structural equation modelling by making assumptions about the relationships among the constituent factors and examining the influence of tourists' anticipatory motives and landscape perception factors. The findings not only elucidate the impact of low expectation confirmation on tourists' intentions to terminate their visits but also offer valuable insights into potential negative phenomena in intangible cultural heritage tourism. This study highlights the crucial role of perceived authenticity in shaping tourists' decision-making processes and establishes a new theoretical framework for the preservation and management of intangible cultural heritage.

**Keywords:** Authenticity; Intangible Cultural Heritage; Landscape Perception; Tourism

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## **INTRODUCTION**

Research on the authenticity of ICH tourism and the motivation of ICH tourism has gained the attention of multidisciplinary scholars, who have employed various perspectives, including perceived quality, perceived value, and place identity (Madkhali et al., 2024), as well as satisfaction, well-being, and behavioural intentions (Chen, 2023). The literature also contains a cumulative body of evidence indicating negative outcomes resulting from a lack of authenticity (García-Esparza, 2016), outcomes that lead people to attempt to terminate travel intentions (Park et al., 2019). While these streams of research have provided thoughtful scholarship on tourism research, an alternative research perspective has recently emerged that discusses the impact of landscape perception on tourism intentions (Azinuddin et al., 2022). Consistent with this line, this current study aims to investigate the factors and mechanisms that influence the termination of tourism intention by combining ECT and LPT.

This study proposes an integrated research model from a dual theoretical perspective, aiming to investigate the factors and mechanisms influencing the termination of tourism intention. The antecedent factors affecting tourists' 'expectations of the authenticity of ICH tourism are revealed, and how these factors influence tourists' tour termination intentions through landscape perceptions are analysed. First, tourists have certain expectations about the authenticity of ICH, and these expectations drive their travelling intentions to a certain extent; second, tourists' expectancy motivation affects their perception of the authenticity of ICH landscapes; third, when tourists perceive a lack of authenticity in ICH landscapes, it leads to low expectancy confirmations, and such low expectancy confirmations further affect their travelling termination. Finally, low expectation confirmation mediated by the perceived authenticity of ICH landscapes ultimately determines tourists' intention to terminate the tour.

In addition, the model elucidates the statistically significant effects of each factor of perceived lack of authenticity in ICH landscapes on tourists' intention to terminate their trips. Through this comprehensive framework, this study provides an in-depth understanding of tourist behaviour in ICH tourism, reveals how the perceived lack of authenticity in ICH landscapes affects the termination of tourism intention, and provides a theoretical foundation for research and practice in related fields.

## **LITERATURE REVIEW**

### **Expectation confirmation theory (ECT)**

Expectation Confirmation Theory (ECT) posits that the discrepancy between tourists' expectations and their actual experiences significantly influences the level of expectation confirmation, subsequently impacting their behavioral intentions. ECT elucidates how tourists' motivations shape their perceptions of the authenticity of intangible cultural heritage (ICH) landscapes, thereby

affecting the degree of expectation confirmation. When expectation confirmation is low—often due to a perceived lack of authenticity—tourists may develop intentions to terminate their participation in tourism activities, such as shortening the visit, discontinuing the experience, or opting not to engage in future ICH tourism (Yuan & Marzuki, 2024). ECT has been widely applied in research concerning tourism, consumer behaviour, and service quality, with several countries utilizing it to examine tourists' destination intentions (Basil Chibuike et al., 2021). For instance, Fan and Xie explored tourists' perceptions of ancient village landscapes to enhance attractiveness and experiential quality (Zhuang et al., 2022). The study by Akhir et al. (2021) supports the notion that environmental design can enhance tourists' expectation confirmation by creating visually appealing and authentic settings (Mt Akhir et al., 2021). In the context of ICH tourism, ECT offers a framework for understanding tourists' perceptions and preferences, contributing to enhanced experiences and cultural preservation. Expectation motivation is a crucial factor in determining termination intentions, as tourists may be inclined to end their trip due to low confirmation levels, and vice versa.

### **Landscape Perception Theory (LPT)**

Landscape Perception Theory (LPT) examines how human perceptions of landscapes influence interactions within these environments (Tan & Teoh, 2019). Combining principles from environmental psychology and landscape design, LPT investigates the ways in which humans perceive, prefer, and evaluate landscapes (Shi et al., 2023). Zube et al. (1982) identified four primary research paradigms—expert, psychophysical, cognitive, and empirical—and integrated them into a comprehensive landscape perception model that includes three core dimensions: human, landscape, and interaction (Gobster et al., 2003). According to this model, landscapes consist of both material and immaterial elements, with interaction being central to the perception process (Khanom et al., 2019). This finding suggests that in the realm of ICH tourism, tourists' perceptions of landscape authenticity—including material authenticity, cultural interaction, and local engagement—are critical factors influencing their overall experience and behavioural intentions. This supports Zube et al.'s integrated model, which emphasizes the interconnected elements of people, landscape, and interaction.

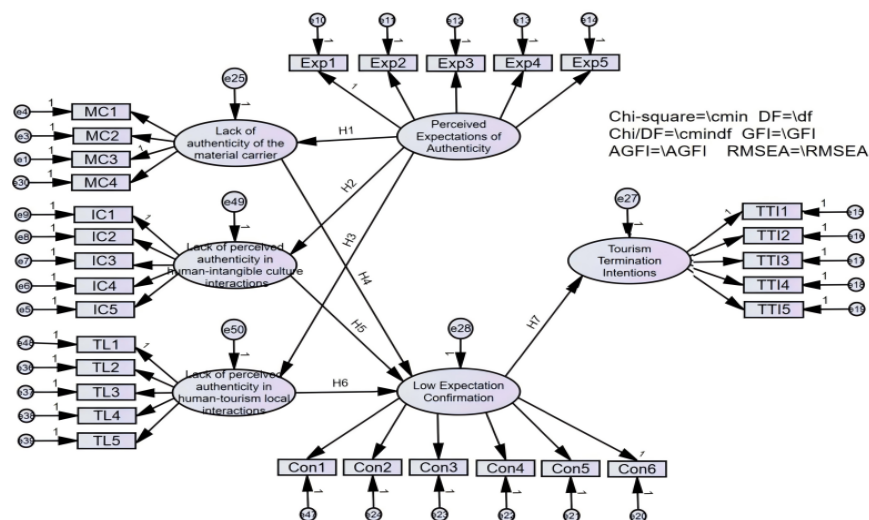
### **Summary of Conceptual Model of the Study**

This study empirically examines an integrated model to understand processes influencing tourism disruption intentions in ICH tourism. ICH tourism, centered on participating in and experiencing cultural elements such as traditional performing arts, craft skills, social customs, and festivals, emphasizes respect for cultural roots. Through immersive experiences, it not only enriches tourists' visits but also aids in cultural preservation and promotes sustainable development,

highlighting authenticity as a core element for both ICH tourism and preservation (Lei et al., 2022).

The model (Figure 1) is built on several key arguments: Tourists' expectations of ICH authenticity shape their travel intentions. These expectations influence how they perceive landscape authenticity, where perceived authenticity encompasses the physical setting, cultural interactions, and engagement with the destination. When perceived authenticity does not meet expectations, it results in low confirmation, which may increase the likelihood of tour termination. Thus, unmet authenticity expectations drive a higher intent to discontinue the visit.

This study investigates these dynamics within a theoretical model, linking expectation-based authenticity perceptions to tour termination intentions. Employing expectancy confirmation theory, this model explains how perceived landscape authenticity influences tourist behaviours in ICH tourism. This framework offers new insights and theoretical foundations for understanding tourist behaviour in ICH settings.



**Figure 1.** The Authenticity of Intangible Cultural Heritage Model Based on Tourism Terminate Intention

Source: Author's Model Based

## RESEARCH HYPOTHESIS

Based on the integrated model of Expectation Confirmation Theory and Landscape Perception Theory, this study investigates the factors and mechanisms influencing the termination of tourism intention, lack of authenticity in human and ICH interactions, lack of authenticity in human-tourism local interactions,

low expectation confirmation, and the willingness to terminate tourism. Based on the above discussion, this paper proposes the following hypotheses.

- H1: Perceived expectations of authenticity are positively related to material carriers' perceived lack of authenticity regarding terminating tourism intentions.
- H2: Perceived expectations of authenticity are positively related to perceived lack of authenticity in human-intangible cultural heritage interactions about termination of tourism intention.
- H3: Perceived expectations of authenticity are positively related to the perceived lack of authenticity of human-tourism local interaction localities regarding termination of tourist intentions.
- H4: Perceived lack of authenticity of the material carriers is positively associated with low expectation confirmation regarding the intention to terminate the tour.
- H5: Perceived lack of authenticity in human-intangible cultural heritage interactions is positively related to low expectation for confirmation of intention to terminate tourism.
- H6: Perceived lack of authenticity of human-tourism local interaction is positively related to low expectation for confirmation of the intention to terminate tourism.
- H7: Low expectations for confirmation of perceived authenticity is positively associated with tourists' intention to terminate the tour.

## **RESEARCH METHODOLOGY**

### ***Participants and procedures***

This study examines factors influencing tourism termination intentions in the context of ICH tourism in China. ICH, a vital symbol of cultural heritage, plays a significant role in preserving traditional culture. As of 2023, China has 43 ICH items listed by UNESCO, the highest globally (Lei et al., 2022). Chinese policies encourage the exploration and promotion of local ICH resources through tourism. While focusing on Chinese ICH, this study addresses common issues relevant to ICH tourism worldwide, enhancing generalizability.

To capture diverse perspectives, no restrictions on gender, age, or occupation were set for respondents. Survey participants included those who had experienced or were interested in ICH tourism. Respondents accessed the questionnaire through a QR code or link, with voluntary and informed participation ensured. The survey was conducted on the Chinese Question Star platform and other online channels, collecting 311 valid responses between May and June 2024, meeting Bentler and Chou's (1987) minimum sample requirement of five times the estimated parameter.

### Survey instruments

Validated scales from relevant literature were adapted to fit this study. The questionnaire was divided into two parts: Part 1 collected demographic information (Table 1), and Part 2 assessed the impact of perceived authenticity on tourism behaviour. Responses were recorded using a seven-point Likert scale, from "1" (totally disagree) to "7" (totally agree). Table 2 presents the operational definitions, question items, and scales.

**Table 1: Descriptive statistics**

Category		Number	Percentage
Gender	Male	142	45.7
	Female	169	54.3
Age	Under 20	38	12.2
	21-30	70	22.5
	31-40	99	31.8
	41-50	78	25.1
	51-60	17	5.5
	Over 61	9	2.9
Education	Junior high school or below	17	5.5
	High school or junior college	101	32.5
	Bachelor's degree or college	153	48.9
	Master's degree	36	11.6
Occupation	Doctor or above	5	1.6
	company employee	99	31.8
	Employees of government agencies and institutions	32	10.3
	Self-employed	41	13.2
	Designers	88	28.3
	Students	38	12.2
	Retirees	9	2.9
	Others	4	1.3

Source: Author's Calculation

**Table 2: Definition of variable operability and reference scales.**

Variable	Adapted Construct Items			Source
Perceived Expectations of Authenticity	Exp1	Expect attractions to provide a rich traditional cultural experience.	1=completely disagree, 7=completely agree	Zhao and Lu (2018)
	Exp2	Expect the historical buildings and cultural activities of the attractions to remain original and authentic.		
	Exp3	Expect to discover new places and things.		
	Exp4	I expect the attractions to give me insights and broaden my horizons.		
	Exp5	I expect to see landscapes that are different from the environment in which I live.		
Lack of Perceived Authenticity of Material Carriers	MC1	The smaller the proportion of historical buildings (ancestral halls, pagodas, ancient dwellings, etc.), the more authenticity is missing.	1=completely disagree, 7=completely agree	(Li et al., 2022)
	MC2	Landscape with obvious traces of commercialization or modernization will lead to a lack of authenticity.		
	MC3	Historical buildings are only used as sightseeing attractions, and the intangible cultural values they carry have not been passed on, which will lead to a lack of authenticity.		
	MC4	There is no cultural heritage protection and exhibition centre to inherit and protect intangible cultural heritage, which will lead to a lack of authenticity.		
Lack of Authenticity in Human-Intangible	IC1	Failure to perceive traditional ways of production and life (food and drink, traditional crafts, etc.) can lead to a lack of authenticity.	1=completely disagree,	

Variable	Adapted Construct Items		Source
Cultural Heritage Interactions	IC2	Failure to perceive traditional customs and practices (religious and sacrificial activities, temple fairs and gatherings, etc.) can lead to a lack of authenticity.	7=completely agree  (Li et al., 2022)
	IC3	Failure to perceive traditional spirituality (religious beliefs, totems, values, etc.) can lead to a lack of authenticity.	
	IC4	Failure to perceive traditional cultural entertainment (folk art, Nuo opera, theatre, etc.) can lead to a lack of authenticity.	
	IC5	Failure to perceive historical records (myths and legends, historical figures, historical events, etc.) can lead to a lack of authenticity.	
Lack of Authenticity of Human-Tourism Local Interaction	TL1	Failure to perceive the use of traditional materials for handicrafts can lead to a lack of authenticity.	1=completely disagree, 7=completely agree  (Li et al., 2022)
	TL2	Failure to perceive special flavour foods (snacks, special dishes) and traditional clothing can lead to a lack of authenticity.	
	TL3	Failure to perceive the handmade production of handicrafts can lead to a lack of authenticity.	
	TL4	Failure to perceive the use of instruments and crafts related to traditional crafts will lead to a lack of authenticity.	
	TL5	Failure to perceive the use of the local dialect of tourism can lead to a lack of authenticity.	
Low Expectation Confirmation	Con1	There is no deep experience and feeling of the traditional culture of tourist attractions.	1=completely disagree, 7=completely agree  Kay (2009) and Zhao and Lu (2018)
	Con2	Land for tourism construction is constantly seizing land for cultural resources and replacing it with imitations or other facilities with better economic benefits.	
	Con3	Local landscapes have been modernised at will, and most of them have been constructively damaged, losing their original ancient meaning.	
	Con4	I did not have a full and effective exposure to and experience of the original culture but accepted a 'pseudo-culture' that has been 'packaged'.	
	Con5	I am willing to participate in non-heritage activities, but I cannot really experience and learn more traditional skills and customs during the tour.	
	Con6	Activities organised by tourist attractions are not meaningful to the transmission and education of non-heritage culture.	
Tourism Termination Intentions	TT11	I am not willing to revisit the tourist attraction because of the lack of authenticity experience.	1=completely disagree, 7=completely agree  (Luqman et al., 2018)
	TT12	Because of the lack of perceived authenticity, I would consider not visiting similar tourist attractions in the future.	
	TT13	Because of the lack of perceived authenticity, I would not recommend others to visit similar tourist attractions.	
	TT14	Because of the lack of perceived authenticity, I would shorten the duration of the tour.	
	TS15	Because of the perceived lack of authenticity, I am not interested in intangible cultural heritage tourism.	

*Source: Author's Variable Operability and Reference Scales*

## RESULTS

### *Results of reliability analysis*

In this study, SPSS 24.0 was used for reliability analysis to measure the degree of consistency or stability of the results; as shown in Table 3, the Cronbach's  $\alpha$  coefficients of each measurement variable ranged from 0.870–0.916, which were all greater than 0.6, and the Cronbach's  $\alpha$  if Item Deleted values are not higher than the current Cronbach's  $\alpha$  value results, and Corrected Item-to-Total

Correlation values are all greater than 0.5, which indicates that the scale in this study has good reliability.

**Table 3:** Definition of variable operability and reference scales.

Dimension	Items	Corrected Item-to-Total Correlation	Cronbach's $\alpha$ if Item Deleted	Cronbach's $\alpha$
Perceived Expectations of Authenticity	Exp1	0.788	0.853	0.890
	Exp2	0.739	0.865	
	Exp3	0.664	0.881	
	Exp4	0.727	0.868	
	Exp5	0.746	0.863	
Lack of Perceived Authenticity of Material Carriers	MC1	0.687	0.880	0.888
	MC2	0.783	0.844	
	MC3	0.849	0.819	
	MC4	0.701	0.875	
Lack of Authenticity in Human-Intangible Cultural Heritage Interactions	IC1	0.796	0.895	0.916
	IC2	0.751	0.904	
	IC3	0.785	0.897	
	IC4	0.820	0.890	
	IC5	0.773	0.900	
Lack of Authenticity of Human-Tourism Local Interaction	TL1	0.699	0.847	0.873
	TL2	0.677	0.852	
	TL3	0.699	0.848	
	TL4	0.671	0.853	
	TL5	0.765	0.830	
Low Expectation Confirmation	Con1	0.762	0.877	0.900
	Con2	0.669	0.891	
	Con3	0.665	0.891	
	Con4	0.782	0.874	
	Con5	0.790	0.873	
	Con6	0.702	0.886	
Tourism Termination Intentions	TTI1	0.743	0.830	0.870
	TTI2	0.659	0.851	
	TTI3	0.620	0.860	
	TTI4	0.796	0.816	
	TTI5	0.658	0.851	

Source: Author's Calculation

### Exploratory factor analysis results

As shown in Table 4, this study conducted an exploratory factor analysis using SPSS 24.0 to analyse the data for Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The results showed that the KMO values of all variables were higher than 0.5 and the significance level of Bartlett's spherical test was less than 0.05, indicating that all variables were significant in Bartlett's spherical test. These results indicate that the data are suitable for factor analysis. After further factor analysis using principal component analysis, the results showed that only one factor with an eigen root greater than 1 could be extracted for each variable and the cumulative variance explained was more than 50%, indicating that the analysed factors explained the variables well. In addition, the covariance of all items was greater than 0.5 and the factor loadings were higher than 0.6, which is in line with previous recommendations. In summary, the conclusions drawn from this study have a high degree of consistency and reliability.

**Table 4:** Exploratory factor analysis results

Dimension	Items	KMO	Bartlett Sphere Test	Factor Loading	Commonality	Eigenvalue	Total variation explained%
Perceived Expectations of Authenticity	Exp1	0.881	0.000	0.771	0.761	3.475	69.506
	Exp2			0.755	0.705		
	Exp3			0.741	0.631		
	Exp4			0.784	0.703		
	Exp5			0.780	0.718		
Lack of Perceived Authenticity of Material Carriers	Mat1	0.818	0.000	0.854	0.673	2.997	74.926
	Mat2			0.833	0.790		
	Mat3			0.752	0.859		
	Mat4			0.743	0.686		
Lack of Authenticity in Human- Intangible Cultural Heritage Interactions	Emb1	0.896	0.000	0.787	0.765	3.745	74.897
	Emb2			0.772	0.706		
	Emb3			0.814	0.750		
	Emb4			0.843	0.801		
	Emb5			0.814	0.745		
Lack of Authenticity of Human-Tourism Local Interaction	Use1	0.867	0.000	0.786	0.682	3.324	66.476
	Use2			0.710	0.634		
	Use3			0.774	0.671		
	Use4			0.698	0.621		
	Use5			0.817	0.750		
Low Expectation Confirmation	Con1	0.872	0.000	0.762	0.714	3.353	67.068
	Con2			0.792	0.594		
	Con3			0.765	0.601		
	Con4			0.740	0.732		
	Con5			0.730	0.741		
	Con6			0.785	0.646		
Tourism Termination Intentions	TTI1	0.866	0.000	0.686	0.711	3.291	65.813
	TTI2			0.795	0.647		
	TTI3			0.698	0.573		
	TTI4			0.759	0.776		
	TTI5			0.747	0.614		

*Source: Author's Calculation*

### ***Construct validity and reliability***

This study calculated Cronbach's alpha and composite reliability values using Excel running formulas to indicate internal consistency between the items and constructs. The study showed that the Cronbach's alpha coefficient and composite reliability value were both greater than 0.7, indicating internal consistency between the data collection instrument and the items (Hair et al., 2020); as shown in Table 5, the Cronbach's alpha coefficient and composite reliability value were qualified, which proved that the items of each variable had internal consistency and reliability. Secondly, this study measures construct validity by extracting the average variance, and the literature suggests that the AVE value is at least 0.5, hypothesising that each variable meets the criteria for construct validity, as shown in Table 5, the AVE values are all greater than 0.5, indicating good construct validity.



**Table 5: Construct validity and reliability**

Variables	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Perceived Expectations of Authenticity	0.890	0.889	0.616
Lack of Perceived Authenticity of Material Carriers	0.888	0.891	0.674
Lack of Authenticity in Human-Intangible Cultural Heritage Interactions	0.916	0.916	0.686
Lack of Authenticity of Human-Tourism Local Interaction	0.873	0.874	0.582
Low Expectation Confirmation	0.900	0.894	0.586
Tourism Termination Intentions	0.870	0.870	0.575

Source: Author's Calculation

### Results of the test of differential validity

Distinguishing validity refers to the variability between different latent variables. As shown in Table 6, the AVE square root values for each latent variable are significantly higher than the correlation coefficients between the variables, indicating that the scale has good discriminant validity across variables.

**Table 6: Discriminant validity**

	Perceived Expectations of Authenticity	Lack of Perceived Authenticity of Material Carriers	Lack of Authenticity in Human-Intangible Cultural Heritage Interactions	Lack of Authenticity of Human-Tourism Local Interaction	Low Expectation Confirmation	Tourism Termination Intentions
Perceived Expectations of Authenticity	0.785					
Lack of Perceived Authenticity of Material Carriers	0.548	0.762				
Lack of Authenticity in Human-Intangible Cultural Heritage Interactions	0.48	0.263	0.828			
Lack of Authenticity of Human-Tourism Local Interaction	0.492	0.269	0.236	0.821		
Low Expectation Confirmation	0.408	0.431	0.39	0.393	0.758	
Tourism Termination Intentions	0.221	0.233	0.211	0.213	0.541	0.758

Source: Author's Calculation

### **VIF test results**

Table 7 shows the results of the multicollinearity test for the structural model, showing that the VIF values of all variables are less than 3.3, indicating that there is no multicollinearity problem between the variables.

**Table 7: VIF test result**

Dependent Variable: Tourism Suspension Intentions	VIF	1/VIF
Perceived Expectations of Authenticity	1.517	0.659
Lack of Perceived Authenticity of Material Carriers	1.452	0.689
Lack of Authenticity in Human-Intangible Cultural Heritage Interactions	1.412	0.708
Lack of Authenticity of Human-Tourism Local Interaction	1.441	0.693
Low Expectation Confirmation	1.437	0.696

*Source: Author's Calculation*

### **The mediating effect on discontinuance intention through landscape perception**

This study first determined that the indirect effects of authenticity expectations on tourism termination intentions include lack of authenticity of material carriers ( $\beta=0.492$ ,  $p<0.001$ ), lack of authenticity of human-intangible cultural interactions ( $\beta=0.480$ ,  $p<0.001$ ), lack of authenticity of human-tourism local interactions, and low expectancy confirmation ( $\beta=0.548$ ,  $p<0.001$ ) were all significant in their Indirect effects were all significant. The indirect effects of lack of authenticity of material carriers ( $\beta=0.254$ ,  $p<0.001$ ), lack of authenticity of human-intangible culture interactions ( $\beta=0.252$ ,  $p<0.001$ ), lack of authenticity of human-tourism local interactions, and low expectancy confirmation ( $\beta=0.297$ ,  $p<0.001$ ) on the intention to terminate tourism were also significant. All hypothesised paths with 95% confidence intervals (C I) do not contain 0, i.e. hypotheses H1-H7 are valid (Table 8).

**Table 8: Results of hypothesis testing**

Hypothesis	Path	Indirect effect (Standard Error)	Bootstrapping results		
			Lower	Upper	
			Bias-corrected		confidence interval
H1	Authenticity Perception Expectation ->Lack of Perceived Authenticity of Material Carriers	0.492***	0.381	0.599	Supported
H2	Authenticity Perception Expectation ->Lack of Perceived Authenticity of Embody	0.480***	0.373	0.579	Supported
H3	Authenticity Perception Expectation ->Lack of Perceived Authenticity of Use	0.548***	0.446	0.641	Supported
H4	Lack of Perceived Authenticity of Material Carriers -> Low Expectation Confirmation	0.254***	0.118	0.389	Supported
H5	Lack of Perceived Authenticity of Embody -> Low Expectation Confirmation	0.252***	0.117	0.383	Supported
H6	Lack of Perceived Authenticity of Use -> Low Expectation Confirmation	0.297***	0.157	0.426	Supported

Hypothesis	Path	Indirect effect (Standard Error)	Bootstrapping results		
			Lower	Upper	
			Bias-corrected	confidence interval	
H7	Low Expectation Confirmation -> Tourism Termination Intentions	0.541***	0.433	0.641	Supported

Source: Author's Calculation

### Measurement and structural model

In order test the measurement and structural modelling research model, this study performed structural equation modelling using AMOS 24.0 software. This powerful technique combines principal component analysis and regression to estimate measurement and structural models simultaneously. A CFA was fitted to the data following the two-step model estimation method (Anderson & Gerbing, 1988). The model fit indices [ $\chi^2/df= 1.357$ , CFI= 0.897, IFI =0.975, GFI=0.897, RMSEA=0.034] were acceptable. All loadings were above 0.70 and significant ( $p<0.001$ ) (Table 9). Therefore, the model has a sufficient fit (Figure 2).

Table 9: Model Fit Indices

X2/df	RMSEA	GFI	AGFI	CFI	IFI	TLI
1.357	0.034	0.897	0.879	0.974	0.975	0.972

Source: Author's Calculation

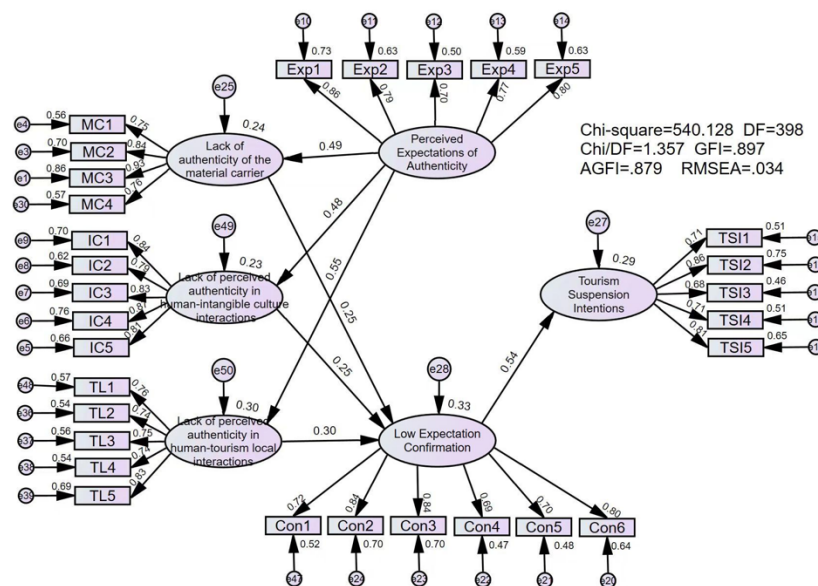


Figure 2. Intangible Cultural Heritage Authenticity Modeling Data Based on Tourism Termination Intentions

Source: Author's Modeling Data Based

## **DISCUSSIONS**

This study presents an integrated research model from a dual theoretical perspective to substantiate the role of authenticity deficits in intangible cultural heritage tourism termination intention. The model is unique in that it attempts to combine authenticity expectations and landscape-perceived authenticity deficit to explore the factors and mechanisms influencing tourism termination behaviour. The model first argues that authenticity expectations have a significant impact on the three basic elements of perceived landscape authenticity. In addition, the landscape's perceived authenticity deficit mediates the tourism termination behaviour change process.

The results of the study show that authenticity expectations have a significant effect on the proximal predictors of tourism termination intention, i.e., lack of perceived authenticity of material carriers, lack of perceived authenticity of human and intangible cultural and cultural interactions, and lack of perceived authenticity of human and tourist destination interactions, and through the mediating role of these predictors, there is a significant indirect effect of authenticity expectations on low-expectation confirmations, and authenticity expectations have a significant indirect effect. These findings are also consistent with Lee's findings that tourists intend to terminate problematic tourism behaviour when they realise that their expectations are unmet and do not make sense to them. These findings are significant because they reveal that tourism intention behaviour can be externally controlled (Caballero, 2017), which may discourage tourists from giving up on continuing to travel to ICH destinations with perceived authenticity problems. Considering these findings, it can be argued that improving landscape authenticity perception factors and mechanisms are necessary to discourage the continuation of ICH tourism with authenticity deficit problems. The findings are also consistent with those of Yuan et al., which confirmed that tourists' motivation to travel directly influences how they perceive and confirm their tourism experience. Further analysis showed that tourists' perceived experience of lack of landscape authenticity directly determines their low expectation of confirmation and willingness to terminate the tour. The model theoretically verifies the importance of authenticity expectations and perceived landscape authenticity on tourism intention, and empirical analysis reveals the complex and close intrinsic relationship between the constituent factors.

## **CONCLUSION**

This study provides antecedents and influences on tourism termination intention behaviour from the perspective of expectation confirmation. The study underscores the influence of landscapes' perceived lack of authenticity and the mechanistic problems associated with tourism termination intention, aiming to enlighten ICH researchers, particularly those delving into the darker aspects of ICH tourism. This comprehensive model further considers future approaches to

ICH preservation and transmission that can be replicated in other landscape design studies so future research can focus on different forms of landscape design for different ICH typologies and further analyse landscape authenticity perceptions and explore their constituent structures in future research has both theoretical and practical value.

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## **URBAN DYNAMICS OF RIVERBANK SETTLEMENT IN SAMARINDA CITY, INDONESIA**

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### **Abstract**

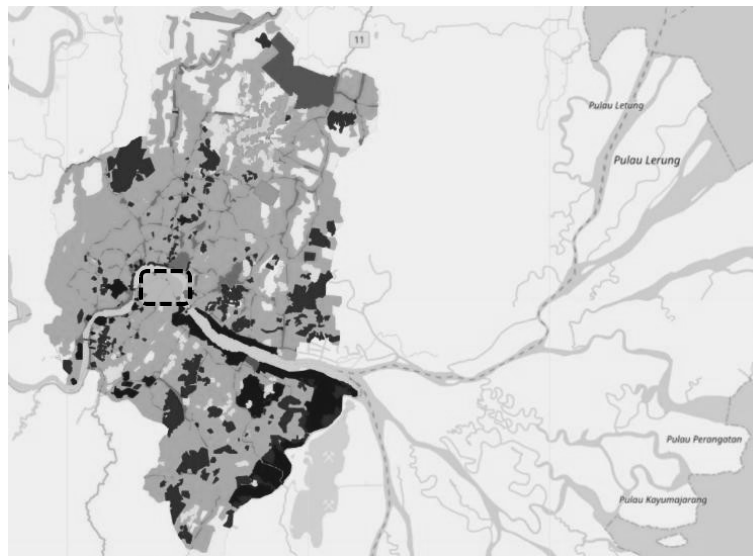
Economic change and government policy are the major factors that determine the settlement on the riverbank in Samarinda, which were originally determined by roads. The transformation problem arises due to economic development with an increase in land-based transportation modes. Therefore, this research aimed to analyze the urban dynamics of settlement based on the configuration and distribution of building masses on the riverbank. It used the qualitative method to determine the urbanity of settlement and the dynamic relationship between mass and environment that creates the morphological characteristics. The result showed that the riverbank settlement in Samarinda is in form of a dense structure due to the availability of limited land. The orientation of settlement persisted towards the river and land as the basis for daily activities. This research made an important contribution to riverbank settlement planning, especially in Samarinda.

***Keywords:*** Urbanity; Settlement; Riverbank; Transformation

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## INTRODUCTION

The large riverbanks in the city of Samarinda are presently characterized by settlements (figure 1). This was because in the Pre-Colonial era, community activities were dependent on river transportation. The settlements were dominated by floating and stilt houses with some parts of the building constructed on land and water, which were accessed using a wooden bridge. The cultural practices is a form of community response to the existence of rivers, which function as agricultural irrigation, shipping routes for the transportation of people and goods, as well as sources of drinking water, washing, and bathing. Therefore, settlement on riverbanks are an important element of cities that need to be integrated into development policies.



**Figure 1.** Study Location: City of Samarinda  
*Source: Gistaru Samarinda, 2024*

The distance to public amenities, cheap housing price, and distance to the workplace are among factors that are important determinants of urban development (Mohd Amirul Mahmud., 2016). The development of these areas are inseparable from economic problems that require public policy planning to respond to existing dynamics. In addition, economic dynamics and development policies are interrelated following the developing social conditions. This dynamics also influenced economic policies in development planning, depicting city development priorities (Stern, 2004). The development plans are realized through city land use and identification of land needs (Odoom, 2016). This



research aimed to describe the urbanity of riverbank settlement in the city of Samarinda in respect to historical practices, while focusing on the relationship between development policy dynamics and the economy.

The community has a culture of living on the water whose existence is still maintained. These large rivers act as the main route for transportation in Kalimantan, thereby promoted the development of settlement along the riverbank. Additionally, in the pre-colonial era, the Samarinda city was a trade center driven by rivers as the major transportation route.

The settlement on the riverbank were originally built for traders as well as used for related transactions. Initially, these settlement had a low density and linear pattern, with each house having a boat mooring for mobility. The land, which was dominated by peat and soft soil layers always submerged in water, was rarely used as settlement areas. Furthermore, there were numerous floating buildings, because these structures supported the flexibility of community activities such as trade-in floating market and fishing on the river. Community social relations was supported by an agricultural-based economic pattern that inspired the formation of settlement (Geenen, 2013).

## **LITERATURE REVIEW**

Management of settlement on riverbank is essential in terms of preservation, restoration, ecosystem conservation, pollution control, and transportation. Similarly, the management of certain regional areas, emotional and recreational values. The morphology of buildings on land differs entirely from those in rivers (Wicaksono, 2022). A preliminary research conducted in the city of Melaka, showed that the guidelines regarding size in the design of riverbank settlement were essential (Ghasemi, 2014).

Government policies also played a significant role in the development of settlement morphology (Zhu, 2019). For example, the Samarinda City Regional Spatial Plan (RTRW) 2023 to 2042 was implemented during the designation of the Samarinda Seberang region as a Social and Cultural Strategic Area. The policy determined how open and built spaces interacted with each other. Community adaptation to riverine environment is closely associated to the role of local government, thereby it is important to understand how the people adjusted to the surrounding (Mousazadeh, 2022). In several countries, the government strictly implemented Standard Operating Procedures for the regulation of riverine community. Furthermore, road construction promoted the development of road-oriented settlement. Community development that originally followed the river flow pattern merged with those oriented towards the road. Similar developments were also observed on the banks of the Kahayan River (Murti, 2020).

Several types of houses are found on riverbanks, namely raft, lanting, pole, and stilt. Raft houses generally inhabited by immigrants workers are

common on the Musi River (Sarwadi, 2001). This differs from the unique lanting houses dominating the city of Banjarmasin. The lanting house tend to float in accordance with the river water level (Setiadi, 2021). Meanwhile, the pole or stilt house model is found in every settlement on the riverbank, both in the cities of Samarinda and Banjarmasin. Open spaces between buildings is important in forming an ideal regional identity. Settlement on the riverbank were often associated with slums (Noor, 2023), therefore, there is need for adequate proportion of open spaces to correct this impression. The relationship between the building mass and open space can be determined using the figure and ground method. Generally, settlement on the riverbank follow a curvilinear pattern, or the curve of the river. In the context of urban open space, the development of a city with a river as the axis needs to consider circulation, access to the water body, city orientation, and the arrangement of surrounding buildings (Anilaputri, 2023). The settlement on the riverbank in the city of Samarinda determined the morphology of the area. It had long been formed and was perceived as the identity of the people. The pattern of urban space use shows the diversification of spatial functions in these areas. The identified problems were associated with settlement spatial planning, and the dynamics of developments, which tend to lead to regional evolution in the future.

## **RESEARCH METHODOLOGY**

This qualitative research adopted a descriptive method with primary and secondary data collected through observation and literature review. The qualitative design comprised research objectives, data collection, and analysis (Leedy, 2019). Data collection methods focused on relevant information, means of collection, and unit of analysis. Meanwhile, primary data was obtained based on field observations, using the analytical descriptive method. The 3D modeling methods served as a means to visualize settlement forms.

## **ANALYSIS AND DISCUSSION**

The development of Samarinda, which was originally a river-based city during the colonial era, was driven by road construction, although many of the community still reside along the riverbanks. Initially, the process was affected by various traditional factors because the community was dependant on the rivers, which acted as trade mobility routes due to limited roads. The colonial government moved the settlement areas from the riverbank to along the city canals. However, as the population increased, land transportation development promoted the orientation of settlement towards roads. This influenced the economic policy of the city, driven by the introduction of technology and capitalist economic system. In addition, large-scale trade experienced rapid growth and was prioritized. Natural product commodities were no longer

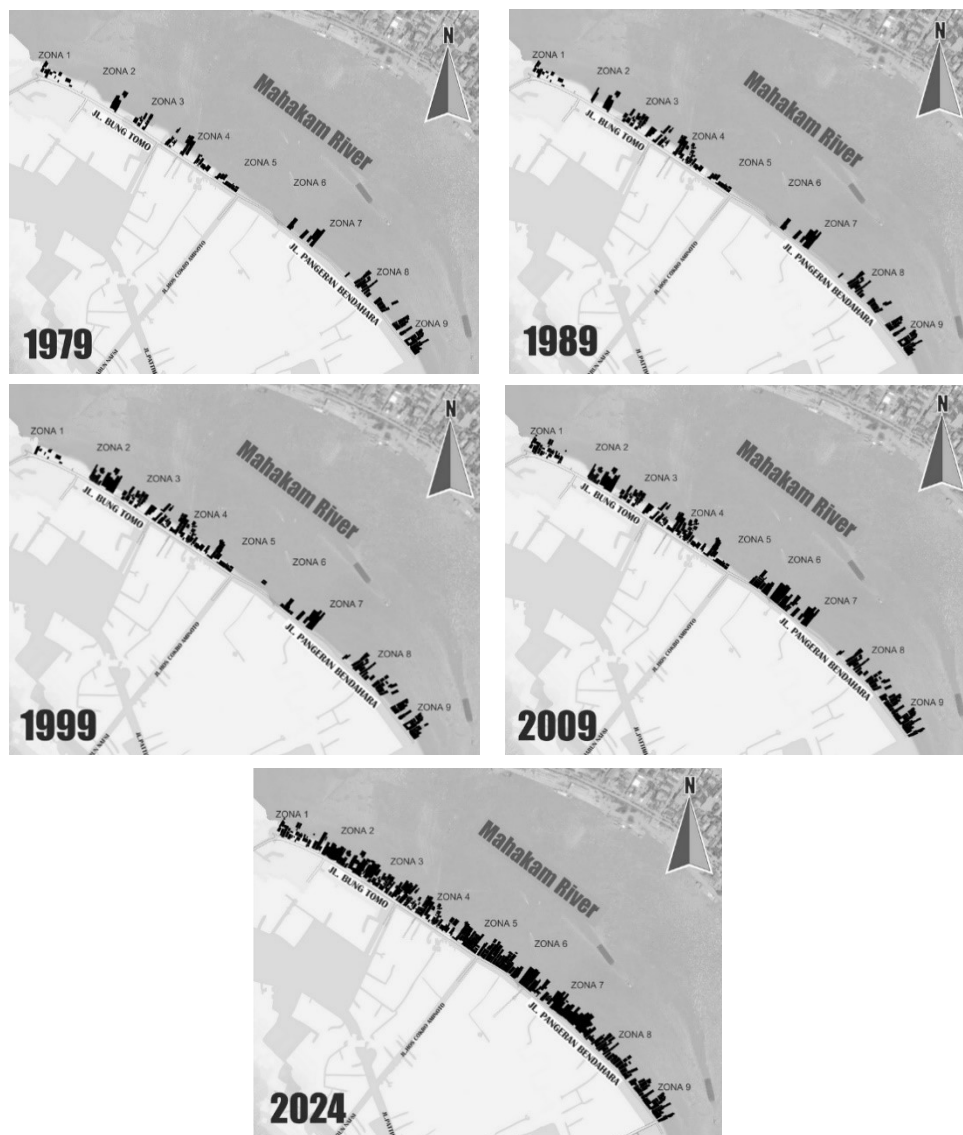
exploited for the needs of the local communities and those outside Kalimantan (Ahyat, 2012).

Urban areas were developed during the early era of independence, despite the unstable economic policies. Initially, the city of Samarinda failed to experience significant changes. The agricultural sector dominated the local economy, while rivers played a major role in transportation. Road construction intensified as population density and community mobility increased. Settlement by the roadside started getting denser, including non-residential activities, while those along the riverbank experienced changes, in the form of community adaptation. These community began to adopt two orientations, facing both river and road (Andini, 2011). Kalimantan is endowed with great natural resource potential, for instance, the cities of Samarinda and Banjarmasin indirectly receive economic benefits from mining activities. This led to the need for large-scale road construction to support mobility to ports and ease the burden on river transportation (Subiyakto, 2002). However, massive road construction incited the development of land-oriented settlement.

The road was built in accordance with the river flow, connecting the airport, city center and rural areas. The construction process increased community mobility, including traffic density. The increasing use of roads and motorized vehicles for human mobility and economic commodities gradually started to reduce the role of rivers as the main transportation route (Subiyakto, 2002). In addition, development driven by economic policies changed the city form, from a community developed along the riverbank to an increasingly broader area following the road network pattern. Roads developed into trade corridors and indirectly changed the professions of the people which was originally river-based. Majority of the people started changing professions, from agriculture to business and trade-related activities. However, due to changes in economic policy orientation, Samarinda city center experienced increased density. These changes promoted rapid expansion of settlement areas. The choice of land no longer considered proximity to the river. Additionally, almost all empty land was used for settlement purpose due to the growth in economic activity. Land closure also occurred along the riverbank, resulting in the use of existing mangrove and peat lands. As a result, many river mouths and water channels experienced narrowing and closure of water flow, including complete blockage by settlement projects, thereby leading to increased sedimentation (Andini, 2011).

The shift in livelihood orientation of the community from a river to land-based economic sector is slowly moving the settlement away from riverine life. Furthermore, the construction of new settlement areas alongside those on the riverbank oriented towards the road increased. This led to the decentralization system policy, implemented in 2001. The finance for development management were handed over to the City/Regency government. Meanwhile, income was raised by inviting investors for the continuation of city development. Policy

changes brought the city of Samarinda face to face with global economic forces or investors. This led to a stronger market-driven economy (Geenen, 2013), causing the urbanity-based development to experience pressure. The city economy, which was previously dominated by the role of rivers, was replaced by a development form based on financial gain and land speculation. This implied that river-based infrastructure development was slow.



**Figure 2.** Development of Samarinda City Riverbank Settlement  
*Source: Survey, 2024*

Figure 2 shows the development of the Kota Lama settlement on the banks of the Mahakam River in Samarinda Seberang which had been in existence for a long time. The increase in building mass was observed since 2009, while the water culture had also been maintained till this day, as proven by the existence of local boats moored in almost every house along the riverbank. The sporadic increase in buildings oriented towards the river body caused irregular circulation patterns as shown in Figure 3.



**Figure 3.** Settlement conditions on the banks of the Mahakam River in Samarinda  
*Source: Survey, 2024*

Empirical data stated that the *Kota Lama* settlement in Baqa Village, Samarinda Seberang, showed significant morphological complexity. The number of building lots in the research area were 162, reflecting the density of settlement on the Mahakam Riverbanks. Meanwhile, one plot can accommodate two to 10 houses oriented towards the river body, showing the adaptation of the community who live on the water. This condition caused the building mass to increase, generating dynamic and varied patterns. The uniqueness also reflected the adaptation of the community to the heterogeneous river environment. The tendency of increased building masses annually, led to new challenges and opportunities in regional planning.

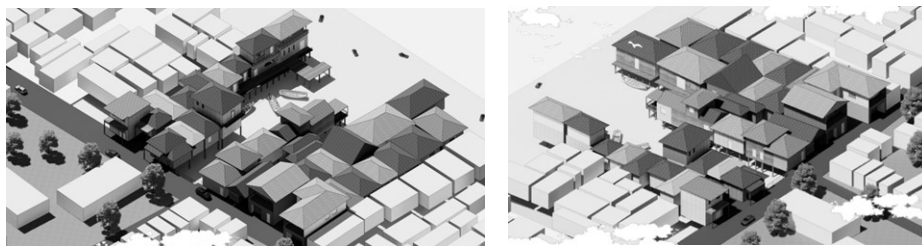
**Table 1.** Building Mass Pattern

Segment	Number of Lots	Total Building Mass	Comparison	Pattern
1	24	54	1 : 2.25	Heterogeneous
2	24	68	1 : 2.83	Heterogeneous
3	18	39	1 : 2.17	Heterogeneous
4	23	53	1 : 2.30	Heterogeneous
5	13	30	1 : 2.31	Heterogeneous
6	15	49	1 : 3.27	Heterogeneous

Segment	Number of Lots	Total Building Mass	Comparison	Pattern
7	17	34	1 : 2.00	Heterogeneous
8	13	28	1 : 2.15	Heterogeneous
9	15	27	1 : 1.80	Heterogeneous
Total	162	382	1 : 2.36	

*Source: Studio, 2024*

Table 1 shows that the settlement on the riverbank, is few as proven by the comparison of 1: 2.36. This explains that on average only two to three building units in a plot were oriented towards the river. However, Figure 4 showed that the irregular placement of the rectangular buildings was oriented towards the river body.



**Figure 4.** Settlement on the banks of the Mahakam River, Samarinda City

*Source: Survey, 2024*

The results of the survey showed that three types of building mass patterns were formed in response to the diversity of the building units, namely:

- a. The mass of the building is square, depicting symmetrical balance in the arrangement of the units. Generally, the building functions as a simple house occupied by the head of the family.
- b. The rectangular pattern of longer building masses, showed variations in design and space configuration. This pattern reflected community adaptation to geographical conditions and the dynamic river environment.
- c. The length of the building mass was approximately 51.5 meters. Additionally, the model with a long mass was often observed along the riverbank in Samarinda. The pattern showed the existence of community adaptation to the use of space and functional needs in the context of settlement on water.

This pattern analysis provided a more detailed picture of the preferences and needs of the community in riverbank areas. In addition, the diversity produced a dynamic diagram of regional morphology, enriching the understanding of settlement complexity on the banks of the Mahakam River which tend to be dense.



**Figure 5.** Development of Riverbank Settlement in Samarinda City  
*Source: Survey, 2024*

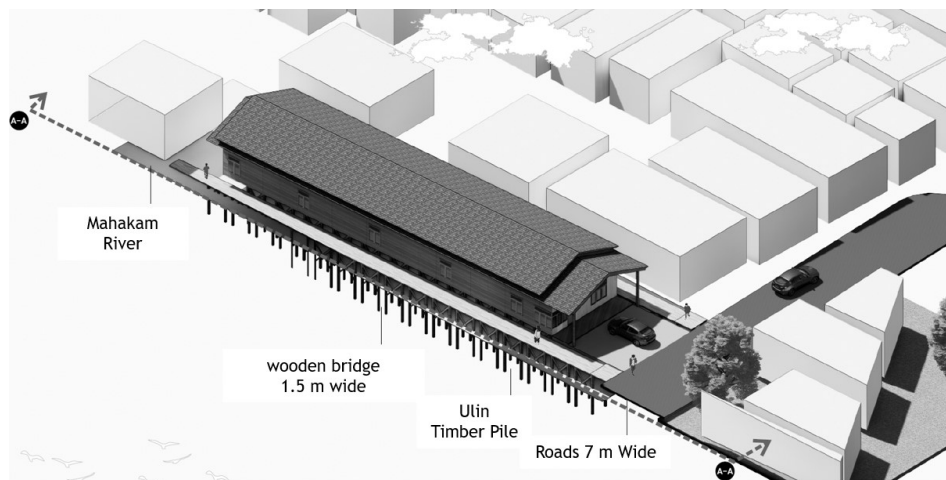
The elongated mass pattern reflected the community adaptation to the geographical conditions of the Mahakam riverbank, which tends to be sloping. This pattern showed the efficiency of land use along the riverbank, where one plot sequentially accommodated several housing units (figure 5).



**Figure 6.** Development of Riverbank Settlement in Samarinda City  
*Source: Survey, 2024*

Houses in rectangular forms extending towards the river body show the flexibility of the community in adapting to the riverbank conditions (figure 6). This form of settlement characteristic produced a dynamic but orderly spatial arrangement. In each plot, the building masses formed rows, which piled up, thereby producing distinctive visual scene with efforts to use the land optimally. This condition reflected the combination of residential function and aesthetics resulting in unique characteristics of riverbank settlements. The dense settlement

with a mass of buildings stacked to the river body produces a narrow distance of approximately 1 meter between the houses. These dense spatial patterns were also visible in the transportation routes towards the river. The movement path in the form of a wooden bridge can only be used by motorbikes, producing a narrow corridor connecting the settlement and river body. This pattern reflected community efforts in terms of maintaining settlement density while providing limited access to the river.



**Figure 7.** Longitudinal Model Settlement on the Riverbank of Samarinda City  
*Source: Survey, 2024*

Empty spaces were found in ditches between the buildings, which led to opening between the building mass and the river body (figure 7). Overall, the spatial pattern formed produced a well-organized regional structure. Settlement density was balanced with measured access routes, maintaining an equilibrium between land efficiency and the need for interaction with the river. The existence of space above the river led to harmony in land use, including the unique character of riverbank settlement.

## CONCLUSION

In conclusion, an urbanity review of the riverbank settlement in the city of Samarinda showed that development and economic policies greatly influenced the patterns. These were transformed from an area previously dominated by the role of rivers and riverine life, as well as agricultural activities towards future development patterns. Presently, the patterns were dominated by land-based infrastructure development and road-based economic activities. Despite the fact that the river physically divided the city, the role in the daily lives of community members was decreasing. As a result, the priority of riverine infrastructure



development and similar activities had also been reduced from the city planning agenda. Adequate attention was given to the river space in the past when policy activity-based urbanization and land-based economic development were insignificant. This was due to the agricultural economy which relied heavily on rivers as a water source and transportation route. Therefore, the cultural practice of residing in a riverine environment was deeply rooted in the community.

Rivers and water spaces were prioritized in Samarinda city planning during the colonial era before the expansion of urbanization and land-oriented development shifted the main role as community mobility routes. After the domination of economic policies driven by market-based development priorities, urbanization became more rapid and massive. Additionally, road-oriented development incited a decline in the closeness of the community and water spaces. The attention given to the river quickly reduced as proven by the increasing number of peatlands, and canals controlled for land development. The need for comprehensive long-term urban planning and development strategies were urgently adopted to prevent disasters originating from water problems in the future. This planning needed to prioritize the continued existence of water urbanism and the connection to a sustainable agricultural-based economy. The evaluation of a market-based economic and development policies, including land-based infrastructure was carried out to ensure the realization of patterns that focused on sustainable water spaces. It was further concluded that:

- a. **Settlement Density:** Settlement density was extremely high, with each lot, although narrow accommodating a large number of building masses lined up, thereby producing a closely packed dense structure. This reflected the community adaptation to limited land on the riverbank, where efficient use of space was the main focus.
- b. **Formed Morphology:** The morphology of the area was classified as heterogeneous with a variety of building mass formations. Based on empirical data, it appeared that the community chose a variety of building forms, ranging from squares, to rectangles. The creativity of this architectural form led to the architectural characteristics of the riverbank settlement.
- c. **Open Space:** The spatial pattern formed showed that the existence of open space was limited. Each lot was completely filled by the mass of the building, leaving slight spaces in-between. This phenomenon resulted in a dense and uniform settlement atmosphere, with limited open space. Furthermore, the open space in the canals and ditches leading to the river served as an access point for sand miners.

This research contributed to understanding the development of settlement on the riverbank. The findings regarding heterogeneous morphology and limited open space were the basis for better spatial planning.

Focusing on efficient land use and diversity in architectural design was the basis for implementing sustainable development policies and maintaining unique characteristics, stated as follows:

- a) **Morphological Specificity:** The morphology of the area showed uniqueness in house architectural design, reflected in the diverse forms, such as square mass with variations in dimensions.
- b) **High Settlement Density:** This research reported that there was high settlement density. Each lot on the riverbank contained several buildings stacked together, resulting in a dense settlement structure, perceived as a response to the limited land on the riverbank.
- c) **Limited Open Space:** The spatial pattern formed showed that there was limited open space. Even though there were some empty spaces, such as those where the ditch met the river, these were few.
- d) **Implications for City Planning:** This research provided input for city spatial planning, specifically regarding settlement density, efficient land use, and paying attention to open space on the riverbank. In the future, settlement planning on riverbanks needs to consider specific morphology and dynamics of spatial patterns to produce a sustainable environment in line with community needs.

## ACKNOWLEDGEMENTS

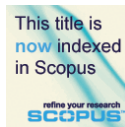
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## **URBAN SPRAWL TRANSITION RULE ALGORITHM CONCEPT IN CELLULAR AUTOMATA FRAMEWORK: CASE STUDY OF MALALAYANG DISTRICT, MANADO CITY, INDONESIA**

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### **Abstract**

This study aimed to develop an urban sprawl model transition rule algorithm based on land coverage indicators in a cellular automata grid framework. This study attempts to identify various attributes that impact land coverage in a spatial grid cell using statistical and spatial analysis methods. This concept provides a theoretical and methodological basis for developing a more comprehensive urban sprawl simulation model. The results indicated three determinant factors for the condition of land coverage in a cellular automata spatial grid cell: built-up land conditions, slope gradients, and the availability of road network infrastructure. The concept of the algorithm found can be expressed through the following statements: 1) built-up land in a particular spatial grid will be influenced by the condition of built-up land in neighboring grid cells, with a determination of 67%; 2) every one unit increase in the average area of built-up land in neighboring cells will be associated with the same phenomenon in a particular grid cell of 1.08 units; 3) built-up land on each spatial grid is correlated with the slope gradient and the availability of road network infrastructure on the spatial grid; 4) the flatter the slope condition of a spatial grid will be associated with higher built-up land in the spatial grid cell; and 5) the better the road infrastructure availability on a particular spatial grid will be associated with higher built-up land.

**Keywords:** Urban Sprawl, Transition Rule Algorithm, Cellular Automata, Built-up Land

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## **INTRODUCTION**

Urban sprawl, or the expansion of urban areas characterized by low-density development and outward expansion, is often viewed negatively because of its association with various environmental and social problems such as increased land consumption, traffic congestion, and air pollution. Urban planners and policymakers should implement strategies to address the challenges of urban expansion, involving a smart growth approach that emphasizes efficient development management through mixed-use land zoning, the optimization of green open spaces, and community involvement in planning. These strategies aim to improve infrastructure efficiency and reduce open space fragmentation. In addition, urban densification through vertical development or more efficient land use helps reduce the need for expansion to the outskirts, thereby protecting ecosystems and productive land around the city.

Manado City, the capital of North Sulawesi Province in Indonesia, is an urban area that is inseparable from urban sprawl. This development is characterized by low population density, unplanned development patterns, and inconsistent changes in land use, especially on the outskirts. The spatial structure of Manado City is monocentric within certain boundaries of the city center but is starting to shift to a polycentric pattern in the suburbs. In peri-urban zones, a significant challenge is urban sprawl and its associated impacts, including fragmentation of green open spaces, increased dependence on private vehicles, and higher infrastructure investment and maintenance costs (Rogi et al., 2024). This condition often occurs because of leapfrogging development, reducing spatial efficiency. Consequently, green open spaces are converted into settlements or commercial areas, separate from the city center. (Bambulu et al., 2018). Urban sprawl in Manado has negative consequences such as increasing infrastructure management costs, decreasing environmental quality, and increasing transportation burdens. One solution could be the application of the compact city concept, which encourages the efficient land use and focuses on settlement density and diversity of land functions to support sustainability (Tilaar et al., 2017).

Understanding the characteristics of urban sprawl in an area provides insights into its growth patterns and determinants, allowing better prediction. One approach for understanding urban sprawl is the cellular automata method. An advantage of this method is its ability to capture complex spatial dynamics. Each cell in the model represents a land unit that can change its status based on certain transition rules, allowing for the observation of how changes in one location can trigger changes in others. Cellular automata are useful tools for spatial planning and decision-making related to urban growth management.

This study aimed to develop a transition rule algorithm to model urban sprawl based on built-up land or open-space indicators within the framework of

a cellular automata grid. Through an analysis of the attributes of an urban cell, this study attempted to identify the determinant factors that influence the conditions of built-up land or open space, which were then used to formulate the algorithm concept. Statistical and spatial analysis methods were used to link these attributes to built-up land or open space conditions. These results provide a theoretical and methodological basis for developing a more comprehensive urban sprawl simulation model.

## **LITERATURE REVIEW**

### ***On Urban Sprawl***

Urban sprawl is a phenomenon of uncontrolled urban expansion characterized by high land consumption, low population density, and landscape fragmentation (Sudhira et al., 2012). According to Soetomo (2013), urban sprawl is a model of urban extension that occurs horizontally, leading to the formation of "mega urban" areas. Urban sprawl is an inefficient form of development (Bento et al. 2006). Sprawling negatively impacts the environment, resulting in loss of natural habitat, decreased water quality, and greenhouse gas emissions (Ewing & Rong, 2008). Urban expansion can lead to longer travel times, increased dependence on motorized vehicles, and reduced walking ability (Ewing & Cervero, 2010).

Brueckner (2000) states that the normal expansion of urban spaces is primarily caused by an increasing population and income, and decreasing travel costs. However, incorrect policies can negatively distort this process and justify negative perceptions surrounding the sprawl phenomenon. Burchell & Mukherji (2003) indicate that compared to urban sprawl, intelligently managed physical growth of cities can save human and natural resources extensively.

Hasse & Lathrop (2003) measure sprawl in housing units using five variables as sprawl characteristics, namely building density, leapfrog development patterns, segregated land use, development within the reach of the road network (highway strip), and distance to the city center (node inaccessibility). Burchfield et al. (2005) define the sprawl index as the percentage of undeveloped land around an average urban residence. Angel et al. (2007) state that five attributes should be considered while measuring urban sprawl, one of which is the reduced continuity of built-up areas and the fragmentation of open spaces.

A significant indicator of sprawl is the open-space ratio. This metric is defined as the proportion of unbuilt areas within an area (Tan & Sia, 2019). Open spaces have many benefits such as providing space for recreation, improving air and water quality, and reducing the heat island effect (Benedict & McMahon, 2006). One study showed that sprawl is negatively correlated with the ratio of open spaces: the higher the level of sprawl, the lower the ratio of open spaces

(Sudhira et al., 2012). This was because of the conversion of open land into built-up areas for housing, commerce, and infrastructure.

### **Cellular Automata and Its Transition Rules Algorithm**

The cellular automata method is a computational model that can be used to simulate complex spatial phenomena such as urban sprawl. With its ability to simulate spatial and temporal changes in land use, this method allows us to determine how complex and nonlinear urban growth patterns are. Cellular automata can integrate various factors that influence urban growth, such as government policies, accessibility, and community preferences. This method can also be used to project future scenarios and evaluate the impacts of various policies on urban growth patterns (Batty & Xie, 1994; Batty et al., 1999).

Cellular automata are dynamic models that are discrete in time, space, and state (Balzter et al. 1998). The basic concept of cellular automata is that a spatial grid cell can be conditioned based on the variation in its neighborhood cells, that can be viewed through two approaches: the Moore neighborhood concept, which consists of eight cells surrounding a central cell in two dimensions, and the Von Neumann neighborhood, which consists of four cells orthogonally surrounding a central cell in two dimensions (Basse, 2013).

The primary component of cellular automata is the definition of transition rules that determine changes in the conditions of certain attributes in a geographic process. Various methods have been used to describe the transition rules of cellular automata, such as multi-criteria evaluations, regression models, and artificial neural networks (Cao et al., 2015). Using its transition algorithm, cellular automata can predict the potential sprawl development, evaluate the impact of different policies on sprawl, and identify effective strategies for controlling sprawl.

Several studies have shown that cellular automata can be used to simulate sprawl with high accuracy. These models consider factors such as population density, accessibility, and land-use zoning (Wu & Webster, 1998; Tsai, 2005; Pinto et al., 2021).

## **RESEARCH METHODOLOGY**

In general, this research was conducted with the following steps:

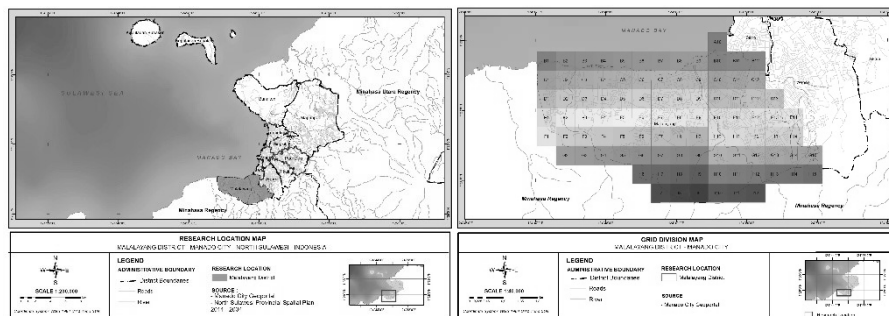
- 1) Preparation. At this stage, the scope of the study area in the peri-urban area of Manado City was determined and divided into a cellular automata grid framework.
- 2) Data Collection. The collected data included the spatial data of the study area, describing the variation in cell attributes in the area grid.

- 3) Data Analysis. The analysis included a) spatial analysis to explore the sprawl pattern in the study area, especially based on open space indicators and built-up land as a complement; and b) statistical analysis of the condition of urban cell attributes according to the grid framework. In this analysis, the intercorrelation patterns between various urban cell attributes and built-up land and open space conditions were examined to identify the factors that contribute to sprawl.
- 4) Conceptualization of the Transition Algorithm. The concept of the urban cell condition transition algorithm, which indicates the sprawl phenomenon, was developed based on the intercorrelation tendencies between urban cell attributes, particularly built-up land and open space.
- 5) Drawing Conclusions and Formulating Recommendations.

## RESULT AND DISCUSSION

### *Overview of Study Area and Grid Division of Cellular Automata Framework*

This study is located in Malalayang District, one of the peri-urban areas of Manado City. It was chosen because it exhibits the phenomenon of urban sprawl, where built-up land distribution indicates a significant fragmentation of green open spaces in the city image map. For data collection in the cellular automata framework, the study area was derived from several grids measuring  $500 \times 500$  m, which were observation units for collecting attribute data. Each grid had an area of  $250,000 \text{ m}^2$  (25 Ha). The delineation of the study area and division of the cellular automata framework grid are shown in Figure 1.



**Figure 1. Delineation & Cellular Automata Grid Framework of Study Area**

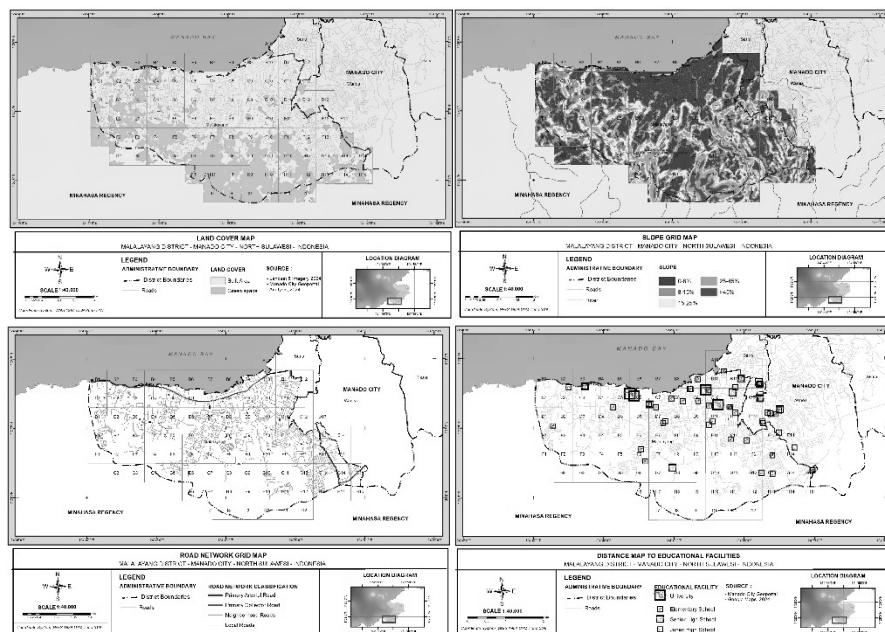
*Source: Geoportal Site Data, Field Observation & Interpretation of Research Team*

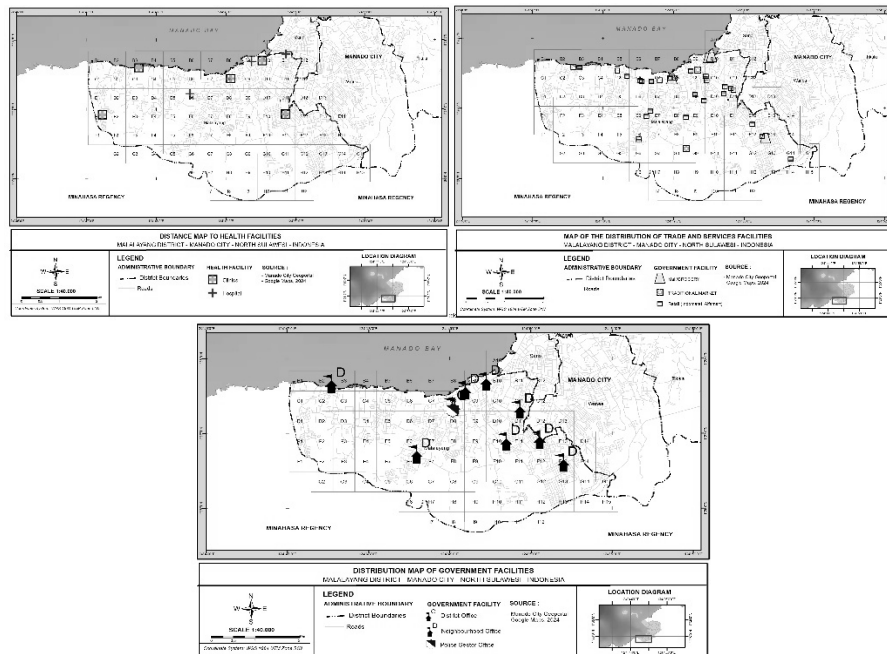
### *Basic Data According to Cellular Automata Grid*

Based on grid division, some grid attributes were recorded, which were considered as variables in the development of urban sprawl transition rules in the cellular automata framework. In general, two groups of grid data attributes exist. The first is an attribute that has the potential to be a dependent variable in the



transition rule algorithm as well as the main indicator of the urban sprawl phenomenon, namely, the area of built-up land that is complementary to the area of open space in each grid. This attribute is also considered an independent variable that determines the sprawl conditions in the neighboring grid cells. Second, other attributes have the potential to be independent variables (determinants) in the transition rule algorithm, including slope conditions, road infrastructure availability conditions, and accessibility distance conditions for certain public facilities such as education, health, trade and services, and government. Built-up land attributes were recorded in units of hectare (Ha) per grid. Other attributes were recorded in score units, each with a certain range, with low scores representing conditions that were perceived as bad and high scores representing conditions that were perceived as good in the context of encouraging physical growth in the area in question and its neighboring grids. These data were obtained from several secondary data sources, including image maps and shape files accessed at the geoportal site, along with field observations. Figure 2 shows the spatial data for each attribute presented above for each grid of the study area.



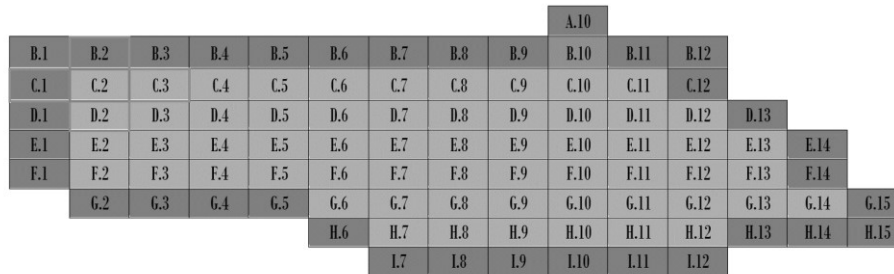


**Figure 2.** Thematic Maps of Grid Attribute Data of Study Area  
Source: Geoportal Site Data, Field Observation & Research Team Interpretation

Referring to the thematic map above as well as the quantification of each attribute, basic data were obtained from seven attributes observed in a total of 96 (ninety-six) grid cells in the study area.

### Data Processing for Analysis Input

Basic data obtained is further processed and prepared as input for analysis to identify potential sprawl growth transition rules within the cellular automata grid framework. A correlation analysis is conducted between the attributes of the sprawl indicator variables in a given grid cell, particularly, the condition of built-up land, and various attributes in directly adjacent grids cells. These neighboring grid cells are considered determinant variables influencing the sprawl indicator in the observed grid cell. Figure 3 shows a map of the grid positions in the study area as a cellular automata framework. The lighter-colored grid cells are the observed grid cells because each has directly adjacent grid cells on the top, bottom, left, and right sides of the cell. For example, grid cell C2, as one of the observed grid cells, has 4 adjacent grid cells, each of which is B2, C1, C3, and D2.



**Figure 3.** Cellular Automata Grid Framework of Study Area  
 Source: Processed Data Results of Research Team

In the correlation analysis, there were two groups of data: 1) internal attribute or observed grids, which were theoretically positioned as dependent variables, and 2) adjacent grid attributes, which were viewed as independent variables or those estimated to influence the condition of the internal attribute or observed grids. The first group includes the built-up land area (Y1), which is complementary to the open space area (Y2) and the open space fragmentation index (Y2/Y1). The value of the first data attribute in each observed grid cell is the same as that of the basic data obtained. The second dataset includes the average value of built-up land area (X1), slope gradient score (X2), road infrastructure availability score (X3), and the score of the distance of accessibility to educational facilities (X4), health (X5), trade and services (X6), and government (X7) in the four grid cells that are directly adjacent to the observation cell. Referring to the description of data processing above, Table 1 shows a recapitulation of the distribution of the values of each variable in each observation grid cell, which includes the values of the variables in the 61 observed grid cell units. These processed data are then used as input at the analysis stage, especially for correlation and regression analyses, to identify the possibility of a sprawl growth transition rule algorithm in the cellular automata grid framework.

**Table 1.** Data Processing Results for Analysis Input

Data Number	Grid Name	Y1 (Ha)	Y2 (Ha)	(Y2/Y1)	X1 (Ha)	X2 (Score)	X3 (Score)	X4 (Score)	X5 (Score)	X6 (Score)	X7 (Score)
1	B.10	23,49	0,00	0,00	18,54	4,78	0,86	2,15	1,62	2,01	1,17
2	C.2	19,41	5,59	0,29	13,72	4,02	1,45	1,95	1,23	1,67	1,09
3	C.3	14,05	10,95	0,78	13,15	4,08	1,49	2,06	1,26	1,68	1,11
4	C.4	16,25	8,75	0,54	16,27	4,26	1,59	2,30	1,38	1,71	1,19
5	C.5	23,44	1,56	0,07	17,30	4,61	1,41	2,48	1,56	1,72	1,27
6	C.6	23,87	1,13	0,05	17,52	3,47	0,98	2,42	1,63	1,79	1,33
7	C.7	24,83	0,17	0,01	18,38	3,65	1,04	2,25	1,44	1,87	1,34
8	C.8	24,83	0,17	0,01	19,40	4,80	1,28	2,13	1,43	1,85	1,27
9	C.9	25,00	0,00	0,00	22,59	4,83	1,25	2,19	1,43	1,79	1,24
10	C.10	23,97	1,03	0,04	23,25	4,51	1,19	2,28	1,41	1,84	1,15

11	C.11	24,34	0,66	0,03	23,73	4,52	1,31	2,16	1,52	1,81	1,13
12	D.2	14,94	10,06	0,67	15,59	4,13	1,13	2,02	1,23	1,72	1,13
13	D.3	13,14	11,86	0,90	15,45	4,06	1,19	2,10	1,31	1,74	1,15
14	D.4	23,35	1,65	0,07	17,24	4,13	1,10	2,29	1,48	1,77	1,21
15	D.5	23,86	1,14	0,05	21,12	4,37	1,24	2,37	1,67	1,76	1,26
16	D.6	21,79	3,21	0,15	23,43	4,49	1,23	2,27	1,68	1,76	1,28
17	D.7	24,83	0,17	0,01	23,65	4,60	1,19	2,13	1,57	1,82	1,31
18	D.8	24,65	0,35	0,01	24,49	4,54	1,24	2,04	1,38	1,75	1,33
19	D.9	23,99	1,01	0,04	23,03	4,48	1,20	2,14	1,40	1,71	1,24
20	D.10	20,18	4,82	0,24	23,68	4,27	1,19	2,27	1,35	1,64	1,15
21	D.11	24,88	0,12	0,00	22,76	3,97	1,06	2,15	1,33	1,76	1,13
22	D.12	22,55	2,45	0,11	23,08	4,01	1,02	1,87	1,37	1,80	1,08
23	E.2	11,07	13,93	1,26	12,35	3,93	1,10	2,09	1,22	1,78	1,18
24	E.3	9,48	15,52	1,64	13,76	4,01	1,14	2,23	1,35	1,79	1,19
25	E.4	15,70	9,30	0,59	13,01	3,95	1,22	2,29	1,50	1,78	1,20
26	E.5	15,88	9,12	0,57	16,63	4,01	1,05	2,24	1,65	1,73	1,20
27	E.6	21,15	3,85	0,18	20,50	4,26	1,15	2,16	1,70	1,69	1,20
28	E.7	23,34	1,66	0,07	20,94	4,07	1,17	2,01	1,58	1,72	1,24
29	E.8	24,33	0,67	0,03	21,54	4,43	1,11	2,11	1,46	1,72	1,27
30	E.9	22,28	2,72	0,12	21,80	3,95	1,27	2,17	1,38	1,61	1,24
31	E.10	21,89	3,11	0,14	20,87	3,93	1,19	2,14	1,28	1,73	1,17
32	E.11	23,97	1,03	0,04	20,38	3,56	1,13	2,06	1,24	1,75	1,07
33	E.12	21,09	3,91	0,19	23,16	3,89	1,17	1,94	1,24	1,90	1,09
34	E.13	23,20	1,80	0,08	23,47	3,86	0,61	1,72	1,34	1,95	1,08
35	F.2	9,63	15,37	1,60	12,53	4,24	0,85	2,17	1,25	1,81	1,21
36	F.3	15,13	9,87	0,65	9,86	3,88	0,82	2,27	1,37	1,80	1,21
37	F.4	3,33	21,67	6,51	13,22	3,92	1,06	2,28	1,50	1,76	1,20
38	F.5	5,82	19,18	3,30	14,28	3,84	1,14	2,20	1,59	1,67	1,15
39	F.6	20,98	4,02	0,19	11,86	3,64	1,19	2,08	1,62	1,62	1,14
40	F.7	13,47	11,53	0,86	15,55	3,95	0,83	2,05	1,57	1,59	1,17
41	F.8	15,92	9,08	0,57	16,60	4,03	1,32	2,15	1,47	1,65	1,22
42	F.9	16,99	8,01	0,47	16,10	4,03	1,41	2,25	1,39	1,70	1,22
43	F.10	17,04	7,96	0,47	16,60	3,64	1,17	2,20	1,29	1,78	1,15
44	F.11	13,63	11,37	0,83	17,70	3,78	1,12	2,10	1,21	1,91	1,11
45	F.12	22,92	2,08	0,09	18,89	3,63	1,13	1,92	1,26	1,94	1,07
46	F.13	24,25	0,75	0,03	20,04	3,84	1,19	1,81	1,33	1,99	1,07
47	G.6	6,98	18,02	2,58	10,85	3,45	0,55	2,08	1,58	1,59	1,13
48	G.7	1,98	23,02	11,66	8,15	3,63	1,02	2,10	1,55	1,64	1,16
49	G.8	11,61	13,39	1,15	8,14	3,83	0,76	2,23	1,48	1,66	1,22
50	G.9	9,17	15,83	1,73	10,87	3,78	0,95	2,31	1,40	1,77	1,22
51	G.10	13,87	11,13	0,80	10,31	3,46	1,35	2,26	1,33	1,88	1,18
52	G.11	6,87	18,13	2,64	15,16	3,66	1,02	2,13	1,29	1,96	1,15
53	G.12	16,61	8,39	0,51	15,14	3,81	1,00	2,00	1,30	1,99	1,11
54	G.13	22,36	2,64	0,12	18,18	3,77	1,30	1,86	1,34	1,94	1,08
55	G.14	15,00	10,00	0,67	17,53	3,70	1,59	1,71	1,38	1,93	1,09
56	H.7	0,52	24,48	46,88	2,80	3,41	0,00	2,17	1,53	1,68	1,19
57	H.8	5,50	19,50	3,55	3,66	3,63	0,36	2,27	1,48	1,76	1,23
58	H.9	1,02	23,98	23,55	6,10	3,41	0,75	2,34	1,42	1,85	1,24
59	H.10	8,18	16,82	2,06	9,20	3,08	0,50	2,29	1,37	1,95	1,22
60	H.11	16,54	8,46	0,51	6,50	3,04	0,75	2,19	1,34	1,99	1,18
61	H.12	8,42	16,58	1,97	15,14	3,59	0,75	2,05	1,34	1,97	1,14

*Source: Recapitulation of Processed Research Team Data Results*

### Analysis Result & Interpretation

Referring to the processed data, the next stage is a correlation analysis, which aims to identify the strength and direction of the relationships between the observed variables. Correlation analysis was conducted using the Pearson product-moment quantitative data correlation analysis method, which was calculated using Microsoft Excel. The results of the correlation analysis that have been carried out are presented in full in Table 2.

**Table 2.** Correlation Analysis Results

	Y1	Y2	Y2/Y1	X1	X2	X3	X4	X5	X6	X7
Y1	1									
Y2	0,9996438 6	1								
Y2/Y1	0,5665429 8	0,5656098 34	1							
X1	0,8166758 55	0,8151164 6	0,5189694 5	1						
X2	0,5370322 23	0,5422652 4	0,3151772 3	0,6310045 78	1					
X3	0,4963432 8	0,4919376 6	0,5576780 8	0,5346536 64	0,4737474 23	1				
X4	0,1678318 5	0,1670291 84	0,1161668 95	0,2622475 5	0,0882111 91	0,07988 472	1			
X5	0,0494559 95	0,0545889	-0,1224371 74	0,0084550 46	0,2278085 92	0,12635 705	0,3911612 38	1		
X6	0,1168651 16	0,1235880 5	0,1214628 8	0,0717478 33	0,1705289 3	0,11031 287	0,2752918 7	0,3360242 6	1	
X7	0,0904719 12	0,0893474 4	0,0482507 2	0,0045371 71	0,2951092 91	0,04548 726	0,6521993 58	0,4965929 1	0,2320181 2	1

Source: Results of Research Team Analysis

The results indicate that between the first data group (Y1, Y2, and Y1/Y2) and the second data group (X1 to X7), significant correlation coefficient figures only occur between the three variables of the first data group with three variables from the second data group, namely variables X1, X2, and X3, with correlation coefficient values in the range of (+/-) 0.5 to 0.8, indicating a moderate to high level of correlation, both in the same direction (between Y1 and X1, X2, and X3) and in the opposite direction (Y2 and Y2/Y1 with X1, X2, X3). The correlation between the variables X4 and X7 can be ignored because their values approach 0. This indicates that the observed grid's land cover conditions, both

built-up land and open space areas (Y1 and Y2), were significantly correlated with the conditions of built-up land area (X1), slope gradient (X2), and availability of road infrastructure (X3) in adjacent grid cells. The positive correlation between the internal grid variable (Y1) and the three adjacent grid variables (X1, X2, and X3) indicates that high built-up land area, slope gradient score, and road infrastructure availability score in cells directly adjacent to an observed grid cell are also associated with high built-up land area inside the observed grid cell, and vice versa. The negative correlation between the unbuilt land area (Y2) and open space fragmentation index (Y2/Y1) with the other three variables can be understood logically in connection with the fact that the Y2 value is complementary to the Y1 value. This is also confirmed by the correlation coefficient value between the variables of the first data group, namely between variables Y1 and Y2, which have values close to 1, and between Y2/Y1 and Y1 and Y2, which have relatively the same values but in opposite directions. In the scope of the second group of data, it can be observed that between variables X1, X2, and X3, each has a fairly significant (moderate) level of intercorrelation, with a value of approximately 0.5, and is positive in the same direction. A significant and positive correlation was also observed between variables X4 (access to educational facilities) and X5 (access to health facilities), and variable X7 (access to government facilities).

Hence, to identify the urban sprawl transition rule algorithm within the cellular automata framework, the internal grid built-up land area variable (Y1) or the open space area variable (Y2) can be positioned as an indicator of the sprawl phenomenon of a spatial unit grid is influenced by at least three variables in the grid cells directly adjacent to the grid, which in this case include the built-up land area variable (X1), slope gradient score (X2), and road infrastructure availability score (X3).

Furthermore, the transition rule algorithm in question was identified using multivariate regression analysis involving variable Y1 as the dependent variable and variables X1, X2, and X3 as the independent variables. This multivariate regression analysis was conducted through Microsoft Excel. The results are presented in Table 3.

**Table 3.** Results of Stage 1 Regression Analysis

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,819838597
R Square	0,672135326
Adjusted R Square	0,65487929
Standard Error	4,201141052
Observations	61

ANOVA

	df	SS	MS	F	Significance F
Regression	3	2062,393241	687,4644137	38,95073847	7,9451E-14
Residual	57	1006,02641	17,64958614		
Total	60	3068,419651			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	2,985731754	5,877446808	-0,50799809	0,613414999	14,75511598	8,783652469	14,75511598	8,783652469
X1	1,003714072	0,137106074	7,320711908	9,29198E-10	0,729163893	1,27826425	0,729163893	1,27826425
X2	0,320625279	1,790675333	0,179052714	0,858531252	3,265140224	3,906390783	3,265140224	3,906390783
X3	2,017523626	2,308592199	0,873919451	0,385829309	2,605352511	6,640399763	2,605352511	6,640399763

Source: Results of Research Team Analysis

The results indicate that some interpretations can be proposed. First, with an 'R Square' value of 0.67 (level of correlation between the predictive and factual values of the Y1 variable), it can be interpreted that approximately 67% of the variation in the Y1 value is contributed by variables X1, X2, and X3, and 33% in the Y1 value is contributed by several other variables. Second, the results of the ANOVA test indicate that the Significance F value (probability value) was <0.5, demonstrating that the regression analysis results were statistically significant. Third, the regression analysis results indicate that the coefficient and intercept values of the multivariate regression equation were obtained, mathematically describing the influence of variables X1, X2, and X3 on Y1. The regression equation can be written as follows:

$$Y1 = X1 + 0,32X2 + 2,02X3 - 2,99, \text{ where:}$$

Y1 = Observed Grid Built-up Land Area

X1 = Average Adjacent Grids Built-up Land Area

X2 = Adjacent Grids Slope Score

X3 = Adjacent Grids Road Infrastructure Availability Score

However, since the previous correlation analysis indicated a relatively high intercorrelation among the three independent variables, the prediction of the dependent variable Y (internal grid built-up land) should be based only on the independent variable with the highest determination level. In this case, the variable is X1 (average area of built-up land in adjacent grids). By eliminating variables X2 and X3, the following are the results of a simple linear regression analysis indicating the determination of variable X1 on Y1.

**Table 3.** Results of Stage 2 Regression Analysis

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,816675855
R Square	0,666959451
Adjusted R Square	0,661314696
Standard Error	4,161787759
Observations	61

ANOVA

	df	SS	MS	F	Significance F
Regression	1	2046,511487	2046,511487	118,1556054	1,02992E-15
Residual	59	1021,908164	17,32047735		
Total	60	3068,419651			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	0,713311509	1,717000229	0,415440544	0,679326478	-2,722398012	4,149021031	-2,722398012	4,149021031
X1	1,075011329	0,098897628	10,86994045	1,02992E-15	0,877117632	1,272905026	0,877117632	1,272905026

*Source: Results of Research Team Analysis*

Some interpretations can be made from the results of the regression analysis. First, as in the previous regression, the 'R Square' value of 0.67 indicates that approximately 67% of the variation in the Y1 value is contributed by the independent variable X1, and the remaining 33% is contributed by other variables. Second, the results of the ANOVA test, with a Significance F value of <0.5, indicate the statistical significance of the regression. Third, the coefficient and intercept values for the simple regression equation are also obtained, which can be expressed as follows:

**Y1 = 1,08X1 – 0,71, where:**

Y1 = Built-up Land Area Observed Grid

X1 = Average Built-up Land Area Adjacent Grids



This equation can be observed as the urban sprawl transition rule algorithm, using a land cover condition indicator within the cellular automata grid. It suggests that every one-unit (Ha) increase in the average built-up land area of the four adjacent grids will contribute to an increase of 1.08 units (Ha) of built-up land area of the observed grid, without considering other driving factors.

## **CONCLUSION**

After formulating the problem and research objectives, the results of this study can be summarized as follows:

- 1) In the context of urban sprawl and the cellular automata grid framework, certain neighboring grid cell attributes can be considered as driving factors for variations in built-up land conditions in a particular spatial grid cell. Out of the seven neighboring grid cell attributes considered as driving factors, only three (built-up land conditions, slope gradient, and availability of road infrastructure) were significantly correlated with the built-up land area variable in the observed cell. However, the correlation analysis also indicates a relatively strong intercorrelation between the three variables. As observed in the regression relationship, the three variables cannot be used simultaneously as predictors because they are not statistically independent. Referring to the correlation coefficient value, the most significant predictor variable for variations in built-up land area within a spatial grid cell in the cellular automata framework is the average built-up land area of neighboring grid cells. The other two variables can be regarded as secondary predictors, influencing the outcomes indirectly.
- 2) Conceptually, the urban sprawl transition rule algorithm developed in this study can be expressed as follows.
  - Built-up land or open space in a particular spatial grid was influenced by the condition of built-up land and open space in neighboring grid cells, with a determination level of 67%. The rest were influenced by other driving factors.
  - Every one-unit (Ha) increase in the average area of built-up land or a decrease in an open space area in a group of neighboring cells is followed by the same phenomenon in a particular grid cell, with a quantity of 1.08 units (Ha).
  - The condition of built-up land and open space in each spatial grid cell correlated with the slope conditions and availability of road network infrastructure in the spatial grid cell. The flatter the slope conditions and

the higher the availability of road infrastructure in a spatial grid, the higher the condition of built-up land cover in that cell.

## ACKNOWLEDGMENT

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## DISCLOSURE STATEMENT

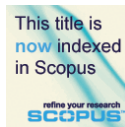
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## **AGILE CITIES: PROSPECTS AND CHALLENGES OF SPATIAL PLANNING FOR URBAN ECONOMIC RESILIENCE IN THE ISLAMIC CULTURAL CONTEXT OF Banda Aceh, INDONESIA**

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### **Abstract**

Urban economic resilience is increasingly critical for cities facing environmental, economic, and social challenges. This study investigates the prospects and challenges of agile spatial planning in fostering economic resilience within the Islamic cultural context of Banda Aceh, Indonesia. Grounded in the agile cities framework, which emphasises flexibility, adaptability, and stakeholder engagement, this research examines how Islamic principles, including social cohesion, environmental stewardship, and public welfare (maslaha) inform urban planning to build resilience. Using a qualitative approach with semi-structured interviews involving 10 key stakeholders and systematic observation, the study identifies key strategies such as flexible zoning, adaptive reuse, and sustained community engagement as prospects to enhance resilience while preserving cultural identity. Nevertheless, challenges remain in balancing tradition with modernity, institutional inertia, and sustaining stakeholder commitment. Findings suggest that integrating cultural heritage with adaptive planning supports sustainable development, positioning Banda Aceh as a potential model for cities seeking to harmonise tradition and modernity. Recommendations include revising zoning regulations for adaptability, fostering continuous community engagement, and utilising digital platforms to improve participation. Future research should examine the long-term impacts of these strategies to further support resilient and culturally cohesive urban development.

**Keywords:** Cultural Integration, Flexible Zoning, Islamic Cultural Values, Spatial Planning, Urban Economic Resilience

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## INTRODUCTION

Urban economic resilience has become a pivotal theme in urban studies, particularly in response to escalating environmental, economic, and social challenges. Resilient cities are characterised by their capacity to absorb, adapt, and recover from disruptions, maintaining core functions and facilitating recovery (Simmie & Martin, 2010). This resilience is especially pertinent for cities like Banda Aceh, which are culturally Islamic and highly vulnerable to external shocks (Haiqal et al., 2019; Ismail et al., 2018). Although factors such as economic diversity, human capital, and governance efficacy contribute to resilience (Zhou & Qi, 2023), research is limited on how spatial planning rooted in Islamic values can strengthen economic resilience within an agile city framework.

The "agile cities" concept advocates flexibility and adaptability in addressing complex urban challenges, encouraging iterative spatial planning, stakeholder engagement, and diverse perspectives (Lukman & Hakim, 2024). While this framework endorses resilience through strategies such as mixed-use development and green infrastructure (Cao, 2023), the influence of culturally specific values, such as those inherent in Islamic urbanism, remains underexplored (Zuraidi et al., 2021, 2022). Understanding how Islamic cultural contexts shape agile spatial planning and resilience in urban settings like Banda Aceh reveals a significant research gap.

In Banda Aceh, Islamic principles of social cohesion, environmental stewardship, and public welfare (*maslaha*) inform the urban landscape, structuring spatial layouts and communal spaces around elements like mosques and markets to foster social bonds and inclusivity (Zuraidi et al., 2020, 2023). Natural landmarks, such as the Krueng Aceh River and the Bustanussalatin Garden, exemplify environmental stewardship, symbolising harmony with nature and enhancing the adaptability of public spaces (Istiqamah & Herlily, 2018). This cultural framework is reinforced by Indonesia's Special Autonomy Law for Aceh (Law No. 18 of 2001), granting Banda Aceh authority to apply *Sharia*-based regulations in urban planning titled *Undang-Undang Republik Indonesia Nomor 18 Tahun 2001 Tentang Otonomi Khusus Bagi Provinsi Daerah Istimewa Aceh Sebagai Provinsi Nanggroë Aceh Darussalam* (2001). This autonomy enables the integration of Islamic principles into spatial planning, aligning urban design with both cultural identity and resilience objectives.

Despite these unique cultural and legal contexts, research is scarce on how Islamic values, when embedded in agile spatial planning, support urban economic resilience in Banda Aceh. This study addresses this gap by examining the prospects and challenges of implementing agile spatial planning within an Islamic cultural framework, specifically investigating how the integration of Islamic principles in Banda Aceh supports or limits urban resilience. This study

offers insights into how Islamic cultural contexts can harmonise with agile city strategies, guiding urban planners in Muslim-majority cities aiming to enhance economic resilience while preserving cultural identity. By exploring the intersection of agile spatial planning and Islamic urbanism, this research presents a model for culturally integrated resilience in urban planning, offering practical implications for cities facing similar challenges in an evolving global landscape.

## **METHODS**

### **Study Area**

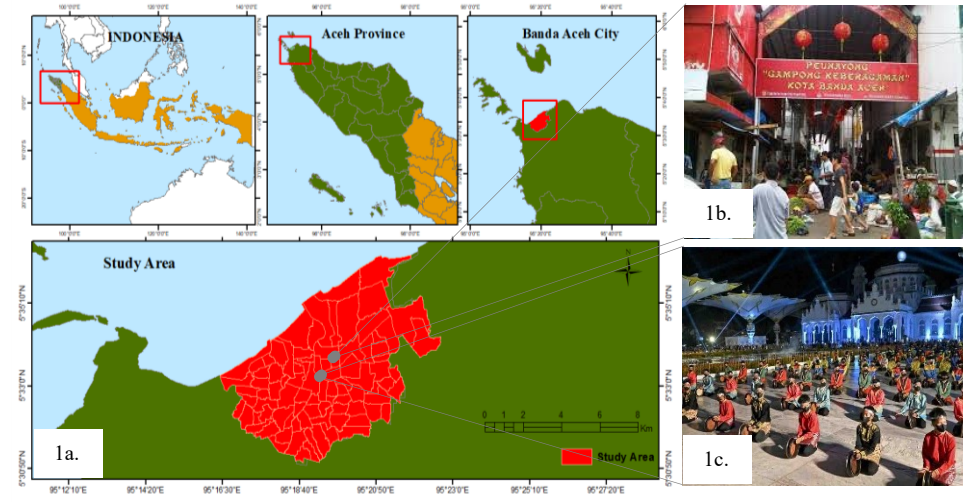
This research was conducted in Banda Aceh, Indonesia, a city characterised by its vulnerability to natural disasters and predominantly Muslim population (Figure 1a.). In 2004, an earthquake and tsunami destroyed approximately 27% of the city's 60.33 km<sup>2</sup> area, leaving extensive structural damage and claiming around 27,000 from a population of 243,895 (Aceh Disaster Management Strategic Plan (2018-2022), 2018). Figures 1b and 1c illustrate Banda Aceh's integration of cultural heritage into its urban landscape. Figure 1a captures *Peunayong* Market during the *Meugang* festival, highlighting its cultural and economic significance, while Figure 1c shows *Mesjid Raya Baiturrahman* hosting a *Rapai Geleng* performance, symbolising its dual role as a religious and cultural venue.

### **Research Design**

This study employed a qualitative approach, ideal for exploring complex social phenomena such as urban resilience within specific cultural contexts. This approach enabled an in-depth examination of how spatial planning aligns with Islamic cultural values, capturing participants' experiences, attitudes, and perceptions (Crewell, 2013). Semi-structured interviews and systematic observation documented both stakeholders' subjective experiences and the objective realities of spatial planning in Banda Aceh.

### ***Semi-structured interviews***

To examine spatial planning and economic resilience in Banda Aceh, purposive sampling was used to select 10 key stakeholders with expertise in urban planning, disaster management, socio-economics, and cultural dynamics within an Islamic framework. This diverse group, including public officials, private sector leaders, and community representatives, provided a comprehensive understanding of urban resilience (Palinkas et al., 2015). Participants were selected based on professional experience, community influence, and sectoral involvement (Table 1). Interviews, lasting 30-45 minutes each, were conducted over several months to gather detailed insights.



**Figure 1:** a) Study Area, b) Peunayong Market, c) Masjid Raya Baiturrahman  
 Source: a) Author (2024), b) Arief Maulana (2017), c) Chaideer Mahyudin/AFP via Liputan6.com (2024)

### ***Systematic Observation***

In addition to interviews, systematic observations were conducted to capture real-time interactions and behaviours in urban spaces, enhancing data depth (Kawulich, 2005). Over three months, the principal researcher observed key sites, including *Peunayong Market* and *Masjid Raya Baiturrahman*, to assess how Islamic cultural values shape urban dynamics and community responses to planning changes. These observations offered a holistic perspective, bridging the gap between stakeholder perceptions and on-the-ground practices.

### ***Triangulation and Data Analysis***

The integration of interviews and observations enabled methodological triangulation, enhancing the study's validity and reliability (Yin, 2018). Thematic analysis identified recurring themes, providing a nuanced understanding of cultural influences on spatial planning (Braun & Clarke, 2006). Comparative analysis was employed to evaluate planning strategies in Banda Aceh, contrasting Islamic urban planning principles with practical applications, particularly regarding flexibility, adaptability, and responsiveness. Table 2 presents ratings for these factors.

**Table 1:** Profile of Stakeholders Interviewed in Banda Aceh

Inf. Code	Profession	Age Range	Year of Exp.	Sector	Selection Criteria
SH1	Urban Planner	40-45	15-20	Public Sector	Expertise in spatial planning, key urban projects
SH2	Disaster Management Specialist	50-55	25+	Disaster Management	Leadership in disaster recovery
SH3	Researcher	45-50	15-25	Research Center	Disaster management research
SH4	Academic	40-45	20	Education	Socio-economic culture, urban resilience expert
SH5	City Council Representative	40-45	15-20	Private Sector	Local governance expertise
SH6	Islamic School Leader	40-45	15-20	Private Sector	Insights on socio-cultural development
SH7	Urban Development Consultant	35-40	10-15	Private Consultancy	Spatial planning and resilience consulting
SH8	Environmental Specialist	45-50	15-20	Public Sector	Sustainable development
SH9	NGO Representative	35-40	10-15	Disaster Risk Reduction	Community resilience, risk reduction
SH10	SME Development Expert	35-40	10-15	Private Sector	Economic diversification, SME support

**Table 2:** Interpretation of the Ratings for Each Factor

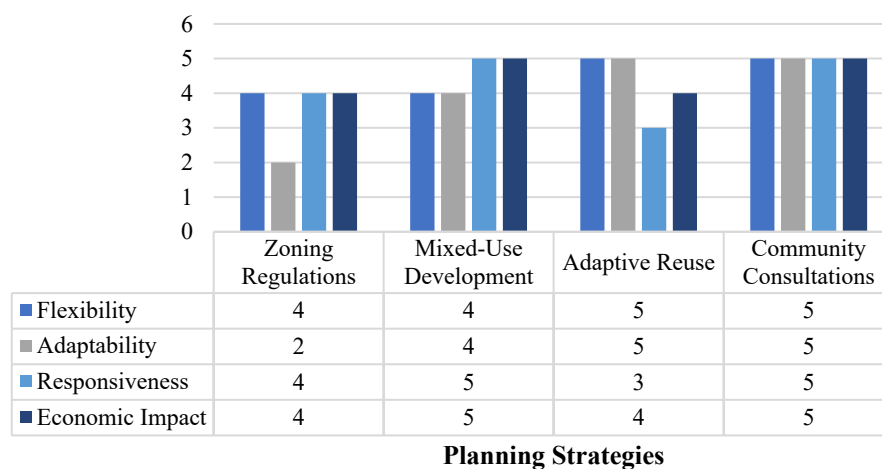
Factor	Low	Low to Moderate	Moderate	Moderate to High	High
Flexibility	Rigid regulations, difficult to modify	Limited adjustments within boundaries	Some adjustments possible	Generally flexible, allows modifications	Quick and efficient modifications as needed
Adaptability	Struggles with unexpected changes	Adapt with significant effort	Can accommodate changes with planning	Adjusts to new circumstances with effort	Easily adapts to new circumstances
Responsiveness	Slow, Feedback ignored	Acknowledges feedback, delayed	Considers feedback, moderate speed	Swift integration, timely action	Proactive, immediate action
Economic Impact	Minimal, may hinder development	Contributes, but not substantially	Supports growth, not transformative	Drives growth, encourages resilience	Significant impact, drives resilience



## RESULTS AND DISCUSSION

### The prospect of Agile Spatial Planning for Urban Economic Resilience in Banda Aceh

The thematic and comparative analyses of planning strategies in Banda Aceh provide insights into their flexibility, adaptability, responsiveness, and economic impact, consistent with existing literature on urban resilience and adaptive planning (Figure 2). From the thematic analysis, five themes emerged:



1= Low; 2= Low to Moderate; 3= Moderate; 4= Moderate to High; 5= High

**Figure 2:** Planning Strategies Comparison

*Source: Author Analysis (2024)*

#### ***Theme 1: Integration of Islamic Values in Urban Planning***

Integrating Islamic principles into urban planning in Banda Aceh is fundamental to enhancing social cohesion and securing community support for new developments. This alignment with cultural values fortifies the social fabric while promoting sustainable practices inherent in Islamic teachings (Awaliyah, 2023). As one urban planner articulated, “*Islamic values like social cohesion and environmental stewardship are foundational. They shape our approach to resilience by fostering a sense of collective responsibility*” (Interviewee SH1). This perspective underscores the critical role of Islamic values in guiding urban resilience strategies, fostering an environment where cultural heritage is preserved alongside economic adaptability.

Literature highlights the importance of culturally inclusive planning for urban resilience, as it respects community values and fosters social cohesion and collective agency. For example, Eren & Henneberry (2022), illustrate how

Istanbul's 'glocalisation' – the blending of local identity with global economic forces – strengthens resilience. Similarly, Founoun et al. (2022), emphasise that resource-efficient or 'frugal' planning approaches, aligned with local culture, are vital in resource-limited contexts. In Banda Aceh, applying these principles supports a resilience model that is both cost-effective and culturally sensitive, ensuring urban development respects Islamic values while adapting to modern challenges.

While some contend that traditional values may hinder modernisation (United Nations, 2019), Banda Aceh's model demonstrates that integrating Islamic values into urban planning aligns development with cultural identity, supporting both economic resilience and continuity. This active incorporation of local values illustrates that cultural identity and innovation can synergise to foster a sustainable and resilient urban environment. By embedding Islamic values into the urban landscape, Banda Aceh preserves its cultural heritage while enhancing its capacity for economic adaptability and environmental stewardship.

### ***Theme 2: Flexibility and Adaptability***

The comparative analysis identifies flexible zoning regulations and adaptive reuse as key strategies for bolstering economic resilience. As Davoudi (2021) observes, resilience planning must accommodate uncertainty through adaptable approaches. Flexible zoning enables cities to quickly adjust land use to accommodate economic shifts without compromising community values. Adaptive reuse, such as the transformation of old markets into multifunctional spaces, further illustrates this adaptability. In Banda Aceh, the old *Peunayoung* market area now hosts a variety of cultural and community activities, including the *Meugang* festival marking Ramadan, the *Barongsai* parade and the 'Peunayoung and Krueng Aceh Festivals,' demonstrating how spaces can serve multiple purposes throughout the year.

Mazlan et al. (2022) found that spatial flexibility and adaptability, particularly in informal economies, are essential for resilience. During the COVID-19 pandemic, businesses in Kuching maintained operations through flexible locations and digital platforms. Similarly, Banda Aceh's adaptive zoning and reuse strategies preserve cultural heritage while meeting evolving economic needs. Zoning regulations in Banda Aceh are rated "moderate to high" in flexibility, though adaptability improvements are required. "*Flexibility in zoning allows us to quickly adapt to changing economic needs without compromising community values,*" noted one expert (Interviewee SH1). Adaptive reuse, rated high in flexibility, efficiently meets new demands, as noted by another expert: "*Repurposing existing structures efficiently meets new demands without extensive new construction*" (Interviewee SH7).

Flexible zoning and adaptive reuse are critical for fostering resilience, allowing cities to respond swiftly to economic changes and community needs (World Economic Forum & Accenture, 2024). Davoudi (2021) also stresses that adaptability is essential for resilience, with these strategies minimising the need for new construction and aligning with sustainable development goals. Mazlan et al. (2022) further emphasise that adaptive strategies, including digital integration, enhance cities' responsiveness to economic shifts. However, excessive flexibility can introduce regulatory uncertainty, potentially deterring investment (V. H. Hoffmann et al., 2009). Banda Aceh's balanced approach, maintaining regulatory stability alongside flexibility, offers a viable model for other cities pursuing resilience.

### ***Theme 3: Community Engagement and Responsiveness***

Effective community consultations have led to planning initiatives that are highly responsive to local needs, achieving high scores across key factors (Figure 2). Observations at community meetings indicated active participation and a diversity of perspectives, resulting in more inclusive planning outcomes. "*Creating platforms for ongoing dialogue with the community is crucial for responsive planning*", stated one NGO sector participant (Interviewee SH9). This continuous engagement ensures that urban planning adapts to the community's evolving needs while cultivating a sense of ownership and cooperation among residents.

Ongoing community engagement is essential for maintaining relevant and effective urban planning (Gagan Deep, 2023). By actively engaging stakeholders, Banda Aceh can promote more inclusive and adaptable planning initiatives, which enhances both the quality of urban development and the community's trust and cooperation – factors essential for long-term economic resilience. Evidence indicates that participatory planning processes often lead to more effective and sustainable urban outcomes (Iamtrakul et al., 2021). However, critics argue that extensive consultations may slow down decision-making and lead to compromises that dilute the effectiveness of planning. Banda Aceh's experience suggests that the benefits of community engagement, including increased relevance and community buy-in, outweigh these potential drawbacks.

### ***Theme 4: Economic Diversification***

Spatial planning strategies that promote mixed-use developments and support small and medium enterprises (SMEs) are key opportunities for economic diversification. Mixed-use development rates highly in adaptability, responsiveness, and economic impact, demonstrating its potential. Observations of mixed-use areas revealed thriving local businesses and active community interactions. As one interviewee noted, "*Mixed-use developments provide a*

*platform for small businesses to thrive and diversify our economy"* (Interviewee SH5). Supporting local businesses, fostering tourism, and developing mixed-use areas help to buffer economic shocks and create a more robust local economy. *"Diversifying our economic base through spatial planning is vital for resilience against economic downturns"* (Interviewee SH10).

Economic diversification through spatial planning is essential for reducing vulnerability to economic shocks (Coulson et al., 2020). By promoting mixed-use developments and supporting SMEs, Banda Aceh can build a more resilient and dynamic economy. These strategies not only generate economic benefits but also enhance social cohesion by fostering vibrant, mixed-use communities (Mbata, 2024). Encouraging tourism and local business development further strengthens economic resilience, offering a buffer against external economic fluctuations (Watson & Deller, 2021). Literature supports the view that a diversified economic base significantly contributes to urban resilience (Cao, 2023). Although some scholars highlight challenges with mixed-use developments, such as congestion and higher infrastructure costs (Lehmann, 2016), the economic benefits observed in Banda Aceh suggest that the advantages of these strategies can outweigh potential drawbacks.

#### ***Theme 5: Infrastructure and Sustainability***

There is a strong alignment between sustainable urban planning practices and Islamic principles. Observations of green infrastructure projects, such as eco-friendly parks and water management systems, underscore benefits for both economic resilience and environmental health. *"Our principles of environmental stewardship align well with sustainable development practices"* (Interviewee SH1). Leveraging Islamic principles that advocate for environmental stewardship and social equity can guide the development of resilient urban environments that are both culturally and economically sustainable. *"By integrating our cultural values with sustainable practices, we can achieve a resilient urban ecosystem"* (Interviewee SH8).

Belaïd et al. (2023) observe that successful smart city initiatives in the MENA region often integrate local cultural values with modern infrastructure, fostering public engagement and long-term sustainability. Applying this approach in Banda Aceh could strengthen sustainable development by ensuring infrastructure respects Islamic principles while embracing modern solutions. This balance fosters a resilient urban model that is both culturally rooted and future-proof. Although initial costs for sustainable infrastructure can be high (Nasereddin & Price, 2021), the long-term benefits—such as reduced environmental impact and improved public health—justify the investment. Studies consistently show that green infrastructure and sustainable planning

significantly enhance urban resilience and environmental quality (Ashinze et al., 2024).

### Challenges of Agile Spatial Planning for Urban Economic Resilience in Banda Aceh

Thematic analysis identified key challenges to agile spatial planning aimed at enhancing urban economic resilience in Banda Aceh. Addressing these challenges requires tailored solutions and policy recommendations, as highlighted by stakeholders during interviews, as summarised in Table 3. The main challenges identified include balancing tradition with modernity, institutional inertia, and sustaining stakeholder engagement.

**Table 3:** Challenges and Solutions

Challenges	Solutions/Policy Recommendations
Institutional Inertia	<ul style="list-style-type: none"> <li>• Develop tailored capacity-building programs for planning institutions.</li> <li>• Establish innovation incubators to nurture and implement new planning methodologies in spatial planning.</li> </ul>
Balancing Tradition and Modernity	<ul style="list-style-type: none"> <li>• Facilitate collaborative design charrettes that bring together traditional and modern stakeholders, fostering integration of cultural aesthetics with contemporary urban design.</li> <li>• Develop adaptive planning guidelines that balance cultural heritage preservation with promoting modern infrastructure needs.</li> </ul>
Maintaining Stakeholder Engagement	<ul style="list-style-type: none"> <li>• Introduce digital engagement platforms to enable real-time feedback and communication.</li> <li>• Organise regular inclusive workshops and forums to support ongoing community participation and transparency.</li> </ul>

*Sources: Author analysis (2024)*

#### Theme 1: Institutional Inertia

Addressing institutional inertia within planning institutions is essential for implementing agile, adaptive planning effectively. While zoning regulations in Banda Aceh allow for flexibility, bureaucratic delays often impede adaptability. Observations of planning meetings revealed slow decision-making, highlighting a need for capacity-building initiatives and policy reforms to encourage innovative practices. *"Institutional change is slow, but with the right training and policies, we can adopt more agile methods"* (Interviewee SH3). Current bureaucratic processes thus challenge the swift adoption of flexible and adaptive strategies.

The challenge of institutional inertia is widely discussed in urban planning literature, with calls for institutional reform to enable adaptive governance (Liu, 2020). The proposed solutions align with prior studies, underscoring the importance of capacity-building and fostering innovation within planning institutions (Healey, 2006). However, while innovation incubators offer

potential, their impact may be limited by broader institutional resistance (Hartono, 2018). Effective reform thus demands comprehensive reforms at multiple governance levels.

### ***Theme 2: Balancing Tradition and Modernity***

Balancing the preservation of Banda Aceh's Islamic cultural heritage with the need for modern economic infrastructure presents a significant challenge. Observations reveal a tension between conserving historical sites and expanding commercial areas. Integrating tradition with modernity is essential for sustaining cultural identity alongside economic growth. One interviewee highlighted this, noting, *"We need to ensure our Islamic heritage value is preserved while we bring in new infrastructure to support economic activities"* (Interviewee SH2). This balance is particularly relevant in mixed-use developments, which must respect cultural contexts while fostering economic activity.

While the need to balance tradition and modernity is widely acknowledged in urban planning literature, Banda Aceh's context presents unique challenges and opportunities. Studies emphasise the role of cultural heritage in enhancing urban identity and supporting tourism (Loulanski & Loulanski, 2011). Collaborative design charrettes, as suggested, align with inclusive planning processes recommended by scholars, who advocate involving diverse stakeholders in decision-making (Kempenaar, 2021). However, the success of such approaches may depend on community engagement levels and the willingness of planning institutions to adopt adaptive methods.

### ***Theme 3: Maintaining Stakeholder Engagement***

Sustaining engagement and consistently integrating feedback throughout the planning process remains a challenge. As one participant stated, *"While initial consultations are thorough, continuous engagement is where we often fall short"* (Interviewee SH4). Developing mechanisms for ongoing feedback and participation, such as digital platforms for continuous communication, could enhance the relevance and effectiveness of spatial planning initiatives. Observations of previous projects showed lapses in follow-up engagement. *"Creating platforms for ongoing dialogue with the community is crucial for responsive planning"* (Interviewee SH9).

The significance of stakeholder engagement in urban planning is well-documented, with studies highlighting its role in fostering trust, legitimacy, and social inclusion. The proposed solutions align with recommendations for participatory planning processes that empower communities and promote transparency (Sulemana, 2016). However, while digital engagement platforms create new opportunities, they may also heighten existing inequalities in access to information and participation (Nations et al., 2021). Thus, meaningful

stakeholder engagement requires a balanced approach that combines online and offline methods, tailored to the local context (C. P. Hoffmann & Lutz, 2014).

## CONCLUSION

This study highlights the importance of integrating agile spatial planning with Islamic cultural values in bolstering urban economic resilience in Banda Aceh. Findings demonstrate that incorporating principles such as *maslaha* (public welfare) and environmental stewardship into urban design promotes social cohesion and multifunctional public spaces, enabling adaptability. Effective strategies such as flexible zoning and the adaptive reuse of existing structures, as illustrated by the *Peunayoung* market area, support a variety of cultural and economic activities. Continuous stakeholder engagement ensures that urban planning remains attuned to community needs, balancing modern economic demands with traditional values.

These findings suggest that combining cultural heritage with adaptive planning can facilitate sustainable urban development, positioning Banda Aceh as a model for other cities with similar challenges. However, a balance between flexibility and regulatory stability is essential to sustain investment confidence. Therefore, it is recommended that zoning regulations be revised to support more adaptable land use, encouraging the adaptive reuse of cultural landmarks within a sustainability framework. Furthermore, maintaining inclusivity and responsiveness through ongoing community engagement, supported by forums and digital platforms, is vital.

Future research should incorporate quantitative analysis to enhance understanding of how agile spatial planning supports urban resilience across diverse contexts. Investigating the long-term impacts of such strategies will further contribute to the development of resilient and culturally cohesive cities. In conclusion, Banda Aceh's experience shows that integrating cultural values with modern planning fosters an adaptable and resilient urban environment, achieving a sustainable balance between tradition and innovation.

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## **AGILE URBAN SYMBIOSIS: STRATEGIC DEVELOPMENT OF HOSUR AS A RESILIENT SATELLITE CITY FOR BENGALURU, INDIA**

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### **Abstract**

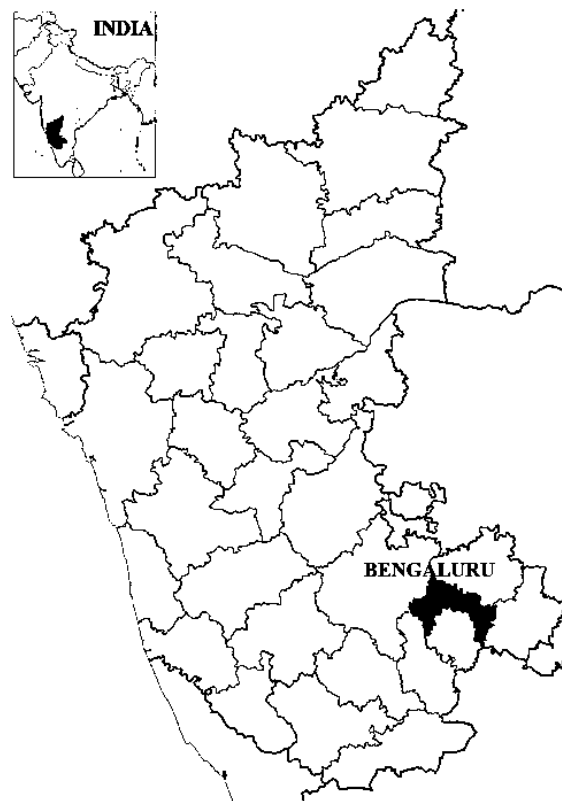
Urban environments exhibit mounting complexity, yet traditional centralized planning methodologies struggle adapting to rapid transformations. An agile approach prioritizes iterative, experimental interventions reconciling short-term necessities and long-term resilience. This paper investigates agile adaptation's potential calibrating secondary municipalities like Hosur, India into sustainable ancillary settlements for major metropolises including Bengaluru. Utilizing Durkheim's organic solidarity concept, diverse, interdependent urban collectives foster social cohesion while enabling flexibility. Through limited pilot initiatives, collaborative governance, and scenario analyses, municipal bureaucracies can nimbly confront uncertainty and evade lock-in to rigid developmental trajectories. Hosur's proximity to Bengaluru engenders opportunities for developing sustainable, habitable auxiliary urban capacity, contingent on reimagining inclusive urban design and infrastructure augmenting resilience, accessibility, and quality of life. This manifests a novel iteration of engineered organic solidarity between municipalities. Though situated in different states, the potential for a symbiotic relationship between Hosur and Bengaluru is contingent on effective intergovernmental collaboration between Tamil Nadu and Karnataka. Adopting an agile paradigm, civic governments can implement adaptive governance addressing immediate needs while expanding prospective options. This empowers equitable enhancement of resilience and sustainability.

**Keywords:** Transformation, Agile City, Organic Solidarity, Reimagine, Contingent.

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## INTRODUCTION

The United Nations projects that 68% of the global population will reside in urban areas by 2050 (United Nations, Department of Economic and Social Affairs, Population Division (2018), highlighting the growing urbanization trend. This is exemplified by Bengaluru, Karnataka's capital, which has reached an estimated population of 12 million in 2024, demonstrating the increasing pressure on urban infrastructure and resources (Figure 1).



**Figure 1:** Location & setting – Bengaluru  
*Source: Wikimedia.org (Edited by Author)*

The metropolitan area of Bengaluru contributes 18 percent to the states' total population (64 million) as per Census of India. The currently operational Revised Master Plan (RMP) 2015 for land use in the Bengaluru Development Authority has increased the area designated for residential purposes from 28.48% in 2005 to 40.07%, while reducing the area allocated for industrial use from 9.65% to 6.80% (Hanumantharaju & Hanjagi, 2018). The Bangalore metropolitan area's expansion from 100 to 600 square kilometers by 2020, driven by

anticipated population growth and housing demand, has severely impacted water bodies and vegetation cover (Manoharan, et al., 2022). This rapid urbanization has led to water shortages while creating urban sprawl as development extends into peripheral areas. The influence of urbanization extends beyond the Bengaluru Metropolitan Area (BMA) and Karnataka's border, as evidenced by Hosur's growth in Tamil Nadu, driven by Bengaluru's proximity. During India's techno boom in the mid-2000s, Hosur served as a satellite town for Bengaluru's Electronic City. The National Highways Authority of India (NHAI) has opened eighty kilometres of the 288-kilometer Satellite Town Ring Road (STRR), an access-controlled motorway around Bengaluru that diverts commercial vehicles from entering the city.

Located 35 kilometres from Bengaluru, Hosur presents unique opportunities for economic and infrastructural integration, pioneering interstate urban collaboration between Tamil Nadu and Karnataka. The city can develop specialized industrial and residential functions supporting Bengaluru's growth, while infrastructure projects like STRR enhance connectivity. This spatial relationship enables resource sharing and distribution of urban pressure across both administrative regions.

This research aims to study if a secondary municipality like Hosur be developed as a sustainable ancillary settlement for a major metropolis like Bengaluru through an agile approach.

Following are the objectives of the research can be identified:

- I. This research aims to analyse how Hosur's geographic proximity to Bengaluru can be strategically leveraged to develop sustainable urban capacity, with a focus on identifying complementary development opportunities and assessing critical infrastructure and connectivity requirements that would benefit both cities.
- II. The study seeks to investigate effective mechanisms for intergovernmental collaboration between Tamil Nadu and Karnataka, specifically focusing on developing frameworks for cross-border urban planning, resource sharing, and identifying necessary policy interventions for seamless integration between the two states.
- III. The research will explore the implementation of an agile urban development approach, emphasizing iterative and experimental interventions through pilot initiatives and scenario planning, while establishing robust feedback mechanisms for adaptive planning and governance.

This research explores sustainable urban development through cross-border governance and agile planning, examining how secondary cities like Hosur can complement larger metropolises, potentially serving as a model for developing nations.

## **THEORETICAL FRAMEWORK**

The Concentric Zone Model (Burgess, 1925) and Multiple Nuclei Model (Harris & Ullman, 1945) remain relevant in understanding Bengaluru's urban growth. The city's expansion, evident in the BMA and BMR boundaries, aligns with the concentric zone pattern, while its diverse nuclei challenge the traditional CBD-centric model.

However, cities like Bengaluru also display VUCA characteristics (Volatility, Uncertainty, Complexity, and Ambiguity), as described by the U.S. Army Heritage and Education Centre in 2018. These VUCA traits, stemming from leadership theories by Warren Bennis and Burt Nanus, pose significant challenges as urbanization continues to grow. The VUCA framework provides a lens for organizations to interpret their challenges and opportunities, emphasizing the need for strategic foresight, insight, and the behaviour of entities within organizations.

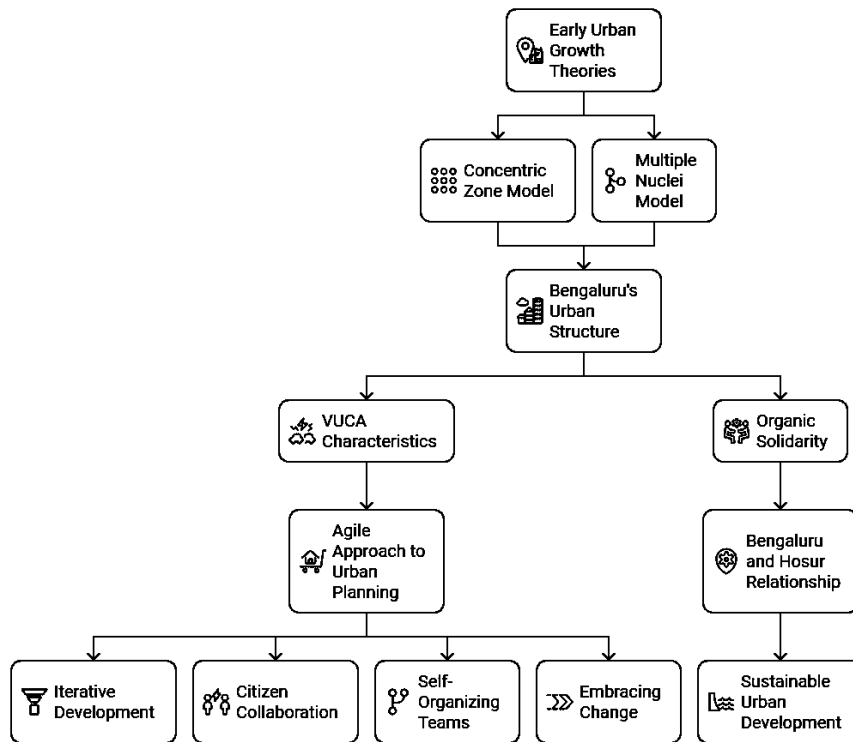
In response to these VUCA challenges, an agile approach to planning and executing urban development becomes increasingly relevant. Agile principles, such as iterative development, citizen collaboration, self-organizing teams, and embracing change and continuous improvement, offer a flexible and adaptable framework for addressing the dynamic and complex nature of urban environments.

Furthermore, the concept of organic solidarity, developed by Émile Durkheim in book *The division of labor in society*, highlights the social integration and interdependence that arises from the division of labor and specialization in modern societies. Vukov et al. (2018) examined organic solidarity in modern urban labor markets, demonstrating how specialized professional networks create intricate social interdependencies in metropolitan environments. This concept can be applied to the relationship between Bengaluru and Hosur, where Hosur can serve as a specialized and interdependent ancillary settlement to the larger metropolis of Bengaluru.

Leveraging classic urban theories (Burgess, 1925; Harris & Ullman, 1945) and the VUCA framework, this research explores the potential of Hosur as a sustainable urban centre complementary to Bengaluru, employing agile urban planning and development. This approach seeks to foster "designed organic solidarities of cities" (Durkheim), where interdependence and specialization between urban centres are actively cultivated.

This theoretical framework (Figure 2) integrates concepts from urban planning, leadership theories, organizational agility, and social

theory, providing a multidimensional lens for exploring the research objectives and developing strategies for sustainable urban development in the context of Bengaluru and Hosur.



**Figure 2:** Flowchart to explain conceptual Framework

Source: Author

## REVIEW OF LITERATURE

The investigation delves into the intertwined dynamics of Bengaluru and Hosur, underscoring the necessity to comprehend their distinct challenges and adaptive strategies, thereby unravelling the potential of symbiotic relationship between these two urban centres.

Bengaluru's shift from utilizing local water sources to depending on distant ones has undermined its capacity to withstand flooding and drought events, emphasizing the critical need for an integrated approach that recognizes the significance of local ecosystems in enhancing urban resilience (P. & Sivapullaiah, 2020). Bengaluru grapples with a significant challenge - stimulating its liveability while catering to the overflowing population. There is an ever-increasing need for housing, physical and social infrastructure. Previously, the city had a diverse land use pattern across multiple sectors. However, it now

exhibits a concentric land use pattern, which primarily extends towards the east and north, giving rise to new suburban areas (Sen, 2013). The city faces challenges in balancing growth and preserving liveability simultaneously.

A second-grade municipality typically refers to Municipal Councils or Nagar Palikas in India, which are municipalities for smaller urban areas or towns with a significant population. Secondary municipalities in India face several challenges due to their transitional nature and limited resources. Hosur, with 0.12 million populations in 2011, has the status of secondary municipality (Hosur Development Plan, 2018). Secondary cities serve as critical economic connectors complementing megacities in a nation's urban network, and spatial planning coupled with local economic development initiatives at the secondary city level plays a pivotal role in promoting balanced regional and national economic growth, as neglecting to enhance their economic functions and linkages can exacerbate regional disparities.

There are two main views on India's pattern of urbanization until the 2000s. The first view (Kundu 1983) says that the distribution of urban population across town sizes was "top-heavy." This means that large towns and cities were the main drivers of urbanization. Small and medium-sized cities barely grew. The second view (Pant and Mohan 1982) believes that the structure of urbanization was roughly balanced. The distribution across town sizes was stable. In summary, one view suggests large cities dominated urbanization. The other view suggests a more balanced growth across town sizes.

The concept of 'agile' describes methods that inherently accommodate necessary changes during execution (Cambridge Dictionary). The "agile city" concept was introduced by Carlos Vaz Marques in 2002. Agile urbanism is a responsive approach to urban development that focuses on incremental, inclusive interventions aimed at involving various stakeholders in producing versatile, adaptive, and context-driven urban changes. While adaptive theory of governance puts focus on joint decision-making and policy adaptation skills (Folke et al., 2005). The concept of an "agile city" can be described as one that achieves resilience, adaptability, and sustainability through flexible infrastructure, innovative governance, and data-driven decision-making (Samzadeh et al., 2013). These principles are particularly relevant for developing Hosur as a sustainable ancillary settlement for Bengaluru, enabling responsive strategies to address emerging challenges and opportunities.

Émile Durkheim's concept of organic solidarity refers to the interdependence and complementarity of diverse individuals and groups within a complex society, fostering social cohesion (Durkheim, 1893). This theory resonates with the research aim of examining the potential for Hosur to serve as a specialized and interdependent ancillary settlement to Bengaluru. Organic solidarity highlights the benefits of division of labor and specialization, which could be achieved by fostering a symbiotic relationship between the two urban



centres. Social cohesion theory further emphasizes the importance of promoting inclusiveness, shared values, and a sense of belonging within urban communities to enhance resilience and sustainability (Jenson, 1998). These concepts could be valuable in shaping strategies for integrating Hosur into the broader urban fabric of the Bengaluru metropolitan region while maintaining social cohesion and a sense of identity.

Resilience theory in urban planning emphasizes the ability of cities to withstand, adapt, and recover from various shocks and stresses, such as environmental, economic, and social challenges (Meerow et al., 2016). This is particularly relevant given the research aim of developing Hosur as a sustainable ancillary settlement, which requires resilience in the face of urbanization pressures and environmental constraints. Sustainable urban development theory focuses on integrating economic, social, and environmental considerations in urban planning to ensure long-term viability and quality of life (Jenks & Jones, 2010). These theoretical perspectives could inform strategies for balancing economic growth, social inclusion, and environmental protection in the development of Hosur as a sustainable urban center supporting Bengaluru.

Inclusive urban design principles emphasize the creation of accessible, equitable, and user-friendly urban environments that cater to the diverse needs of different groups and promote social inclusion (Hamraie, 2017). Infrastructure theory explores the role of physical and social infrastructure in shaping urban development, resilience, and access to essential services and resources (Graham & Marvin, 2001). These theories could provide valuable insights for ensuring that the development of Hosur as an ancillary settlement prioritizes inclusivity, accessibility, and the provision of adequate infrastructure to support a growing urban population while promoting social equity and quality of life.

Intergovernmental relations theory examines the interactions, power dynamics, and coordination mechanisms between different levels of government (national, state, local) in addressing complex policy issues and implementing collaborative initiatives (Wright, 1988). Given that Hosur and Bengaluru are in different states (Tamil Nadu and Karnataka, respectively), intergovernmental collaboration and coordination will be crucial for the successful development of Hosur as a sustainable ancillary settlement. This theory could provide insights into navigating the complexities of cross-state urban planning and fostering effective collaboration between the two state governments and local authorities. A study of Semarang, Indonesia shows that mayoral leadership in disaster resilience needs public-private partnerships to overcome bureaucratic challenges (Budiati, 2017).

Urban Consolidation (UC) has been defined as "the process of increasing and/or maintaining the density of housing in established residential areas to increase or maintain the population densities of those areas" (Smith, 1997). Similarly, researchers have described this phenomenon as "an

intensification of built form and activity within a particular urban area" (Buxton & Tieman, 2005). The concept of "intensification" of urban land, driven by increased pressure on infrastructure and services, remains a recurring concern associated with urban consolidation (Smith, 1997; Buxton & Tieman, 2005).

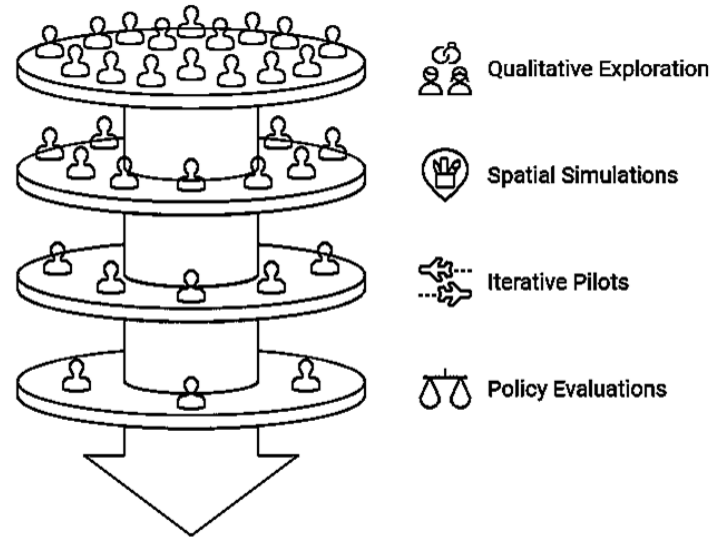
By drawing upon diverse theoretical perspectives, the literature review provides a comprehensive framework for examining the research aim, addressing urban planning, governance, social inclusion, resilience, and intergovernmental coordination in developing Hosur as a sustainable ancillary settlement for Bengaluru.

Flexibility in urban planning allows necessary adjustments to land and built environment utilization. It promotes adaptability and enables modifications as required. New developments should be reversible, low-impact, or adaptable for alternative uses. Many cities have abandoned, unused built assets, demonstrating how failing to plan for temporary, time-bound uses leads to waste. Transitory land uses highlight the need for accommodating change.

## **RESEARCH METHODOLOGY**

The projected exploration path intertwines diverse informational streams, merging subjective and objective approaches to thoroughly probe the viability of sculpting Hosur into a sustainable auxiliary urban cluster complementing Bengaluru's landscape. The impressionistic facet delves into an exhaustive case chronicle, unearthing historical growth narratives, metropolitan tribulations, and prevailing policies through immersive stakeholder involvements and synthesis of primary and ancillary data repositories. Augmenting this qualitative tapestry, spatial simulations and geographic informatics will quantify land utilization motifs, demographic currents, and infrastructural potentials, enabling foresight rooted in data-driven projections.

Iterative pilot undertakings, anchored in the agile urbanism ethos, will serve as experimental crucibles, monitored and refined through inclusive participatory processes. Policy and governance examinations will dissect existing regulatory frameworks, illuminating barriers and openings for intergovernmental synergies between the Tamil Nadu and Karnataka domains. The synthesis crescendo will convergent distil insights across investigative tributaries, forging a holistic stratagem for Hosur's sustainable metamorphosis as an ancillary settlement, encompassing recommendations for urban choreography, infrastructural augmentations, policy evolutions, and institutional architectures.



**Figure 3:** Methodological Funnel for the research

*Source: Author*

The methodology's transdisciplinary essence, interweaving qualitative insights and quantitative spatial analytics with iterative pilots and policy evaluations, aspires to cultivate resilience, organic solidarity, and adaptive governance, culminating in an actionable pathway for symbiotic urban florescence across state demarcations.

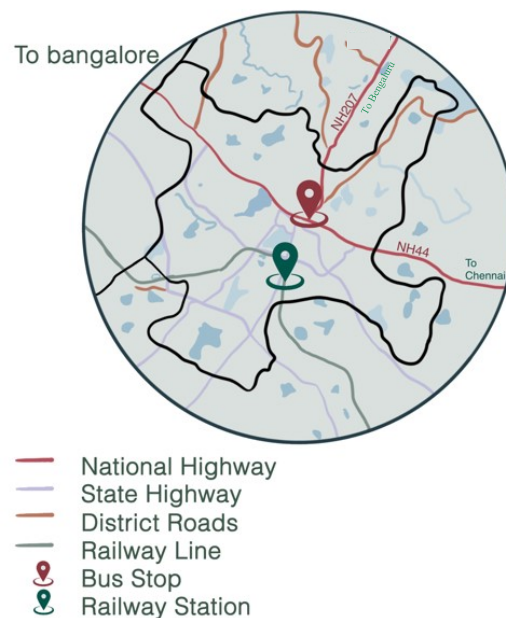
## DISCUSSIONS, ANALYSIS AND FINDINGS

Prior to India's independence, the settlement of Hosur was predominantly rural, with its economy heavily reliant on agriculture and animal rearing practices. In 1962, Hosur was established as a selection grade town panchayat. Subsequently, it was upgraded to the status of a second-grade municipality (Hosur Municipality: Profile and key information). This implies that the town has an annual income below 4.00 crore (Directorate of Municipal Administration, 2024) increasing the necessity to augment the city's revenue streams.

As part of state's industrial growth initiatives, the State Industries Promotion Corporation (SIPCOT) was established in 1971 (Hosur New Town Development Plan, 2022). A city's prospects are inextricably linked to its place within the broader national and global urban hierarchies (Brundtland, 1987). India's technological revolution in the mid-2000s propelled Bengaluru to the forefront, establishing it as a preeminent centre for the information technology and electronics industries. During India's technology boom in the mid-2000s, Bengaluru emerged as a major IT and electronics hub. This rapid growth led to specialized technology parks like Electronic City. A Study of Kaduna analyses

it's mono-centric urban pattern increases traffic and carbon emissions, recommending better urban planning to improve sustainability (Zakka, Permana & Majid, 2017).

With the surging demand for skilled labour and supporting infrastructure, Hosur, a town situated just 35 kilometres from Bengaluru, emerged as a satellite town for the burgeoning Electronic City. Hosur's proximity to Bengaluru and its relatively lower cost of living rendered it an alluring residential and commercial hub, catering to the workforce and businesses associated with the Electronic City (Figure 4). Several IT and electronics companies established operations in Hosur, leveraging its strategic location, talent pool access, and Bengaluru's resources.



**Figure 4:** Bengaluru to Hosur - Connectivity

*Source: 2018 B.Arch. Batch, VSPARC*

It also witnessed an influx of professionals and workers commuting to Electronic City. Its development as a satellite town was facilitated by improved transportation links like expanded road networks and commuter bus services between the two locations (Figure 4). Hosur capitalized on Bengaluru's technology boom by positioning itself as a supporting satellite, providing residential and commercial options while benefiting from the larger city's growth. A study conducted in Malaysia examined urbanization from 1980-2010,

emphasizing natural increase over migration as the primary growth factor (Danial & Williamson, 2022).

This symbiotic relationship got strengthened by the construction of Chennai – Bengaluru Highway in 2001. Bengaluru City was now able to tap into the resources and infrastructure with ease in Hosur, while providing employment opportunities and economic growth for the satellite town. Over time, Hosur evolved into a complementary urban centre, offering residential areas, commercial spaces, and supporting services for the tech workforce employed in Electronic City.

The completion of the longest national highway, NH-7 (now NH-44), in 2023 opened further opportunities for industries. These opportunities arose along the entire stretch of the highway. This stretch runs from Electronic City in Bengaluru to Hosur in Tamil Nadu. The availability of this highway corridor facilitated the establishment of various industries along its path. Further to restrict freight movement inside the city, a plan was proposed to create eight logistic hubs 100 acres. These logistic hubs would be at the periphery of this highway. One of the proposed logistic hubs is on Hosur Road. This hub is meant to serve the industries located in Hosur and surrounding areas. The logistic hub handles freight and goods infrastructure for this region.

Establishing a dedicated logistics hub aims to reduce freight traffic congestion in Bengaluru. By linking Hosur to this hub, the movement of goods and materials for industries in Hosur and surrounding areas will be streamlined. This logistical infrastructure outside Bengaluru's urban core will enhance efficiency, mitigate congestion, and optimize freight transportation via a centralized cargo management facility. The objective is to facilitate smoother logistics operations, easing the city's transportation burden while serving industries' supply chain needs.

The research methodology for developing Hosur as a resilient satellite city employs a transdisciplinary framework, integrating qualitative insights with quantitative spatial analytics. The morphological analysis reveals Bengaluru's transformation from heterogeneous land use patterns to concentrated development, leading to infrastructural stress and ecological degradation (Manoharan et al., 2022).

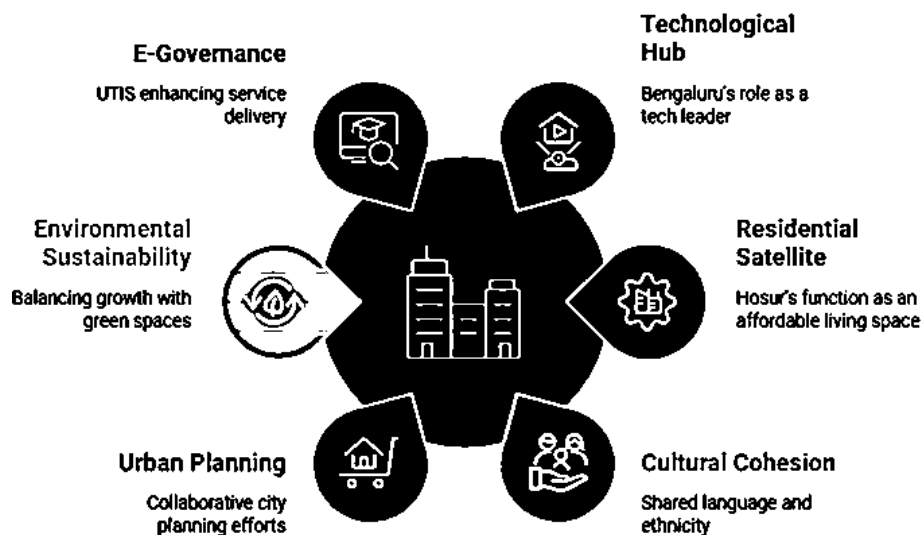
Hosur's strategic location, 35 kilometers from Bengaluru, presents an opportunity for urban symbiosis, enhanced by infrastructural interventions like the Satellite Town Ring Road and NH-44. The theoretical framework synthesizes agile urbanism principles for adaptive planning with Durkheim's organic solidarity concept, fostering socio-spatial integration while acknowledging the VUCA (Volatility, Uncertainty, Complexity, Ambiguity) environment of contemporary urbanization.

The spatial strategy emphasizes environmental stewardship through green infrastructure networks and ecological buffer zones, counteracting the

urban heat island effect and enhancing ecosystem services. The urban fabric is conceived as a dynamic system, responding to demographic flux and evolving infrastructure demands through iterative pilot projects.

The governance framework advocates interstate collaboration between Tamil Nadu and Karnataka, promoting adaptive management through incremental interventions. This approach enables the creation of a resilient urban ecosystem that balances density with livability, fostering sustainable development across administrative boundaries.

Hosur and Bengaluru form a complementary urban partnership, where Bengaluru serves as a technology and business hub while Hosur functions as an affordable residential and industrial satellite town, providing manufacturing facilities and support services that help sustain Bengaluru's economic ecosystem. The relationship between Hosur and Bengaluru exemplifies urban interdependence, with each city focusing on its strengths while supporting the other's needs. Their shared cultural characteristics, including language and ethnicity, facilitate social cohesion. Through inclusive urban planning, equitable resource access, and collaborative decision-making, both cities can foster a unified identity that transcends state boundaries. This interdependent partnership creates a resilient urban system where both communities work together to address challenges and adapt to changes. The complementary roles of the two cities reflect what Meijers and Burger (2017) term as "functional polycentricism," where cities develop specialized roles within a larger urban system:



**Figure 5:** Factors contributing to Urban Interdependence  
*Source: Author*

The Agile City explores how the design and development of buildings and communities can enable cities to rapidly bridge the gap between their current environmental impact and desired sustainability goals. By creating spaces that are more functional, efficient, and aligned with our aspirations, we can transform urban areas into vibrant, eco-friendly environments that meet both our practical needs and our vision for a better future. When two cities engage in a mutually beneficial, symbiotic relationship, it enables them to exhibit agility collectively. If one city experiences deficiencies or shortcomings, the other can alleviate and compensate for those gaps, thereby reducing the strain or distress caused by those deficiencies. This symbiotic dynamic allows the strengths of one city to counterbalance the weaknesses of the other, fostering a responsive and adaptable system that can nimbly address various challenges or lacunae. The Hosur new town development plan- 2046 aims to strike a balance between promoting industrial growth and achieving environmental sustainability. The town plans to preserve blue and green assets Green Belts, Green Barrier to the existing forests, social forestry in vacant government lands, mined areas and on roadsides, etc.

The Urban Tree Information System (UTIS) serves as a sophisticated e-governance solution for Urban Local Bodies in Tamil Nadu, particularly implemented in Hosur Town, offering citizens seamless access to services through multiple channels while ensuring efficiency, transparency, and reliability in service delivery. The platform not only democratizes access to essential services for residents but also maintains high standards of accuracy and affordability, allowing citizens to engage with governmental services at their convenience from any location. Beyond citizen services, UTIS streamlines internal administrative procedures and departmental functions, facilitating effective enforcement of regulations and enabling smooth intergovernmental operations (G2G) between Hosur and Bengaluru, demonstrating its vital role in fostering cross-jurisdictional urban governance.

## **PILOT STRATEGIES & RECOMMENDATIONS**

The development of Hosur as a strategic satellite town showcases an integrated approach to managing Bengaluru's urban expansion. The proposed Satellite Town Ring Road (STRR) will connect 12 major towns around Bengaluru, with Hosur serving as a crucial node in absorbing industrial and workforce pressures from the metropolis. The planned metro rail link between Bommasandra and Hosur represents a significant pilot initiative, with the Tamil Nadu government recognizing its potential to boost Hosur's industrial growth, which already hosts over 2,000 MSMEs. As part of the "Golden V" region, Hosur's rapid population growth has necessitated thoughtful expansion strategies, leading to the proposal of a satellite township at Chandapura, strategically located 16 km away between Hosur and Electronic City. This development approach mirrors successful models like the greater Minsk metropolitan area in Belarus, where satellite cities are

functionally organized to complement the main city's economic characteristics, creating a sustainable urban ecosystem that benefits both regions.

#### Conclusions

Developing secondary municipalities like Hosur as sustainable ancillary settlements for major metropolises like Bengaluru offers a promising approach to address urban challenges. Through an agile paradigm involving iterative interventions, collaborative governance, and scenario analysis, cities can nimbly adapt to rapid transformations. Fostering a symbiotic, interdependent relationship between Hosur and Bengaluru, rooted in Durkheim's organic solidarity concept, can promote social cohesion while enabling flexibility.

Effective intergovernmental collaboration between Tamil Nadu and Karnataka is crucial for realizing this vision across state boundaries. Pilot initiatives like the Satellite Town Ring Road and metro rail connectivity can catalyse sustainable urban development in Hosur. Prioritizing inclusive urban design, resilient infrastructure, and resource preservation should underpin planning efforts.

Fostering a symbiotic relationship between Hosur and Bengaluru based on complementary roles and mutual interdependence can create a cohesive urban collective that is economically vibrant and socially resilient. By promoting inclusive planning, shared values, and participatory governance, this interdependent system can leverage the strengths of both cities to address challenges and drive sustainable urban development.

Ultimately, embracing an agile, adaptive approach empowers equitable enhancement of urban resilience and long-term sustainability in the face of mounting complexities. Reimagining the relationship between core cities and satellite towns holds transformative potential.

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## **INVESTIGATING FACTORS INFLUENCING RESIDENTIAL LOCATION CHOICE USING PLS-SEM ANALYSIS: A CASE STUDY IN SEBERANG PERAI, PENANG, MALAYSIA**

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### **Abstract**

Individuals often select their residence based on the availability of land and housing on the market and by taking into consideration of various factors involved. This is known as residential location choice. The inconsistency in earlier studies regarding modelling residential location choice persists despite numerous attempts made from a multidisciplinary background. As a result, it is difficult to understand the factors influencing residential location choice. By using PLS-SEM, this study seeks to understand the factors influencing residential location choice. Four hundred eighty-four heads of household in Seberang Perai provided primary data for the study. SMART-PLS software version 3.0 was used to assist in the PLS-SEM analysis. The results showed that social relations, neighbourhood features, and housing quality are the significant factors influencing residential location choice in Seberang Perai. These results serve as a guide for future research that considers variables from the economic, geographical, and social perspectives when examining the factors that influence residential location choice. A model of residential location choice that considers social, geographical, and economic factors can assist in creating agile cities by enabling planners to design flexible, inclusive urban environments that adapt to changing needs and conditions.

**Keywords:** PLS-SEM, Residential Location Choice, Accessibility, House Quality, Layout, Neighbourhood Feature, Social Relations

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## **INTRODUCTION**

Presenting a household's preferred spatial location and suggesting policy implications for future housing construction are two common uses of residential location choice modelling (Jin & Lee, 2017). By modelling residential location choice, researchers may get an extensive comprehension of household behaviour and the factors that influence decision-making. Moreover, modelling assists in depicting the characteristics and spatial diversity of locations.

Previous research on modelling residential location choice has been inconsistent, despite numerous attempts made from a multidisciplinary background. Economically, the development of bid rent models (Ellickson, 1981; Hurtubia et al., 2010) and utility maximization (Alonso, 1960) primarily incorporated key economic elements. On the other hand, modelling residential location choice was focused on geographical perspectives such as spatial interaction (Lowry, 1964), spatial parameters (Evans, 1973; Muth, 1969), and interaction with transportation (Pagliara et al., 2010) while from a social perspective, life cycle parameters are the focus (Lawton et al., 2013; Rossi, 1955).

Due to this issue, research on the household's choice of residential location has been negatively impacted, leading to differing interpretations of the findings depending on the methodology employed. The phenomena will remain incomprehensible, rendering it unfeasible to effectively utilise the crucial data derived from modelling the decision-making process. The data are related to the selection of residential sites by many stakeholders, including household, developers, and authorities.

Therefore, this study aims to investigate factors influencing residential location choice from various perspectives to provide a more comprehensive framework of modelling the factors from various social, geographical and economic perspectives.

Understanding the factors that influence residential location choice and developing a model that integrates the factors from various perspectives is becoming more crucial. This is particularly true when cities are more inclined towards creating agile cities. This kind of model allows for a thorough comprehension of the ways in which a variety of elements, such as links to the community, the environment, and economic prospects, influence people's decisions about where to reside. Urban planners may create more adaptable communities to changing circumstances by considering these interconnected dimensions, ensuring that housing, services, and infrastructure align with the desires of locals and the reality of the economy. This all-encompassing strategy increases the flexibility, inclusiveness, and adaptability of urban surroundings, which in turn increases the general agility and resilience of the city.

## LITERATURE REVIEW

### Residential Location Choice

When choosing a residential location, a decision-maker can choose from a number of possibilities (based on the evaluation of various options), even if those options do not entirely solve their problem (Aliyu et al., 2018). In reality, selecting a residential location involves making decisions about location and density depending on a number of trade-offs (Michal and Bartlomiej, 2017). Nkeki and Erimona (2018) state that households make decisions based on their needs and preferences when they are in the scenario.

### Factors Influencing Residential Location Choice

Various factors have been identified in previous literature as influencing the selection of residential locations. The compilation of factors is listed in Table 1.

**Table 1:** Factors Influencing Residential Location Choice from Previous Studies

Variable	Dimension	Source
Accessibility	Work/school	(Pagliara et al., 2010)
		(Kim et al., 2005)
		(Karsten, 2007)
		(Lawton et al., 2013)
		(Beckers & Boschman, 2017)
		(Huri et al., 2024)
	Shopping opportunities	(Acheampong & Anokye, 2013)
		(Prashker et al., 2008)
		(Chiarazzo et al., 2014)
		(Weisbrod et al., 1980)
		(Rosli, Bakar, et al., 2024)
		(Rosli, Samat, et al., 2024)
	Recreation opportunities	(J. Guo & Bhat, 2001)
		(Kim et al., 2005)
		(Schirmer et al., 2014)
		(Beckers & Boschman, 2017)
		(Pagliara et al., 2010)
		(Karsten, 2003)
House quality	House price	(Ramli et al., 2024)
		(Karsten, 2007)
		(Pinjari et al., 2009)
		(Mohd Thas Thaker & Chandra Sakaran, 2016)
		(Karsten, 2007)
		(Usman et al., 2015)
		(Liu et al., 2018)
		(Wang et al., 2016)
		(Chiarazzo et al., 2014)
		(Weisbrod et al., 1980)
		(Yeap & Lean, 2020)
		(Zhao, 2018)
		(Acheampong & Anokye, 2013)
		(Habib & Miller, 2009)
	House size	(Balbontin et al., 2015)
		(Adedire, 2017)
		(Choudhury & Ayaz, 2015)
		(Lawton et al., 2013)
		(Hurtubia et al., 2010)
		(Zhou & Kockelman, 2008)
		(Saw & Tan, 2014)
		(Mohd Thass Thaker & Chandra Sakaran, 2016)
		(Srour et al., 2002)
		(Clark & Huang, 2003)
		(Nurizan, Y., & Hashim, 2001)
		(Habib & Miller, 2009)
		(Evans, 1973)
		(Hu & Wang, 2017)
		(Hirt, 2007)
		(Kohler, 2013)
		(Pagliara et al., 2010)
		(Stokenberga, 2019)
		(J. Chen et al., 2008)

Variable	Dimension	Source
Layout	Design and style	(Chiarazzo et al., 2014) (Rachmawati et al., 2019)
	Single and mixed layout, population density, land use	(Hurtubia et al., 2010) (Beckers & Boschman, 2017) (J. Guo & Bhat, 2001) (Jin & Lee, 2017)
Neighbourhood feature	Closeness to facilities and amenities	(Nurizan, Y., & Hashim, 2001) (Hurtubia et al., 2010) (Dissart, 2018) (Gbakeji & Magnus, 2007) (Habib & Miller, 2009) (de Palma et al., 2005) (Schirmer et al., 2014) (Cao, 2008) (Chiarazzo et al., 2014) (Prashker et al., 2008)
		(Usman et al., 2015) (Acheampong, 2018) (Aliyu et al., 2018) (Edwin et al., 2008) (Balbontin et al., 2015) (J. Guo & Bhat, 2001) (Lo & Jim, 2010) (Luttik, 2000) (Pagliara et al., 2010) (Zhu et al., 2017)
		(Guerra, 2015) (De Vos et al., 2016) (Liao et al., 2015)
		(Ewing & Cervero, 2010) (Zhao, 2018)
		(Chapman, D.W. and Lombard, 2006) (Chiarazzo et al., 2014) (Pagliara et al., 2010) (Teck-Hong, 2011)
		(Hirt, 2007) (Acheampong & Anokye, 2013) (Acker et al., 2014) (Schirmer et al., 2014) (Habib & Miller, 2009)
Social relation	Friends and family, same ethnicity	(Morrow-jones, 2008) (Cao, 2008) (Karsten, 2007) (Lang & LeFurgy, 2007)
		(Mohd Thas Thaker & Chandra Sakaran, 2016) (Acker et al., 2014) (Schirmer et al., 2014) (Aliyu et al., 2018)
		(Farrell et al., 2004) (Ahmad, 1992) (Gilbert & Gugler, 1982) (Kapoor et al., 2004) (Gabriel & Rosenthal, 1989) (de Palma et al., 2005) (Z. Zhang et al., 2018) (Nkeki & Erimona, 2018) (Acheampong & Anokye, 2013)
		(Wang et al., 2016) (Aliyu et al., 2018) (Dökmeci et al., 1996) (Limbumba, 2010b) (Stokenberga, 2019) (Guidon et al., 2019) (Fisher et al., 2007) (Acheampong, 2018)

*Source: Author's compilation*

## MATERIALS AND METHODS

This research employed a quantitative methodology. Primary data was gathered using a 5-point Likert scale in the survey that was conducted in Seberang Perai district, in which was chosen due to the areas experienced most rapid physical transformation from agricultural into built areas, with 33.8% of the area is

classified as saturated built-up areas and is dominated by residential Samat & Mahamud (2017). Figure 3.2 below shows the location of the study area.



**Figure 1:** Study area

In Structural Equation Modelling (SEM), the measurement scale does require special consideration to guarantee that it will meet the equidistance condition, which is required for some analytic methodologies, including SEM (Hair, Jr. et al., 2017). According to Hair, Jr. et al., (2017), the most appropriate method for SEM is to use a 5-point Likert scale because the "distance" between Categories 1 and 2 is equal to that between Categories 3 and 4.

There are five (5) measuring constructs for the independent variable: Accessibility, House Quality, Layout, Neighbourhood Feature, and Social Relations. There are (9) nine indicators for the accessibility construct, (5) five for house quality, (2) two for layout, (9) nine for neighbourhood features, and (2) two for social relations. Residential location is the study's dependent variable, and it has three (3) indicators. Table 2 displays the variable, construct, and its indicators.

**Table 2:** Variables, constructs, and the indicators

Variable	Construct	Indicator
<b>Independent Variable</b>	Accessibility (9)	Access to partner's work
		Access to quality school
		Access to shopping centre/mall
		Access to shops and services
		Access to sports and recreation facilities
		Access to public transport services
		Access to eating places
		Access to cultural/entertainment venues
		Access to cultural/entertainment venues
	House Quality (5)	House price/rent
		Floor space
		Land space
		Number of rooms/bathrooms
		Design and feature
	Layout (2)	Single land use
		Mixed land use
	Neighbourhood Feature (9)	Closeness to highway
		Closeness to public transport
		Closeness to public facilities
		Closeness to sports and recreation facilities
		Ease of private vehicle
		Ease of walking
		Ease of cycling
		Cleanliness/Pollution
		Safety/security
	Social Relations (2)	Friends/family
		Same ethnicity
<b>Dependent Variable</b>	Residential Location (3)	House location
		House type
		House Ownership

## ANALYSIS AND DISCUSSION

To analyse the 484 valid responses gathered, this study used the Partial Least-Square of Structural Equation Modelling (PLS-SEM).

### PLS-SEM Analysis

This study's analysis was all carried out with SmartPLS 3.0. The variables Accessibility (ACCESS), House Quality (HQ), Layout (LAYOUT), Neighbourhood Feature (NF), and Social Relations (RELATIONS) comprise the five constructs that form the model of the study. Figure 2 shows the initial PLS path model and Table 3 shows the path coefficient for each construct.



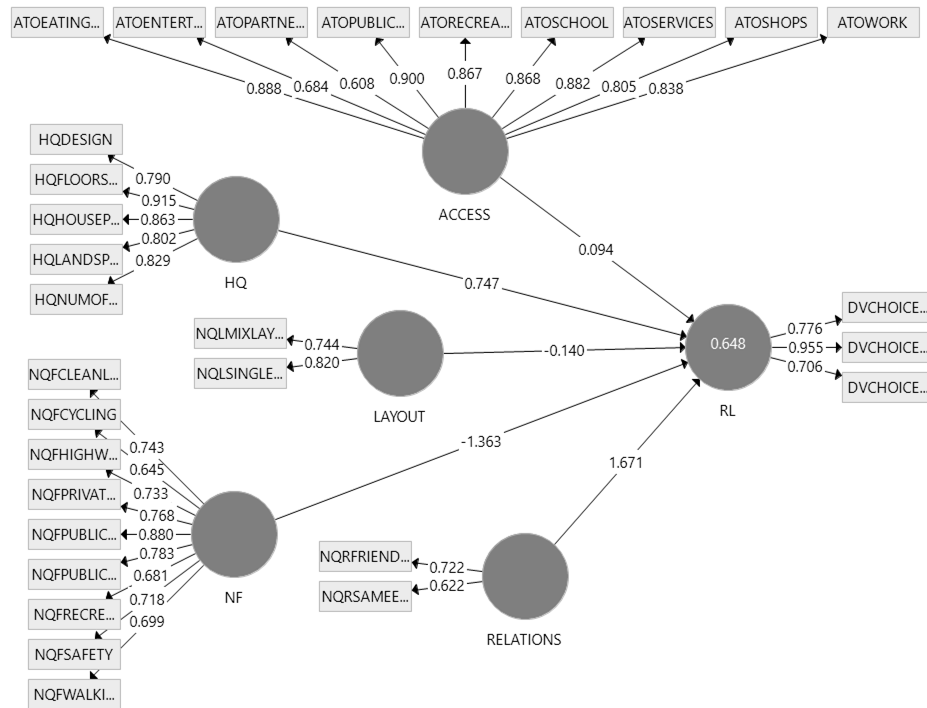


Figure 2: PLS Path Model

Table 3: Results of PLS Path Model

Construct	Path Coefficient	Number of items
Accessibility	0.094	9
House Quality	0.747	5
Layout	-0.140	2
Neighbourhood Feature	-1.363	9
Social relations	1.671	2

Source: PLS-SEM Analysis

### Reflective Measurement Model Assessment

Assessing the reflective measurement model determines the internal consistency reliability, convergent validity (Indicator Reliability through Outer Loadings and Average Variance Extracted (AVE), and discriminant validity for each construct.

#### a) Internal consistency reliability

Internal consistency reliability is the high value resulting from high item correlations. Higher values correspond to higher correlations, which in turn

indicate stronger reliability. The values fall between 0 and 1. Hair, Jr. et al., (2017) state that composite reliability values between 0.60 and 0.70 are appropriate for exploratory research, while values between 0.70 and 0.90 are deemed satisfactory in more advanced stages of the study. Values above 0.90, particularly above 0.95, are deemed undesirable as they are likely to measure the same situation and are unlikely to be valid as the construct's item.

b) Convergent validity

A high correlation between one item and other substitute items of the same construct is referred to as convergent validity (Hair, Jr. et al., 2017). Every item in a reflective construct should measure the same component of the construct. According to Hair, Jr. et al., (2017), in order to assess convergent validity, it is necessary to monitor the values of Average Variance Extracted (AVE) and outer loadings (to check for indicator reliability).

b) (i) Indicator Reliability

The constructs' outer loadings' value provides insight into the reliability of the indicators. A construct with a higher outer loading value, where all related indicators consistently reflect the same construct and measurement, is referred to as indicator reliability. Hair, Jr. et al., (2017) also argue that it is generally accepted that a substantial outer loading threshold is one that is equal to or more than 0.708.

All the constructs were reflective in this study. House Quality and Layout constructs had all their outer loadings well above the 0.708 criterion, but not those of Accessibility, Neighbourhood Feature, or Social Relations. Two indicators of accessibility—Access to Entertainment (0.684) and Access to Partner's Work (0.608)—had values below the cutoff. Three indicators of neighbourhood features—walking (0.699), cycling (0.645), and recreation (0.681)—had values below the cutoff. One social relationship indicator, Same Ethnicity (0.622), is below the threshold.

Indicators with extremely low outer loadings—below 0.40—should permanently be eliminated from the build, according to Hair et al., (2011). But before being eliminated, the loadings over 0.40 and below the cutoff value of 0.708 were thoroughly inspected in accordance with Hair et al.'s (2011) suggestions for the indicator deletion criteria based on outer loadings. Analysis of the effect of removing the indicators on the composite reliability value is required for the indication with outer loadings above 0.40 and below 0.708. Remove the indicator if doing so raises the composite reliability value. Keep the indicator inside the construct if it does not rise.

Only two indicators—Access to Entertainment and Same Ethnicity—were kept in the model after all indicators that scored lower than 0.708 and higher than 0.40 were eliminated. Table 4 summarises the analysis of the removal of the indicators.

**Table 4:** The analysis of the deletion of the indicators

Variable	Items below 0.70	Composite reliability value if delete	Items status
Accessibility (composite reliability = 0.948)	A to partner's work (0.608)	0.945 (not increase)	retain
House quality (composite reliability = 0.923)	-	-	No items deleted
Layout (composite reliability = 0.760)	-	-	No items deleted
Neighbourhood feature (composite reliability = 0.916)	Nqf cycling (0.645)	0.911 (not increase)	Retain
Social relations (composite reliability = 0.623)	Same ethnic (0.622)	1.000 (increase)	delete

b) (ii) Average Variance Extracted (AVE)

As the total of the squared loadings divided by the number of indicators, Average Variance Extracted (AVE) is a frequently used metric to demonstrate convergent validity at the measurement model level (Hair, Jr. et al., 2017). AVE stands for a construct's similarities. As a result, the variance explained by the indicators inside a construct increases with a larger AVE value. Hair, Jr. et al., (2017) state that an ideal AVE value is 0.50 or above.

All constructs in this study had AVE values above the minimal value necessary (0.50) with accessibility (0.706), house quality (0.708), layout (0.613), neighbourhood feature (0.550), and social relations (1.000). This suggests strong convergent validity among all the reflective constructs in this study.

c) Discriminant validity

When determining if a construct is more distinctive than others in terms of accurately representing a phenomenon in a model, discriminant validity should be employed. To what extent a construct is genuinely different from other constructs in the model can be determined by looking at the value of discriminant validity (Hair, Jr. et al., 2017) One can assess discriminant validity using the Heterotrait-Monotrait ratio of correlations (HTMT), which is a more dependable method than the Fornell-Larcker criterion.

According to Hair, Jr. et al., (2017), HTMT is the ratio of the between-trait correlations, which belong to a different construct called heterotrait-heteromethod correlations, to the within-trait correlations, which belong to the same construct called the monotrait-heteromethod correlations. According to (Henseler et al., 2015), discriminant validity is absent the closer the value gets to approaching 1. Although 0.90 is the recommended threshold value, 0.85 would be a more prudent choice. Except for Layout (0.852), which is somewhat above the cautious threshold value of 0.85 but still below 0.90 and acceptable, all the HTMT values in the results are lower than 0.90. The HTMT ratios for accessibility, house quality, neighbourhood features, and social relations are 0.334, 0.573, 0.613, and 0.562, respectively.

### **Structural Model Assessment**

The most crucial aspect of the structural model assessment is analysing the connections between the constructs as well as the model's predictive ability (Hair, Jr. et al., 2017). Collinearity assessment, significance and relevance,  $R^2$  (explanatory power), and  $f^2$  (effect size for exogenous latent variable) make up the assessment.

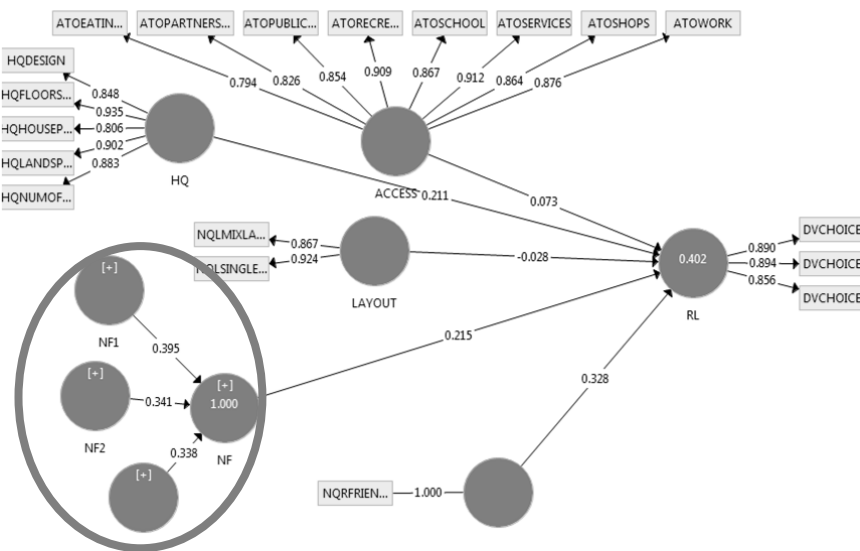
#### **a) Collinearity assessment**

Variance Inflation Factor (VIF) value is observed to see if there are any collinearity problems. The collinearity increases with the VIF value. VIF values greater than five suggest the possibility of a collinearity issue (Hair et al., 2011).

Apart from neighbourhood characteristics, which have a VIF value of 5.542, all constructs have values below the threshold of 5. This suggests that the neighbourhood feature construct—also referred to as the method bias—has a collinearity problem or issue. It is necessary to address the collinearity issue before moving on to the subsequent analysis. To address the collinearity problem, the researcher must either create higher-order constructs or eliminate the constructs by combining predictors into a single construct (Hair, Jr. et al., 2017). Since the higher-order constructs approach effectively addresses the collinearity problems for the neighbourhood feature construct, it was selected for this investigation. Prioritization of one approach over another has not been stated in the prior study. The procedure can be utilized to address the issue and move on to the other analysis if it addresses the collinearity issues.

To address the collinearity problem in the neighbourhood feature construct, the Higher Order Construct, also known as the Higher Order Component (HOC), was developed. The HOC for the neighbourhood feature construct is shown in Figure 2 below, and Table 4 displays the VIF value result following the creation of the HOC. The neighbourhood characteristics' VIF value

decreased from 5.542 to 3.172 in Table 5 below, and it is currently below the five-point threshold. This suggested that the collinearity problem had been resolved.



**Figure 2:** HOC for neighbourhood feature

**Table 5:** VIF value after HOC created

Construct	VIF (<5)
Accessibility	1.223
House Quality	1.736
Layout	2.048
Neighbourhood Feature	3.172
Social relations	1.579
Construct	VIF (<5)

Source: PLS-SEM Analysis

#### b) Significance and relevance

The path coefficients were used to estimate the structural model relationship. According to Hair, Jr. et al., (2017), the path coefficients have a value between -1 and +1. The stronger the link, the farther the value is from zero. Stronger effects on the endogenous variable are indicated by a larger coefficient value deviating from zero (Hair, Jr. et al., 2017). P values were examined for every construct.

Neighbourhood feature (0.344), followed by social relations (0.339) and house quality (0.215), is the strongest influencer, according to the values of the path coefficients. At 0.060, accessibility is the least significant factor. Apart from layout, all factors are positively correlated with residential location. The only determinant with an inverse relationship with the endogenous variable, residential location, is layout (-0.131).

A relationship's significance is determined by its standard error, which is determined by bootstrapping and provides the t and p values (Hair, Jr. et al., 2017). The p-values show that there is a substantial association between House Quality → RL, Neighbourhood Feature → RL, and Social Relations → RL, but not between Layout → RL and Accessibility → RL.

c)  $R^2$  (explanatory power)

According to Hair, Jr. et al., (2017), explanatory power ( $R^2$ ) is a measure of how well the model predicts the future. It is also the total of the effects of exogenous factors on the endogenous variable. The study's  $R^2$  value is 0.470. This shows that the study's constructs accounted for 47% of the endogenous variables (residential location).

d)  $f^2$  (effect size for exogenous latent variable)

According to Hair, Jr. et al., (2017), the effect size  $f^2$  is the result of eliminating a particular exogenous construct from the model and its effect on the endogenous construct. Here is how the  $f^2$  value is calculated:

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

The formula can be used to determine the values of  $f^2$  for each exogenous variable. It may be computed automatically in SmartPLS 3.0. (Cohen, 1988) classed 0.02, 0.15, and 0.35 as minor, medium, and large effects in their guidelines for determining the value of  $f^2$ . According to this study, accessibility (0.005) and layout (0.009) have no significant effects on the residential location of households' residential location in Seberang Perai, which is consistent with all the results discussed in the previous sections. House quality (0.043), neighbourhood feature (0.041), and social relations (0.130) have only minor effects. Thus, these findings showed that while accessibility and layout had little bearing on where households in Seberang Perai resided, housing quality, neighbourhood characteristics, and social relationships did, albeit to a minor extent.

## CONCLUSION

The primary goal of this study is to model the factors influencing residential location choice from economic, geography, and social aspects to gain a more thorough understanding of the issues. Moreover, the created model offers more thorough frameworks that offer comprehension from a holistic viewpoint by considering all elements from potentially disparate perspectives.

This model shows that only three factors—house quality, neighbourhood features, and social relationships—significantly influence residents' choice of residential location in Seberang Perai. The developed model will serve as a good foundation for future research, either by reproducing it in other contexts (urban and peri-urban areas may yield different results in terms of significance) or by identifying additional variables that may have an impact on the choice of residential location and incorporating them into the model to make it more comprehensive and holistic.

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## **HOSPITAL FIRE SAFETY MANAGEMENT COMPONENTS**

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### **Abstract**

Hospital fire safety is one of the many important elements of safety in hospitals. The fire safety management is vital to have a proper response to the fire. The research aims to study the hospital's fire safety management and determine the most important elements of this topic. The methodology used for this research is qualitative research using semi-structured interviews with four participants. The qualitative analysis used is thematic analysis was used to present the themes of the fire safety management using NVIVO software. The findings of this study provided 7 themes for the safety management.

**Keywords:** Fire Safety Management, Thematic Analysis, Hospital, Fire Safety, and NVIVO Software.

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## **INTRODUCTION**

Hospitals are one of the most vital facilities in society as they hold many vulnerable people, the safety of the hospital structure and the occupants inside is an important aspect in the operation of the facility, hospital safety has many aspects to look at, fire safety is one of the important aspects in its safety. Many fire accidents have happened in hospitals around the world, which led to the investigation of why it happens and how to face this phenomenon, according to Liu et al. (2023), on July 13, 2021, at Al-Hussein Hospital, Iraq At least 92 people were killed and dozens wounded in a fire incident, on Sept. 9, 2021, A COVID-19 hospital, North Macedonia a fire incident killed 14 people, on Jan. 29, 2022, a state-run hospital, India a fire incident killed one COVID-19 patient. According to Jiang et al. (2014), On Dec.9th, 2011, more than 90 people died in a fire in India. According to Jaafar et al. (2021), between 2014 and 2015, 40% of fire-related deaths were caused by gas or smoke.

From these accidents and the casualties shown in old data, there must be actions done to minimize and prevent the number of fire incidents and casualties, that is where the terms of fire safety and fire safety management come into use, according to Ebekozi et al. (2021), Fire safety management is the process by which an officer is in control of policy, standards, instruments, details, and procedures to evaluate and monitor fire safety, as fire safety is the measures that are been taken to prevent or lessen the likelihood of fire during unintentional or deliberate fires. Which leads this research to investigate how these goals can be achieved.

## **LITERATURE REVIEW**

Fire safety management is a measure that describes how a facility runs in terms of the policies, procedures, and tools used to prevent fires and boost credibility by promoting the health and safety of hospital buildings is called fire safety management (Agus Salim et al., 2023). Ebekozi et al. (2021), stated that fire safety management is the implementation of fire safety procedures, where a fire safety officer is in control of policies, criteria, data, and practices such as assessing and supervising fire safety. Multiple fire safety organizations have conducted research and implemented fire safety management, the goal of fire safety management is to lessen the possibility of property loss and human injury as a result of a structure fire (Sanni-Anibire & Hassanain, 2015).

There are three main goals for fire protection, prevent combustion of construction elements and objects is the first goal, which is done by Managing sources of ignition, the second goal is to monitor fire growth, which includes using heat, smoke, and flame indicators to find fires, finally to safeguard the vulnerable is the third goal, this entails informing the building's inhabitants (Sanni-Anibire & Hassanain, 2015). The hospital's capability to endure harmful conditions is influenced by several factors, including the building's position,

design specifications, components used, fire control and extinguishment, and interior finish. Understanding these factors is essential to making hospitals safe (Rahmani & Salem, 2018). Building fire protection can be approached from two different angles. Specifically, building design, operation, and management (Ebenehi et al., 2017). Chow (2001), Fire safety management's primary goals are to make sure that in the event of a fire of are all the required fire safety measures will be accessible, residents can employ the fire safety precautions, and people inside will be helped to flee to safety.

Ebenehi et al. (2017), stated that the aims of the fire safety management sections include maintaining fire safety measures and fire prevention, employee training, an emergency action plan, an assessment of building alternatives, and the fire safety management programs consist of examination, education and training, extinguishing fires, emergency service, evaluation of, fire probability, fire prevention, report and record keeping, and communication. Also, Pattnaik and Kumar (2019), provide a systems-based strategy for managing fire safety. It will involve the collaboration of six components that cover every aspect of safety, including building design, maintenance, safety gear, communication, choice-making, and safety culture.

## **RESEARCH METHODOLOGY**

Qualitative approach will be used to conduct the research. The research will depend on conducting interviews with fire experts and specialists and gather the data from them.

For conducting this research, interviews with fire experts and specialists to investigate what is the most important component of fire safety management in hospitals. The strategy for this research will be a qualitative method strategy, the method contains the primary data approach (interview).

### **Primary data**

The design of the interview questions will be dependent on the research objective, the questions will be open-ended to allow room for conversation in the interview and help both the interviewee and interviewer to ask and mention every detail that help fulfilling the research objective. The research questions will be divided into two parts, Part one: introductory questions, these will be asked to identify the interviewee's, Part two: key questions, will be used to obtain data related fire safety management.

## **ANALYSIS AND FINDING**

The research aims to find the essential components of fire safety management. This leads to the use of thematic analysis for the data collected, NVIVO software was used for the analysis process from creating codes, themes, and to presenting the results. This section will present the data collected and the analysis method.

The data analysis will follow the thematic analysis six-phase method mentioned (Byrne, 2022). The interview has been conducted with four participants.

### **Interview Question Part One**

This part represents the background information about the people who participated in the interview. Table 1 represents the background information of each individual.

**Table 9:** Interview participant personal information

<b>Participant number</b>	<b>Workplace</b>	<b>Educational level</b>	<b>Years of experience</b>	<b>position</b>
1	UKM Specialist Children's Hospital	Master	6-10	Hospital emergency manager
2	Pantai health group	Degree	11-15	Safety Officer for Health Group
3	Fire and Rescue Department of Malaysia	Ph.D.	20-25	Head of Fire Safety Approval
4	Hospital Cyberjaya	Degree	16-20	Hospital Fire Safety Officer

From Table 1 we can see that participant 1, 2, and 4 currently work in a hospital and are responsible for its safety, participant 3 currently works for the Malaysian National Fire and Rescue Department under the government. All participants have degrees, also all participants have 10+ years of experience except Participant 1 who has 6-10 years of experience.

### **Interview Question Part Two**

This part focuses on fire safety management in the hospital, for this part, the interview questions and answers are put into NVIVO software to generate the codes. For this part, there were 7 themes.

#### ***Theme 1: Communication***

This theme plays an important role in the process of early fighting of fire. Interview 4 states that alerting the hospital staff and then communicating with the fire station is a vital step in the process “First, you don't alert the whole hospital? No, we solve it first. Okay, if we cannot, then we alert the whole hospital. After that, we call the Fire Department.”

#### ***Theme 2: Complying with Design and Guidelines Standards.***

This theme focused on the building structure design and laws. Compartment. Participants stated that hospitals must have compartments on their floors as it's a method for preventing the fire spread. Participant 3 stated “special

room compartment for the patient. They have to know the location, and they have to know the compartment that can protect the patient.”

Complying with standards. Participant 3 stated “The first, the most important is our legislation, our regulation. It must be firm at first. To regulate the people, we have our regulation.” While participant 1 stated “every staff in the hospital are trained about fire safety so then you can comply with their standard.” Enforcement of regulations. Participant 3 stated “Enforcement is very important. Yeah, and you need every facility to apply the laws. To apply the... The education needs to be applied.”

Fire lift. As part of the design complying with fire safety, Participant 1 stated “So in that case, the knowledge of the building design...the fire left, how many fire lift available in the building? How to activate the fire lift?” Participant 3 stated “That's why they need to have special education, special knowledge to evacuate the patient by using you call it escape back lift.”

Refuge area. Following up with the building design and structure, Participant 3 stated “In hospital building actually they have there, we call it a refuge area.” Also, participant 1 stated that “Where to put patient during search and rescue? Is there any, they call it refuge area?”

Accreditation and endorsement by the fire station. Participant 2 stated “Hospital need to establish Fire Safety Committee as per Fire Service Act 2020, hospital need to appoint Fire Safety Manager and Fire Safety Officer at every shift, and all of the above statement need to be registered and endorsed by nearest Fire Station.” In addition, participant 1 stated “At least, okay, in hospital you have accreditation. Every hospital you have accreditation.”

Proper documentation and recording. Every hospital must have documents on all its activity. Participant 3 stated “Thirdly, is to fire safety recording.” Also, participant 1 stated “Where is the evidence that you're doing once a year fire drill? Documentation.”

Reduce fire load. Participant 3 explained it as it lies under the prevention management of fire, he stated “In terms of the compliance to the regulation, our fire load in hospital building must be reduced”

The maintenance team checks and maintains areas. Participant 1 stated “so this maintenance, It's a team that to make sure the emergency bay Okay When you carry your patient down So that patient needs to go to emergency department or an emergency bay that you identify Okay.”

### ***Theme 3: Control and Monitoring Room***

Participant 1 stated “I will be in the fire control room. Okay. When emergency, I will be there. So everybody will go there. I will give them a brief. The firefighting team and also the search and rescue team will wait for my instructions.”

#### ***Theme 4: Training and Awareness***

For the staff to be capable of executing effective rescue and firefighting there must be prior training.

Fire drill. Participant 4 stated “The last is the fire drill. So fire drill is a compulsory. Every year you must do one fire drill.”

Knowing the design of the fire safety for the building. Participant 1 stated “Whatever fire safety design of the building. You know it. I know.”

Monitoring of training. The participant mentioned this code as a continuous method of validating the training and having feedback on what to fix in the future, participant 1 stated “Do you have a proper monitoring of every training?”

Staff trained and educated on fire safety. Participant 3 stated “First, education, engineering, second, and enforcement. Isn't it? Yeah. We have to educate the people.” While also participant 4, stated “We have three steps for the fire program in the all the hospitals in Malaysia. First, the OKK training. The second is the awareness of the fire safety system. The third is a tabletop.” Participant 1 mentioned that every staff in the hospital must be trained “Every staff in the hospital are trained about fire safety.”

#### ***Theme 5: Defined Hospital Fire Structures and Planning***

Every facility must have its structures and plan to respond to any incidents.

Fire prevention management. Participant 3 stated “Yeah, the most important thing is prevention management.”

A committee and a team. Participant 2 stated “Hospital need to establish Fire Safety Committee as per Fire Service Act 2020.” Also, participant 4 stated “The committee so the pengarah is a director, hospital director is a chairman in the committee fire safety.”

Fire safety structure. It is the layout of roles and responsibilities, participant 1 stated “this our structure is like this Uh, you have emergency manager you have uh safety officer and also you have historian Then for his program, Rescue Fire Fighting Team You have Search and Rescue team, etc.”

Policy. The hospital policy is the rules. Participant 4 stated “We have one policy so we call it internal disaster policy okay include the fire.”

Protocol. Defined as the specific actions for staff. Participant 1 stated “You need to know what is the role of the nurses, director of the hospital, corporate. There should be a protocol.”

Emergency response plan. Participant 1 stated “You need to have the Emergency Response Plan. Which involve all the stakeholders okay. So inside the emergency response plan, you have everything.”

Evacuation plan. Participant 3 stated that special education on hospital evacuation “In normal building, the people can freely evacuate, but in hospital, it's very critical. They need to have special education.”

Firefighting systems. Participant 4 stated that, they have different types of suppression systems “We have three systems here so wet system. That's for the common area. So in the server room, in the medical record room, we use the CO2 sprinkler. Then for the OT, we have a designated special sprinkler.”

Hospital management. Participant 1 stated “The hospital management, which is not a technical person. So in that case, the knowledge of the building design. So, that is one of the thing that it should be in a proper documentation so that they know.”

People management. Participant 3 stated that this management is directed to the process of evacuation “People management. How to evacuate the people?”

### ***Theme 6: Defined Roles***

This theme represents the various roles related to hospital fire safety.

Firefighting team and search and rescue team. This team task is after the occurrence of fire, participant 1 stated “The firefighting team and also the search and rescue team will wait for my instructions. When I deploy them, they will go.” Also, Participant 4 stated “EMR team, okay, supposed to be the first fire responder if any fire in the hospital.”

Plan for the staff to know their roles and duties. This code was mentioned by Participant 1 regarding the non-specialist staff, the participant stated “You need to know what is the role of the nurses and everyone, we need a proper plan.”

Emergency manager. Is the head of the emergency. Participant 2 stated “Hospital needs to appoint Fire Safety Manager.”

Evacuation officer. Is responsible for monitoring and ensuring the evacuation. Participant 1 stated “Will update the evacuation officer. How many persons reached the assembly point? And is there any person missing?”

Maintenance team. This team is responsible for pre-determined inspection and maintenance. Participant 1 stated that the hospital must have a maintenance team “also having the maintenance team.”

Sweeper. The person in charge is responsible for ensuring that every ward and space is evacuated. Participant 1 stated “The sweeper, we have so many ward, office. There will be a sweeper, has to make sure everybody evacuates.”

Traffic controller. Participant 1 stated “The traffic controller is those teams who control whoever that evacuates and route them to the assembly point.”

Historian. Participant 1 stated that the historian comes after the manager “So for emergency manager, you have Safety officer and you have a historian.”

Safety officer. Participant 2 stated that there must be a safety officer at every shift “Hospital need to appoint fire safety manager officer at every shift.”

### ***Theme 7: Defined Responsibilities and Actions***

This theme provides exact actions and decisions for the staff when a fire occurs.

Evacuation of patients. Evacuation of patients in hospitals is considered a very complex action, due to the complexity of the condition of the people inside. Participant 4 stated “the ward management to evacuate patients to the designated area” Also mentioned by Participant 3, is one of the types of evacuation “They implement, we call it a progressive evacuation, horizontal progressive evacuation. They cannot fully evacuate the patient in case of fire.”

Having codes to alert the hospital. Participant 4 stated “We respond first. If the fire cannot be dissolved, we connect code NOVA to activate hospital to aware about the fire. After that we call the Fire Department.”

The sweeper makes sure everyone has left. As mentioned in theme 6 on the sweeper role, it is considered vital as it ensures that no one is left behind.

Traffic staff control the evacuation of people. The reaction of people is unexpected and chaotic, this is why it is vital for ensuring the proper execution of the evacuation, same as mentioned in theme 6 on the role of traffic control.

## **DISCUSSION**

The findings taken from the interviews will be discussed in context to the literature taken from international and local standards, books, and old research.

### **Interview Question Part Two**

Seven themes were identified for this part; the findings are discussed below.

***Theme 1: communication.*** As a part of the fire safety management the communication mentioned by the participant discussed informing the hospitals and the authorities of the fire incident. Ebenehi et al. (2017), stated that the fire safety management program consists of eight elements one is proper communication, also confirmed in the book made by Della-Giustina (2014), that the fire safety program must contain a written recommendation and procedures including the communication part. However, Agus Salim et al. (2023), expressed that most of the issues are due to the communication devices that are not reliable.

***Theme 2: complying with design and guidelines standards.*** Researchers have discussed that the design of the hospital is vital to the protection of people, and it lies under the passive protection systems, Bakar (2006), found that passive fire protection is important in reducing fire risk, basic measures at the planning phase is vital. NHS England (2013), required that the fire safety manual have information on any compartmentation space.

Other hospital designs are related to the spaces that protect the patients. The University of Edinburgh (2023), stated that the fire plan must contain Temporary refuge areas and Lifts. The UBBL of 1984, mandates that



construction materials must possess the required level of fire resistance. Agus Salim et al. (2023), found in their research that Combustible materials and electrical problems were found to be the primary causes of fire occurrences in healthcare facilities.

When it comes to compliance with regulations and standards, Della-Giustina (2014), stated that the fire safety management program must ensure compliance with regulations and fire code. Also, Participants One and Two mentioned talks with the local authorities for extra validation. Abhishek Shastri et al. (2018), stated that hospital must conceive and regularly enforce a set of operational criteria and must never diverge from safety regulations outlined by governmental authorities. Continuing with complying with the standards and regulations, Participants One and Three mentioned that all their training and activity are documented. NHS England (2013), requires a manual that has documentation of practices and fire drills. Also, Chow (2001), stated that for efficient fire safety management, there must be a manual with has documentation.

Ensuring the proper functionality of the hospital fire systems and passive fire design, the hospital applies continuous maintenance, participant one stated that it is vital to provide continuous feedback on the state of design and compliance of the hospital. Nugroho et al. (2022), stated that all used equipment should also undergo routine maintenance, support, and testing.

**Theme 3: control and monitoring room.** Participants One and Two explained this theme as the process of fighting fire before and after any incident occurs, the participants mentioned that the hospital must have a room for the staff to monitor the hospital's operation and condition. Rahardjo and Prihanton (2020), stated that to ensure that the facility is always operational must be sufficient supervision performed. Nugroho et al. (2022), found one of the fire safety management is Monitoring, auditing, and review. Della-Giustina (2014), discussed in his book, that to achieve the goals of the fire safety management program there must be monitoring.

**Theme 4: training and awareness.** This theme represents activities for the staff in the hospital to engage in and knowledge related to fire safety and building, the participant has mentioned different activities for the staff and how they should be trained and educated on fire safety. Ebenehi et al. (2017), stated that to prevent fire-related damage, various actions must be taken, such as teaching staff, and practicing fire drills. In addition to that, Rahardjo and Prihanton (2020), found that regular fire drills are conducted to ensure that the facility is always operational. NHS England (2013), stated that all fire action plans must be routinely practiced, whether through table workouts, walkthroughs, fire drills, or other suitable methods.

**Theme 5: defined hospital fire structures and planning.** This theme is related to the hospital fire structures and plans to respond to any incidents. Kodur et al. (2020), stated that controlling the fuel accessible to ignition and utilizing suppression measures are the fundamental techniques for managing fire and its effects, also utilizing manual or automated fire prevention measures is the other efficient way to manage fire.

The NFPA 550 (2020), used a logic gate to explain fire safety, one of the objectives of fire safety is fire prevention. Also, fire prevention has been mentioned by research as one of the aims of fire safety management (Ebenehi et al. 2017; Nugroho et al. 2020). Della-Giustina (2014), stated in his book that fire prevention is one of the eight components of a fire safety management program, he stated that fire prevention includes Inspections and education, which aim to stop fire losses prior to their start. In addition to that, also Chow (2001), stated that fire prevention is one of the elements of the fire safety management program.

NHS England (2013), mentioned the teams that every hospital must have and considered the committee as a part of the fire structure of the hospital. Suhaili et al. (2020), in their study, found that hospital must have a fire safety committee.

The fire safety structure described by the participant is the layout of roles and responsibilities. NHS England (2013), states that it is important to clearly define the fire safety management structure, the structure includes roles such as trust board, chief executive, fire safety manager, etc. Also Della-Giustina (2014), the hospital must have a solid organizational structure and must include a thorough management program for fire safety. In addition, the 2021 IFC (2020), stated that the layout of the structure also must be freely accessible in the place of work for referencing and going over by employees.

The hospital policy is the rules and way fire safety activity must be done. Participant Four stated that his hospital has a policy for internal disasters. Agus Salim et al. (2023), found in their research that one of the common issues is related to fire safety management issues with policy.

The hospital protocol is defined as the steps for reacting to fire when it occurs, participant 1 stated that it is a defined role of each person. NHS England (2013), stated that fire safety protocols should cover a wide variety of themes and offer guidance and instructions, such as Preventing fires, Security, Maintaining fire gear, Protocols and preparing for emergencies. 2021 IFC (2020), states that there must be a plan follows the protocols for floor or building evacuation.

The participant mentioned the emergency plan as the plan for response which must be defined and detailed for all activities and components that must be done. 2021 IFC (2020), mentioned topics that must be implemented in any building to be able to fight the fire and prevent it, which includes Emergency planning and preparedness. Della-Giustina (2014), Planning for emergencies is crucial to preventing catastrophic, a well-thought-out emergency plan can make

the difference between minor incidents turning into major. The County Durham and Darlington Fire and Rescue Service (2023), in the United Kingdom, developed a fire emergency plan that consists of 21 areas of study, related to training, information, actions, communication, escape routes, assembly points, evacuation arrangements, overall control, firefighting, fire control panel, and contingency plan. NHS England (2013), stated that the emergency action plan especially is for the ward, department, and space, also, the guide recommends details such as plans of the property and details on the fire and safety systems, services, and environmental systems, as well as the hazardous items.

The participant has mentioned that evacuation is one of the first actions to be done when alerted of fire incidents in the hospital. Researchers have discussed that evacuation is one of the earliest actions when a fire starts, Liu et al. (2023), stated that immediately after a fire starts in a hospital, evacuation and firefighting efforts must be made. Sanni-Anibire & Hassanain (2015), stated that the evacuation system is the most crucial component of fire safety management of buildings. The University of Edinburgh (2023), stated that the evacuation plan will be either simultaneous, phased, or delayed and will be included in the fire warning system. Also, researchers have found some of the risks related to hospital fire safety are risks related to evacuation, Huang et al. (2019), stated some of the hospital risks are risks associated with evacuation, such as numerous evacuees and insufficient rooms in corridors for evacuation.

Regarding the firefighting systems, the participants have mentioned how vital these systems are, and how different types of systems they operate in their hospitals. Bakar (2006), stated that Fire Protection: Passive and Active are important in terms of reducing fire risk and hazard. However, researchers have found primary drivers of fire in hospital buildings. Agus Salim et al. (2023), found Insufficient automated firefighting tools and poor maintenance and management of firefighting tools are primary drivers of fire in hospitals. In addition, Abhishek Shastri et al. (2018), reviewed fire accidents and found that poor maintenance and management of firefighting equipment is one of the errors in fire incidents.

The hospital management needs to be educated and have proper knowledge of the building design and state to have an effective role in fire safety. Participant One has stated that the management people of the hospital must know about the safety design in the hospital. NHS England (2013), stated that fire safety management in hospitals must guarantee that the organization develops and distributes suitable guidance and has roles for the management to be involved in fire safety. Sanni-Anibire & Hassanain (2015), stated that there are issues related to the facility managers such as the facilities manager lacking a thorough understanding of the design and administration of fire safety systems.

Participant Three has mentioned there must be people management. Hamida & Hassanain (2019), have mentioned the staff must be aware of what to

anticipate from people during fire emergencies to create evacuation and housekeeping plans that are adequate. The County Durham and Darlington Fire and Rescue Service (2023), has developed a plan which contains action for staff to make sure the visitors are evacuated to the gathering location.

**Theme 6: defined roles.** The participants have mentioned various roles and teams they implement in their hospitals.

As mentioned by the participants, the hospital must have a rescue team, NHS England (2013), stated that the hospital fire structure must have defined roles, such as Fire Response Team Leader and Fire Response Teams.

Mentioned by Participant One that the non-fire safety staff must have a plan for their roles and actions. Researchers have found that hospital medical staff are one of the issues when facing fire due to their lack of knowledge of their roles. Ong and Suleiman (2015), stated that inadequate medical staff training is one of the issues in firefighting. Also, Ghanbari Kakavand et al. (2016), identified safety threats in hospitals such as insufficient staff education on the use of fire extinguishers.

The role of emergency manager is one of the most important roles in hospital fire safety. Various researchers have stated the importance of fire safety managers, Agus Salim et al. (2023), in hospitals one of the most important stakeholders is the managers. NHS England (2013), stated that the hospital structure for roles must have a fire safety manager. Ebenehi et al. (2017), state that fire safety managers must fulfil their obligations, such as Knowledge of fire safety measures, Risk analysis, and consult with the fire authority and get guidance.

As one of the most important elements in fire safety is the evacuation plan, participants have focused on having an evacuation officer, also, it has been mentioned by researchers. Goniewicz et al. (2020), stated that there must be a classification of individuals in charge of organizing staff (and patients) evacuations.

Another role required for the management to have is a maintenance team. From the literature, researchers have found that hospital fire safety must-have criteria and a team of maintenance, 2021 IFC (2020), states that the fire safety plan must include identification and assignment of persons in charge of maintenance of apparatus used to put out or contain fires. Della-Giustina (2014), stated that to achieve the goals of the fire safety management program one of the elements is maintenance practices, preventing the sources of fire, exploding, and other losses in addition. Moreover, Agus Salim et al. (2023), found that poor maintenance and management of firefighting tools are one of the primary drivers of fire in hospital buildings.

Moving to other roles mentioned by the participants that they apply in their hospitals are sweeper, traffic controller, historian, and safety officer. The

Centers for Disease Control and Prevention (2023), developed a fire emergency plan where each floor has a monitor whose tasks are to verify that every individual has left. Kodur et al. (2020), states that there must be control for those who may be subjected and their possessions to fire. The role of a historian is vital for providing overall monitoring and data of the hospital, Ebenehi et al. (2017), found that the fire safety management program must contain Report and record keeping, also keep a record of all fire permits. Agus Salim et al. (2023) and Ghanbari Kakavand et al. (2016), found one of the reasons for preventing the enhancement of fire safety is the absence of records related to fire safety. The last role mentioned by the participants is the safety officer, the participants stated that this officer is responsible for monitoring the safety in the hospital during his shift. Ebekozi et al. (2021), stated that the fire safety officer is in control of policies, criteria, data, and practices.

**Theme 7: defined responsibilities and actions.** This theme provides the staff not with their titles but with the exact actions and decisions, the County Durham and Darlington Fire and Rescue Service (2023), stated that the staff have the required level of training for fire evacuation. 2021 IFC. (2020), also stated that the plan must provide the exact processes for evacuating patients who need to be restrained or contained, as well as any necessary post-evacuation protection.

Participant Four has mentioned that his hospital uses codes to alert when a fire occurs, University of Edinburgh (2023), stated that when having an automatic alerting system, the first alert is silent and must be inspected within a certain time frame before simultaneous or phased evacuation is put into action. Finally, the action of the sweeper and traffic controller which has been mentioned in theme 6 discussion gave us what the researchers and standards found on these roles.

## CONCLUSION

This research aims to find a method to minimize the fire incident outcome, by studying the fire safety management components of hospitals. The research has contributed to the topic of hospital fire safety using a qualitative research method by using open-ended interview questions. This study helped in providing data on the components of fire safety management for hospitals. The findings of this study can provide the concerned parties with this topic of having actual data on hospital fire safety management.

The objective to investigate the fire safety management components, two methods have been used, collecting data from previous research and standards and conducting interviews with fire safety specialists. The outcome of the data collected from the interviews and the analysis chapter of the data taken from the interviews provided us with seven themes for the fire action plan such as (1) communication (2) complying with design and guidelines standards (3)

control and monitoring room (4) training and awareness (5) defined hospital fire structures and planning (6) defined roles (7) defined responsibilities and actions.

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## **EXPLORING INTERIOR DESIGN WORK PROCESS IN GOVERNMENT BUILDING PROJECTS**

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### **Abstract**

Government building projects in Malaysia, primarily managed by the Public Works Department (JKR), play a vital role in creating functional, aesthetic, and sustainable environments that meet diverse user needs. Despite structured guidelines for design and construction, interior design works (IDW) often lack standardization and detailed attention, leading to suboptimal functionality, aesthetic inconsistencies, and compromised user satisfaction. This gap between design intent and execution underscores the need for a structured framework to address client values, prioritize meticulous detailing, and streamline processes to enhance IDW quality in government projects. This study aims to explore strategies to enhance IDW processes by addressing these deficiencies. A qualitative research approach was adopted, involving focus group discussions with 25 JKR architects, each with over 10 years of experience managing IDW in government buildings. Thematic analysis revealed significant inconsistencies in current IDW practices, particularly in the lack of meticulous detailing during planning and execution phases. These findings highlight an urgent need for standardized processes and enhanced detailing practices to ensure consistency and quality throughout project stages, from planning to post-construction. The needs to refine IDW processes and prioritizing detail-oriented practices are crucial for achieving higher standards and better alignment with modern design requirements. This approach will elevate user satisfaction and ensure functional, aesthetically pleasing, and user-centric environments. The study provides a foundational framework for improving interior design practices, promoting consistent and high-quality outcomes across government building projects in Malaysia

**Keywords:** Interior Design Works, Design Process, Government Building Projects

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## **INTRODUCTION**

The enhancement of interior design practices in government building projects is a crucial aspect of creating functional, aesthetically pleasing, and sustainable public spaces. Its quality is a critical factor that can significantly impact user satisfaction (Aljunid et al., 2020). In the Malaysian context, the interior design industry is governed by the Architect Rule, which is overseen by the Board of Architects Malaysia (LAM) (Mustapha et al., 2021). However, due to the lack of clarity and understanding on the function of interior design works, this has led to a misconception perception on the importance of interior design works in building industry. Since government buildings in Malaysia are managed by the Public Works Department (JKR), all the guidelines for building works have been structured by the JKR, often with insufficient consideration of interior design.

Several studies have indicated that the quality of government service delivery in relation to government building projects is closely linked to user satisfaction (Adeosun, J.O. et al., 2024; Ameen, A. et al., 2020; Khalil, N. & Nawawi, A.H., 2009; Abdullah, H.S. & Kallianan, M., 2008). Factors such as ease of access, clarity of information, and the availability of communication options can significantly impact user satisfaction with government services (Adeosun, J.O. et al., 2024; Ameen, A. et al., 2020). This suggests that the quality of the interior design process and the overall delivery of government building projects can directly influence user satisfaction. One of prominent issue is the lack of user-centric design approach, where researchers have emphasize the involvement of end-user in the design process often leads to spaces that do not adequately meet the functional needs and preferences, which resulting in dissatisfaction (Bouncken, R. et al., 2021). Insufficient interaction with end users can result in the neglect of important design elements like comfort and usability, which can lead to insufficient attention to detail during the design and implementation stages. Ineffective lighting, mismatched materials, and poorly designed furniture arrangements can all have a detrimental effect on both functional and aesthetic value of a space (Curcic et.al., 2019).

Given the importance of interior design quality and user satisfaction in government building projects, this research aims to explore strategies towards the enhancement of interior design work practices in such projects. The study will explore the current practices and potential improvements that can be implemented to enhance the quality of interior design and improve user satisfaction in government building projects in Malaysia

## **LITERATURE REVIEW**

### **Overview of the Concept of Interior Design Works**

Interior design is the art and science of enhancing the interior spaces in creating a functional, aesthetical pleasing and harmonious environment for its users. It is a multifaceted discipline that encompasses the planning and execution of interior

spaces to enhance both functionality and aesthetics through various elements such as lightings, furniture, materials, furnishing, finishes and interior fittings. Its purpose is to create an efficient space planning by incorporating functionality, visual appealing through colour and texture as well as ensuring safety and regulatory compliance.

In the context of public buildings in Malaysia, interior design plays a crucial role in creating environments that are visually appealing and conducive to the well-being and productivity of their users (Abdul Munir, F.F. et. al., 2024). The principles of interior design, which include balance, harmony, rhythm, scale, and proportion, serve as foundational guidelines that inform the design process and ensure that spaces meet the needs of their occupants through understanding client needs, followed by concept development, space analysis and design implementation (Abd Rahaman, 2023; Adams, 2013).

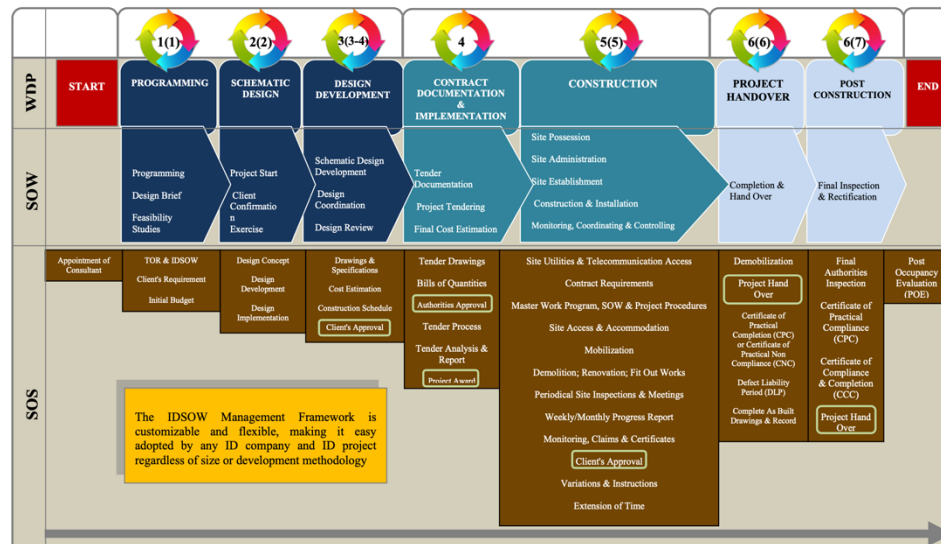
### **Interior Design Works Process**

In general, IDW process involves a series of structured phases that guide the creation of functional, aesthetic and buildability. The work process was initially developed from the RIBA Work of Plan as it is closely aligned with the architectural design process and has been widely adopted in the industry for years (Mustapha et al., 2021; Pilanawithana & Sandanayake, 2017). Since IDW involved works that are typically customized, intricate and high complexity, the needs of specialized IDW processes is vital (Mustapha et al., 2021). According to Interior Design Work Development Plan (IDWDP) by Mustapha, AA (2019) in Figure 1, IDW processes are consists of three key phases: the design phase, execution phase and delivery phase. The design phase comprises of all the preparation stages in design, such as programming (involving with developing design brief as well as feasibility studies), the schematic design stage, (involving with design concept and client approval) and the design development stage (involve with detailed design works and cost estimation).

In the execution phase, it focuses on the implementation and execution of the approved design (Mustapha et al., 2021). This includes the preparation of detailed construction documents, coordination with consultants and contractors, and monitoring the installation and construction processes (Noorhani et al., 2021). Meanwhile, during the delivery phase will be involved with post-occupancy evaluations to assess the project's performance and user satisfaction of the completed interior spaces (Metwally et al., 2019).

In Malaysia, government projects are managed by JKR and its interior design projects prioritize functionality, compliance with regulations, and cost-effectiveness, involving standardized processes, multiple stakeholders, and rigid timelines. In contrast, private projects focus on aesthetics, personalization, and innovation, offering greater flexibility, faster decision-making, and adaptability

in budgets and timelines. These differences reflect the distinct priorities and operational approaches in each sector.



**Figure 1:** IDWDP Management Framework for Interior Design Project Delivery  
*Source: Mustapha, A.A (2019)*

### Project Implementation Work Process by the JKR Malaysia

The Jabatan Kerja Raya Malaysia (JKR) plays a pivotal role in the design and implementation of government buildings across the country. As a government agency, JKR is responsible for ensuring that all public infrastructure is designed, constructed and maintained to meet the needs of the Malaysian population while adhering to national standards and regulations. IDW in these projects are regulated under the Architects Act 1967 (Act 117) by the Lembaga Arkitek Malaysia (LAM) or known as the Board of Architects Malaysia, which ensures professionalism through accreditation and adherence to aesthetic, functional and safety standards. JKR Malaysia has outlined its Architecture Manuals with a comprehensive stage such as planning, design, procurement, execution and handover, typically using the conventional consultant method (JKR, 2015). These frameworks ensure high-quality, regulated implementation of interior design works in government projects.

### Planning Phase

The planning phase is the crucial phase for the successful execution of interior design projects. The process begins by conducting feasibility studies to assess the requirements of the building, which include user needs, budgetary and site conditions evaluation. This phase involves the appointment of consultants as well

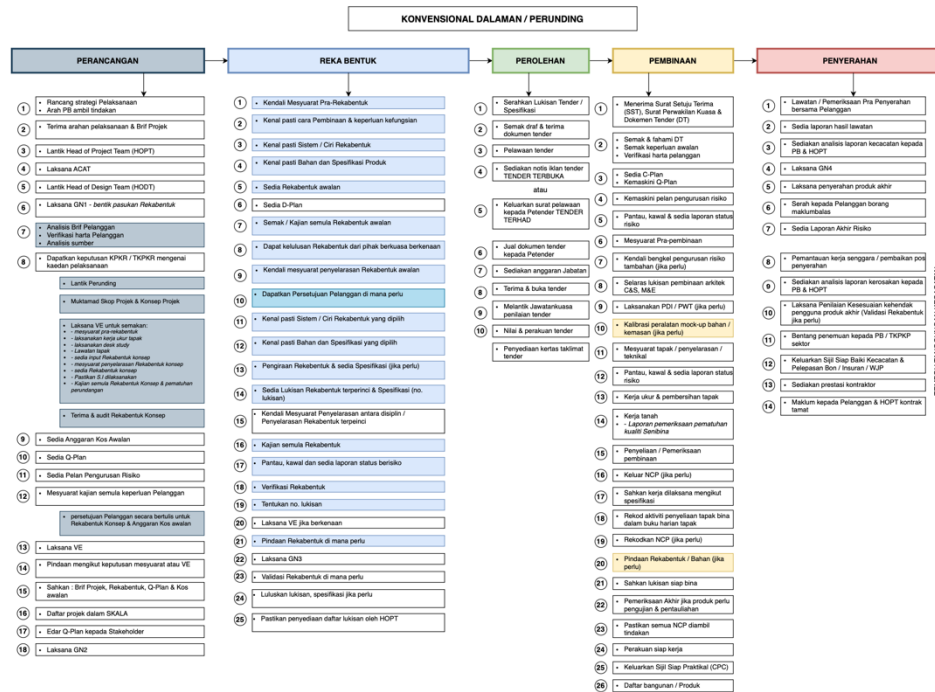
as gathering input from various parties including government officials, end-users and community representatives (Jamaludin & Razali, 2021). The data collected during this phase informs the overall design strategy and helps JKR align its objectives with national policies and sustainability goals (Khalid et al., 2019).

### ***Design Phase***

During this phase, JKR has outlined the process starting from the pre-design meeting until the preparation of technical drawings by the Head of Planning Team (HOPT). Along this phase, design aspect comprises of the identifying design direction, preparation of design proposal, materials selection, client's approval, preliminary design cost and specification, detail drawing preparation and design verification (Figure 2). Despite the structured and systematic approach outlined in the current JKR flowchart for design work processes, a notable gap exists in the lack of detailed guidance specifically addressing the scope of interior design work. While the flowchart comprehensively covers general architectural and construction phases, it often overlooks critical nuances unique to interior design, such as precise material selection, furniture specifications, and the integration of user-centric design elements. Overlooked of these elements may lead to ambiguities during project execution that resulting in misaligned of expectations of client values and the outcome quality of interior spaces. Furthermore, disregarding the importance of interior design scope may lead to misjudgement of aesthetic and functional values tailored to specific government building needs, hindering an effective public environment. Addressing this gap by incorporating a more detailed interior design component in the workflow would enhance project outcomes and align with modern standards and client expectations.

### ***Procurement Phase***

The procurement phase in JKR workflow involves a critical stage where the necessary resources, contractors and suppliers are secured to execute government building projects. This stage ensures all the approved design are well translated into reality through a transparent and structured process that aligns with public procurement regulations and JKR standard policy. The key steps in the procurement phase involves preparing tender documents, tender advertisement, tender evaluation, tender award and contract signing. Lacking of precise specification for interior design works such as finishes, furniture and fixtures, can lead to disputes and comprises in quality. Therefore, a robust procurement phase within its workflow will ensures that the government building projects are executed effectively in term of quality, cost-efficiency and adherence to public sector governance.



**Figure 2:** The Conventional Consultant Procurement – Flowchart of Implementation Work Process

Source: JKR Manual Seni Bina (2015)

### Execution Phase

The execution phase involves the actual construction and implementation of the interior design plans. JKR manages the construction process to ensure compliance with the approved designs and specifications (Figure 2). This includes regular site inspections and quality control measures to maintain high standards of workmanship (Firdaus, 2024). JKR also collaborates with contractors and suppliers to procure materials that meet both aesthetic and performance criteria, focusing on durability and sustainability (Tan et al., 2023). The agency's commitment to quality is reflected in its rigorous adherence to safety standards and building codes throughout the construction process.

### Evaluation Phase

Upon project completion before handover, JKR will be conducting an evaluation phase to assess the effectiveness of the interior spaces in meeting its intended goals. This includes gathering feedback from users regarding their satisfaction with the space functionality and aesthetics. Evaluation process is important for identifying areas for improvements (Jamaludin & Razali, 2021; Khalid et al.,

2019). Additionally, JKR places significant emphasis on the maintenance of government buildings, ensuring that interior spaces remain functional and aesthetically pleasing over time (Khalid, M.K.A, et. al., 2024; Yasin et al., 2022).

## **RESEARCH METHODOLOGY**

This study conducts a qualitative research methodology to explore the work processes of interior design practices in government building projects. The qualitative approach specifically employing focus group discussions expecting to gather an in-depth insight from 25 informants among professional architects at JKR who are actively involved in interior design projects for government buildings. This methodology is particularly suited for exploring the complexities and distinctions of interior design practices, as it allows for the collection of rich, contextual data that quantitative methods may overlook (Akyildiz & Ahmed, 2021).

Focus group discussions were preferred as the primary data collection method due to its ability to facilitate dynamic interactions among participants, enabling them to share experiences, opinions, and insights in a collaborative environment. This approach encourages participants to engage in dialogues, which can lead to the emergence of themes and ideas that may not surface in one-on-one interviews (Omar et al., 2020; Zairul.M, 2019). The focus groups were structured to include a diverse range of JKR architects, ensuring a variety of perspectives on the interior design processes and challenges faced in government building projects. This diversity is crucial for capturing the multifaceted nature of interior design practices and understanding how different experiences influence design decisions (Akyildiz & Ahmed, 2021).

The data collection initially starts by developing a semi-structured discussion guide, outlining the main topics to be explored, and user-centred design practices. This guide served as a framework for the discussions while allowing flexibility for the informants to introduce additional relevant topics (Akyildiz & Ahmed, 2021). Focus group session was moderated by a trained facilitator who ensured that all informants had the opportunity to contribute and that the discussion remained focused on the research objectives (Omar et al., 2020).

Following the focus group discussions, the recorded sessions were transcribed and analysed using qualitative data analysis, the Atlas t.i 24. This software facilitated in organizing data, coding of responses and identification of strategies through themes within the discussions (Zairul. M, 2019). The analysis process involved an iterative approach, where initial codes were generated based on key phrases and concepts, followed by the development of broader themes of specific interior design work process for government building projects.

## **ANALYSIS AND DISCUSSION**

Figure 2 illustrated the workflow process of interior design works practices from six groups of government building project categories, managed by the JKR Malaysia. This discussed project is mapped through the existing workflow of the JKR Conventional Consultant procurement project stages; Planning, Design, Procurement, Execution (Construction) and Evaluation (Handover). From this figure, it shows that these six types of building has outlined a significant differences of process and tasks. The analysis and discussion of the gaps were discussed under the specific themes of issues pertaining to current practices of interior design work in government building project, highlighting areas for improvement and opportunities to enhance the efficiency and effectiveness of the current processes.

### **1. Variation in Interior Design Scope Across Project Types**

The figure reveals distinct processes tailored to various government building categories, such as sports facilities, heritage buildings and institutional buildings. While this categorization reflects an attempt to address the unique needs of each building type, research identified significant inconsistencies in how interior design aspects are addressed across these categories.

- a) Administrative and Commercial Buildings – the process includes essential elements such as schematic design and client approvals. However, a notable gap lies in the absence of standardized guidelines for integrating key interior design components, such as furniture layouts, finishes and user-centric designs. This oversight may result in interiors that lack of cohesion or fail to fully meet the functional and aesthetic needs of their users.
- b) Sports and Recreational Facilities Buildings - the process It does not prioritize the critical aspects such as user comfort, materiality and the functionality of interior spaces. The lack of focus may lead to underwhelming interiors that do not effectively support the intended activities or meet the expectations of stakeholders.
- c) Special and Heritage Buildings – unlike the other categories, project such as parliamentary or historical buildings exhibits more detailed interior design workflows. This reflects the complex and unique requirements of these spaces, which often demand intricate designs to preserve cultural heritage or accommodate high-profile usage. Despite this, the processes for these buildings are not consistently applied across other project types, which creates a significantly disparity.

The inconsistency in scope of interior design work practices create in disparities in the quality and comprehensiveness of interior designs. This lack of uniformity can lead to mismatched outcomes, with some projects failing to align

with user expectations or functional needs. Addressing these inconsistencies by establishing more standardized and detailed guidelines for interior design processes across all building types would ensure higher-quality and more equitable outcomes.

## **2. Insufficient Detailing in Design Development**

The current design process includes schematic and design development stages but lacks explicit guidance in these key areas. Notably, there is no clear framework for furniture layout planning, material selection or user-centric design. Furniture layout is critical for creating functional spaces, however its integration into overall design is overlooked. Similarly, the absence of a standardized approach to sustainable and culturally relevant material selection misses opportunities to align designs with environmental goals and cultural values. Furthermore, minimal focus on engaging end-users limits the ability to tailor spaces to specific needs, reducing usability and satisfaction. Addressing these gaps by incorporating furniture layout, material selection and user-centric design as standard practices could significantly enhance the cohesive and functionality of interior spaces.

## **3. Limited Attention to Interior Aspects During Construction**

The process for most building types does not clearly specify how interior design aspects are monitored and implemented during the construction phase, resulting in potential gaps that could compromise the quality and consistency of the final interior spaces. Activities such as “mock-ups of key furniture” and “coordination of regulations and guidelines” were only discovered being incorporated during the pre-construction stage for special buildings. These steps help to ensure that the design elements are well-coordinated and aligned with the project’s goals before construction begins. However, for the other building types, these critical preparatory activities are absent, leading to potential inconsistencies during execution and an increased risk of misalignments.

In addition to this, it was noticed that site supervision of interior design elements during construction receives limited emphasis in most processes. Key aspects such as monitoring the installation of interior finishes, overseeing furniture placement, and ensuring compliance with the approved design are not explicitly addressed. This lack of oversight during the construction phase increases the likelihood of deviations from the intended design, resulting in spaces that may not fully meet functional or aesthetic requirements.

Establishing thorough and consistent procedures for interior design supervision across all building types is crucial to addressing this issue and guaranteeing the successful completion of interior spaces that are aesthetically pleasing, useful and high quality.



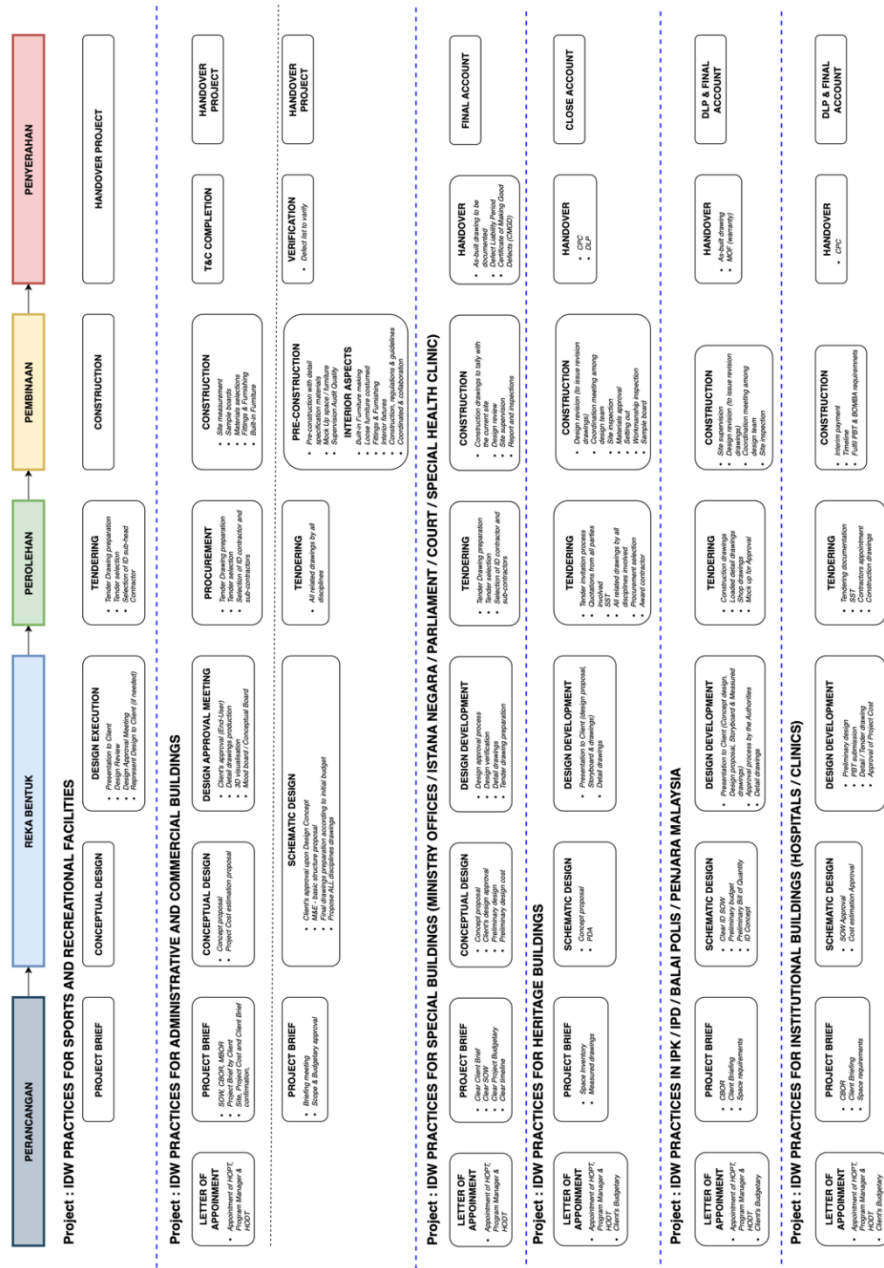
The lack of standardized procedures for supervising and implementing interior design elements during the construction phase introduces a significant risk of compromising the overall quality of the interiors. Without a clear guidelines and consistent monitoring practices, the integrity of the design vision can be lost, and the final outcomes may fail to meet the expectations of clients and end-users. To address this, establishing detailed and uniform protocols for interior design supervision across all building types is essential to ensure the successful realization of high-quality, functional and visually appealing interior spaces.

#### **4. Variability in Client Involvement**

The process places emphasis on client approval stages, particularly in administrative and commercial buildings, where client input is essential to the design process. However, the discussions revealed significant variations in the level of client engagement across different project types. While some projects involve clients extensively in approving designs and materials, ensuring that the final product aligns with their expectations, other exhibit minimal client involvement, particularly in categories such as sports and recreational facilities.

In projects with active client participation, the collaborative approach helps refine the design to better meet functional and aesthetic requirements, fostering a sense of ownership and satisfaction among stakeholders. Conversely, in projects where client engagement is limited, there is a higher likelihood of misalignments between the final design outcomes and the actual needs or preferences of the users. This is particularly evident in sport facilities, where the lack of client inputs during key decision-making stages often leads to functional or aesthetic shortcomings in the interior spaces.

Establishing a consistent framework for client engagement across all project types would help address this disparity. By ensuring that clients are actively involved in interior design decisions at appropriate stages, the process could produce more user-centered and satisfactory outcomes, ultimately enhancing the functionality and appeal of government building interiors. This approach would not only bridge existing gaps but also foster stronger collaboration and alignment among all stakeholders.



**Figure 3:** The Conventional Consultant Procurement – Interior Design Work Process  
for government buildings in Malaysia  
*Source: Author's findings from FGD*

## **5. Lack of Post-Occupancy Evaluation (POE)**

One significant gap identified is the absence of a post-occupancy evaluation (POE) stage in the interior design process for government building projects. This is critical stage for assessing whether the interior design meets the functional, aesthetic, and user satisfaction goals after project completion. POE is a structured mechanism to evaluate whether the interior design can be successfully meets its intended goals, such as functionality, aesthetic appeals and user satisfaction. The omission limits the ability to identify areas for improvement or refine design strategies for future projects.

Incorporating POE stage in the process would provide a systematic approach to gathering feedback from users and stakeholders. The feedbacks received could offer valuable insights of the impact of interior design towards building's operational needs, enhancing user comfort and aligning with the client's objectives. For instances, POE could reveal issues such as inefficient space layouts, insufficient lighting or inappropriate material choices that were not apparent during the design or construction phases. Addressing these defects in subsequent projects would ensure a continuous cycle of improvement.

A POE would also allow JKR to document best practices and lessons learnt, encouraging a culture of adaptability and learning. This could lead to the development of more user-centered designs and the establishment of benchmarks for interior design excellence in government building projects. Incorporating a POE step into the workflow will guarantee more effective and efficient use of government resources while also improving the quality and efficacy of subsequent initiatives.

## **DISCUSSION**

As a recommendation to identified gaps in the interior design work process for government building projects, several strategies for improvement will be proposed.

### **1. Standardize The Interior Design Process**

A need to standardize the process across all building types that involves developing a comprehensive and standardized scope of work that ensures essential elements such as furniture layout planning, material and finishes selections as well as user-centered designs are consistently integrated into every project. A unified approach would help eliminate disparities and promote uniform quality across different categories of government buildings.

### **2. Enhanced Detailing in The Design Development Phase**

It is a very crucial stage for interior design projects. This strategy can be achieved by incorporating specific steps for planning furniture layouts, selecting sustainable materials and engaging with end-users to tailor the interior spaces to

their unique requirements. This degree of specificity would guarantee that design results are both practical and in line with client's expectations.

### **3. Improved Construction Monitoring**

This monitoring procedure is essential to ensure design fidelity. Explicit procedures should be introduced for supervising the implementation of interior design elements during the construction phase. This entails supervising the installation of furniture, finishes, and other design elements to guarantee adherence to the authorised blueprints and quality requirements.

### **4. Consistent Client Engagement**

This engagement is necessary to align project outcomes with stakeholder needs. Clear guidelines should be established to ensure that clients are actively involved in key interior design decisions across all building types. This would foster collaboration and enhance satisfaction with the final results.

### **5. Introducing Post-Occupancy Evaluation**

The process should include POE stage in order to assess the performance of interior spaces after project completion. Feedbacks on usability, design, and user satisfaction would be gathered throughout this assessment, allowing for ongoing development and the incorporation of lessons learnt into subsequent initiatives.

## **CONCLUSION**

In conclusion, the research highlights critical gaps in the current workflows for interior design practices in government building projects managed by JKR, particularly in areas such as standardized processes, detailed design development, construction monitoring, client engagement and post-occupancy evaluations. These gaps reveal inconsistencies in the quality and effectiveness of interior design outcomes across different building types, which can lead to misalignments with user expectations, functionality, and aesthetic goals. By addressing these challenges through the adoption of standardized scopes, enhanced detailing, structured evaluation mechanisms, and consistent stakeholder collaboration, the quality of interior design in government buildings can be significantly elevated. These improvements would not only enhance the functionality and user satisfaction of public spaces but also align with broader national goals for sustainability, cultural identity, and efficient resource utilization, ensuring that government projects set benchmarks for excellence in design and execution.

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## **ASSESSMENT OF TEACHERS' PERCEPTION OF FACILITIES PROVISION IN TEACHERS' QUARTERS**

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### **Abstract**

The persistent issue of vacant teachers' quarters in Malaysia's East Coast Region has raised serious concerns regarding their management, maintenance, and overall liveability. This study seeks to evaluate the facilities of these quarters through a questionnaire survey, aiming to identify key factors influencing occupancy rates. A quantitative research approach is employed, incorporating descriptive analysis, frequency tables, the Relative Importance Index (RII), and Spearman's Rho correlation to analyse responses. The survey examines various aspects of the quarters' facilities, including housing conditions, available amenities, security features, accessibility, and overall maintenance quality. Findings indicate that poor maintenance, outdated infrastructure, inadequate security measures, and insufficient amenities are major contributors to low occupancy rates. The study also explores the correlation between facility conditions and teachers' willingness to reside in these quarters, highlighting the need for regular maintenance, enhanced security, and modernized living spaces to improve occupancy. By addressing these challenges, this study aims to support the development of a more sustainable and conducive housing environment for educators.

**Keywords:** Teachers Quarters, Issues, Existing Facilities, Satisfaction

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## **INTRODUCTION**

Housing is a fundamental necessity, playing a crucial role in individual well-being and societal progress (National Housing Supply and Affordability Council, 2024). Government-sponsored teachers' quarters are designed to provide educators with comfortable living conditions, particularly in rural and underdeveloped areas, helping to alleviate financial burdens and support their teaching responsibilities (NRY Architects, 2000; Mohammad Izzat, 2023).

However, many of these quarters in Malaysia face significant challenges. Issues such as poor maintenance, unsuitable designs, economic constraints, and shifting demographics have contributed to their increasing abandonment (Malaysiakini, 2019). Recent reports indicate that over 39.1% of teachers' quarters remain unoccupied, primarily due to deteriorating conditions, lack of maintenance, and inadequate amenities that fail to meet educators' needs (Malay Mail, 2023).

To address these concerns, the Ministry of Education is implementing policy adjustments, infrastructure improvements, and better housing allocations. With vacancy rates continuing to rise in teachers' quarters across Malaysia's East Coast, it is essential to understand teachers' perspectives and the root causes of this issue. A comprehensive approach is necessary to develop sustainable solutions that ensure these housing facilities are effectively utilized.

## **LITERATURE REVIEW**

The term "housing" is widely used in the environmental field. According to Frediani et al. (2019), housing is a fundamental human need that plays a crucial role in overall well-being, influencing various aspects of life, including health, education, and living standards.

George et al. (2023) highlight that shelter is a fundamental component of humanitarian aid, functioning to ensure safety from threats while facilitating essential family activities. Moreover, shelters play a crucial role in safeguarding displaced populations from environmental hazards, while also providing emotional support and comfort during crises (UNHCR, 2024).

Zihan Kan et al. (2022) highlight housing as a crucial social determinant of health, encompassing factors such as living conditions, affordability, and tenure—each of which significantly impacts mental health outcomes. Similarly, Marnane and Greenop (2023) describe adequate housing as providing security of tenure, essential services, and necessary materials and facilities to meet residents' needs. Their work particularly focuses on the practical aspects of housing in the context of informal settlements and housing inequality. Mee Kam Ng (2021) emphasizes that housing should consider both affordability and the quality of living conditions, as these factors are essential for fostering a healthy lifestyle. Similarly, Hurtubise, Babin, and Grimard (2009) define shelters as locations that



provide protection from danger or discomfort, serving as communal spaces for individuals without alternative housing options.

## DEFINITION OF GOVERNMENT QUARTERS

Zulkanain, Jaafar, and Salim (2022) describe government quarters as housing provided by the government for its employees, ensuring they have appropriate living conditions that support their well-being and productivity. These residences are funded by government allocations specifically designated to create housing facilities for employees across various ministries, including teachers and military personnel. For example, Ibrahim Ngah (2012) highlights various government initiatives aimed at enhancing rural infrastructure and public services. Initiatives include the development of government facilities that symbolize the state's physical presence in underdeveloped areas. Such measures form part of a comprehensive strategy to promote rural development and ensure more equitable access to essential government services nationwide.


The origins of government quarters date back to the colonial era when they were first built to accommodate British administrators. After independence, these properties were repurposed for Malaysian civil servants, reflecting a legacy of colonial policy (Wan Saiful & Zalkapli, 2020). Moreover, government quarters contribute to broader social infrastructure by providing a stable environment that promotes community development among government employees (Zulkanain, Jaafar, & Salim, 2022).




By offering such housing, the government reduces the pressure on public servants to seek accommodations in the private market, thereby lowering their living expenses and enhancing their economic stability (Wan Saiful & Zalkapli, 2020). Despite their importance, many government quarters face challenges such as poor maintenance, underutilization, and a lack of nearby amenities, which can compromise their effectiveness as quality housing solutions (Zulkanain, Jaafar, & Salim, 2022).

## DEFINITION OF CATEGORY OF QUARTERS

The following outlines the definitions of the categories of the quarters identified through secondary data collected from various stakeholders.

**Figure 1: Category of Teacher's Quarters**

Category of Quarters	Photo Description
<b>1. Cluster/ <i>Kelompok</i></b> - A neighborhood area designated for teachers' quarters will feature Teacher's Houses (RG) and Departmental Special Houses (RKJ), located both within and outside the school compound	

Category of Quarters	Photo Description
<b>2. Landed Teacher's House (RGB)/ Rumah Guru Bertanah (RGB)</b> - A type of accommodation that comes in the form of a house, which can be either a standalone house or a terrace house (multi-storey).	 <p>Jenis Rumah Guru (RG) di RG SMKA Johor Bharu (Johor)</p>
<b>3. Multi-storey Teacher's House (RGT) / Rumah Guru Bertingkat (RGT)</b> - A type of multi-storey housing for staff at educational institutions, including apartments, flats, and condominiums.	 <p>Rumah Guru Bertingkat (RGT) di RG SMK Permas 2 (Johor)</p>
<b>4. Departmental Special House / Rumah Khas Jabatan (RKJ)</b> - A house constructed specifically by the Department for the residence of a key officer who must always be available at their workplace or a designated location within the district, such as the headmaster's or principal's residence, as well as the warden's house.	 <p>Rumah Khas Jabatan (RKJ) di RKJ Aminuddin Baki, Kuala Lumpur</p>
<b>5. Educational Institution Quarters (KIP) / Kuarters Institusi Pendidikan (KIP)</b> - Quarters were developed either by the Ministry of Education (KPM) or through a concession granted to ENCORP Systembuilt Sdn Bhd for a period of 30 years, from 1998 to 2028, amounting to a total of 10,000 units across the involved states, which include Kedah, Penang, Perak, Perlis, Selangor, Johor, Pahang, Sabah, and Sarawak.	 <p>Jenis Kuarters Institut Pendidikan di KIP Temin di Jerantut, Pahang</p>
<b>6. Others (Gotong Royong Houses and Others) / Lain-Lain (Rumah Gotong Royong dan Lain-lain)</b> - A type of gotong royong house that is developed through joint funding or KPM, commonly found in Sarawak.	 <p>Jenis Kuarters Institut Pendidikan di KIP Temin di Jerantut, Pahang</p>

## IMPORTANCE OF TEACHER'S QUARTERS

Providing quality housing for teachers is essential for attracting and retaining educators, especially in rural and underserved areas. Safe and comfortable living conditions create a supportive atmosphere for teaching, enabling educators to

focus on their work and build stronger connections with their students (UNESCO, 2024). The Malaysia Education Blueprint (2013) underscores the importance of robust housing support to strengthen the teaching profession and optimize resource allocation. Addressing issues such as vacancies and maintenance in teachers' quarters can enhance these living spaces and improve the overall quality of life for educators (UNESCO, 2024). Accessible and affordable housing not only attracts teachers to underserved regions but also encourages experienced educators to remain in their positions by providing stability and fostering a sense of community (MDPI, 2024; Eacott, 2024). Moreover, living close to schools reduces commuting time and stress, allowing teachers to dedicate more energy to their classrooms (Education Week, 2023). Ultimately, well-managed teachers' housing plays a critical role in enhancing teacher welfare, strengthening education systems, and ensuring a stable, effective workforce. Government-sponsored teachers' quarters are designed to alleviate financial pressures and support educators, particularly in rural and underserved areas. However, these housing units face significant challenges, including poor maintenance, outdated infrastructure, limited amenities, and insufficient security measures. Recent statistics indicate that over 36.6% of teachers' quarters remained unoccupied as of November 2023, highlighting the urgent need for improvements to fully realize their potential benefits.

## DISTRIBUTION OF TEACHER QUARTERS IN MALAYSIA

According to the Ministry of Education (KPM) statistics from November 2023, there are 47,855 quarters, with 17,524 units—or 36.6%—currently unoccupied. The table below shows the distribution of vacant units for Pahang, Terengganu, and Kelantan as of that date. Notably, Pahang has the highest vacancy rate at 56.5%, corresponding to 3,475 units, followed by Terengganu at 51.7%, and Kelantan at 38.1%.

**Table 10:** Distribution of Total Vacant Units as of November 2023 for Pahang, Terengganu and Kelantan

States	No of Quarters	No of Occupied Units	% Occupied units	Number of Vacant Unit	% Vacant Unit
Pahang	6,146	2,671	43.5	3,475	56.5
Terengganu	1,885	911	48.3	974	51.7
Kelantan	1,254	776	61.9	478	38.1

*Source: Ministry of Education, KPM (2023)*

Additionally, statistics from the Ministry of Education (KPM) detail the distribution of teacher's quarters by type across three states. The Educational Institution Quarters (KIP) category leads with 4,354 units, followed by Landed

Teacher's Houses (RGB) at 3,934 units, while Departmental Special Houses (RKJ) have the fewest, with just 70 units.

**Table 2:** Number of units based on the categories of teacher's quarters

States	No of Quarters	RGB	RGT	RKJ	KIP
Pahang	6,146	2,384	371	33	3,358
Terengganu	1,885	839	180	22	844
Kelantan	1,254	711	376	15	152

*Source: Ministry of Education, KPM (2023)*

Pahang tops the list with the most Educational Institution Quarters (KIP), totalling 3,358 units, while Kelantan has the fewest at just 152 units. Additionally, Pahang leads in Landed Teacher's Houses (RGB) with 2,384 units, compared to Kelantan's 711 units. In contrast, Kelantan takes the lead in Multi-storey Teacher's Houses (RGT) with 376 units, whereas Terengganu has the lowest number at 180 units.

## RESEARCH METHODOLOGY

This study employed a quantitative approach to data collection and analysis, gathering numerical data to deepen the understanding of the subject matter. It combined primary data from both offline and online questionnaires with secondary data obtained from literature reviews and content analysis of books, journals, seminar articles, and reports. The research methodology also incorporated both quantitative and theoretical analyses of secondary sources. A questionnaire survey was distributed among teachers residing in government quarters and staff support personnel to gain a comprehensive understanding of the factors influencing teachers' satisfaction with their living conditions, the efficiency of the application process, and challenges related to occupancy.

Focusing on teachers in the East Coast region of Malaysia—specifically Pahang, Kelantan, and Terengganu—and including both primary and secondary school educators, the sample size was determined to ensure reliability and representativeness. According to data from the Department of Statistics Malaysia (2022), there are 34,635 teachers in the region. With a 95% confidence level and a 5% margin of error, a minimum of 380 respondents was needed; however, 560 respondents were selected to allow for a more comprehensive analysis. Sampling was based on the number of teachers' quarters in each state, with proportional stratified random sampling used to ensure representation across different districts.

The allocation of respondents was proportional to the number of available teachers' quarters in each state. Pahang, with 6,146 quarters, was assigned 200 respondents. Kelantan, with 1,885 quarters, also received 200 respondents, while Terengganu, with 1,254 quarters, was allocated 100

respondents. This approach ensured that the data accurately reflected the living conditions, satisfaction levels, and key concerns of teachers residing in these quarters.

**Table 3:** Proposed target respondents for the study

No.	Respondents Address	No of Teachers Quarters	Percentage (%)	No of Target Respondent	Percentage (%)
1.	Pahang	6,146	66.2	200	50
2.	Kelantan	1,885	20.3	100	25
3.	Terengganu	1,254	13.5	100	25
	Total	560	9,285	100	400

*Source: Author's Calculation*

Descriptive statistics were employed to summarize the key characteristics of the dataset, using measures such as percentages, means, the Relative Importance Index (RII), and standard deviations. This analysis helped reveal trends—such as the percentage of vacant teachers' quarters across various states and the satisfaction levels of respondents regarding existing facilities. The RII was used to rank the factors that influenced teachers' decisions to reside in these quarters based on their perceived importance. The ranking was determined by the weightage value, which reflected the total number of respondents for each scale value used in the study; a higher weightage value indicated a more significant issue. In addition, inferential statistical methods were applied to examine relationships, differences, and potential causal factors that affected the occupancy rates of teachers' quarters. Statistical tests, including frequency distributions and Spearman's Rho correlation, were conducted to provide deeper insights into the data.

## ANALYSIS AND DISCUSSION

Table 4 presented the details of the respondents' profiles. Information regarding the respondents' backgrounds was crucial, as it provided context for their responses in the subsequent sections of the survey. A total of 560 individuals responded to the survey.

**Table 4:** Detailed background on respondent's profile

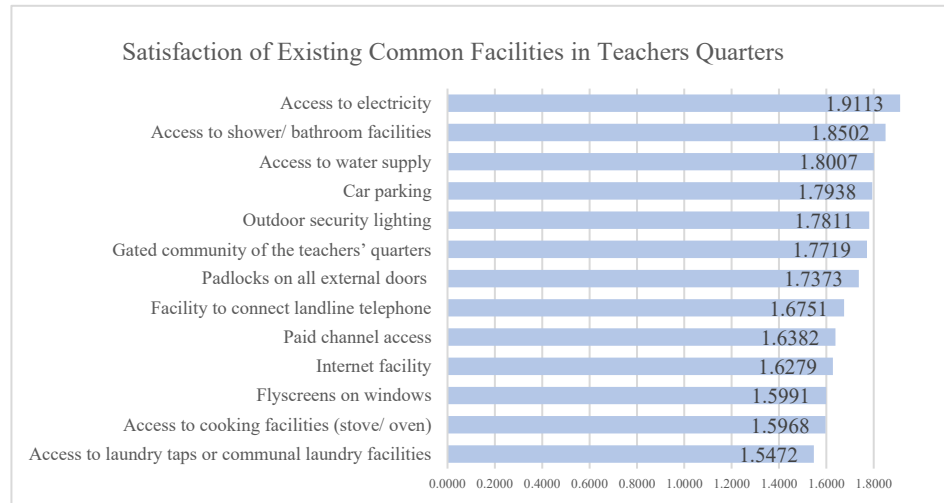
No.	Items	Frequency	Percentage (%)
Gender	Male	203	36.3
	Female	357	63.8
Marital Status	Single	52	9.3
	Married	508	90.7
Education Level	Certificate	70	12.5
	Diploma	34	6.1
	Bachelor's Degree	422	75.4
	Master's Degree	33	5.9
	PhD or equivalent	1	0.2
Age	Less than 25 years	1	0.2
	25 – 29 years	26	4.6
	30 – 34 years	69	12.1
	35 – 39 years	102	18.2
	40 – 44 years	138	24.6
	45 – 49 years	98	17.5
	More than 50 years	127	22.7
Household Monthly Income	RM 2,500 and below	32	5.7
	RM 2,501 – RM 5,000	140	25.
	RM5,001 – RM8,000	212	37.9
	RM 8,001 – RM 11,000	96	17.1
	RM 11,001 – RM 14,000	56	10.0
Duration of working as Teacher/Support Staff	Less than 1 year	10	1.8
	2 – 5 years	82	14.6
	6 – 10 years	92	16.4
	11 – 15 years	129	23.0
	16 – 20 years	59	15.9
	21 – 25 years	74	13.2
	26 – 30 years	75	13.4
	More than 30 years	9	1.6
Residents of Teachers Quarters	Yes	217	38.8
	No	343	61.3
Total		560	100

*Source: Author's Calculation*

Referring to Table 4, 63.8% of respondents were female, and a significant majority (90.7%) were married. Additionally, 65.0% of the participants were over 40 years old, while only 4.8% were under 30. In terms of income, 37.9% of respondents earned a middle-income salary between RM5,001 and RM8,000 per month, compared to 25.0% who earned between RM2,501 and RM5,000. Furthermore, 75.4% of respondents held a bachelor's degree, and the largest group (23.0%) had between 11 and 15 years of work experience. Out of 560 respondents, 343 (61.3%) reported that they did not reside in these accommodations.

Based on the feedback provided by the respondents, a Relative Importance Index (RII) analysis was conducted. This analysis was calculated using the weightage value assigned to each response and the total number of

respondents for each scale value. The resulting ranking indicated that a higher weightage value corresponded to a more significant issue.



**Figure 2:** Results of the RII Calculation for Respondents' Satisfaction Levels with the Facilities Provided in Teachers' Quarters.

Figure 1 presented the Relative Importance Index (RII) values for respondents' satisfaction with various facilities in teachers' quarters. A higher RII value indicated a greater level of satisfaction with a facility. Access to electricity ranked the highest, with an RII value of 1.9113, suggesting that respondents were most satisfied with this facility and that the electricity supply was relatively stable and met their needs. Facilities such as shower/bathroom access (1.8502), water supply (1.8007), and car parking (1.7938) also ranked high, reflecting a generally positive perception of these essential services.

Security-related facilities, including outdoor security lighting (1.7811) and a gated community (1.7719), received a fair level of satisfaction, although there was still room for improvement. Facilities like padlocks on all external doors (1.7373) and the ability to connect a landline telephone (1.6751) showed moderate satisfaction, suggesting that while these amenities were functional, they might not have been as essential or effective as others.

Access to laundry taps/communal laundry facilities had the lowest RII value at 1.5472, indicating the least satisfaction among respondents. This low rating suggested that laundry facilities were inadequate, inconvenient, or poorly maintained. Similarly, other facilities with lower satisfaction scores included access to cooking facilities (1.5968), flyscreens on windows (1.5991), internet access (1.6279), and paid channel access (1.6382), highlighting potential gaps in convenience and connectivity-related services.

**Table 5:** Spearman Rho Analysis Between Satisfaction Levels with the Provided Facilities and Respondents' Background

No	Existing Facilities	Respondents Age		Respondents Household Income	
		cc	p-value	cc	p-value
1.	Gated Community of the Teachers' Quarters	<b>-0.164*</b>	<b>0.015</b>	<b>-0.217**</b>	<b>0.001</b>
2.	Car Parking	<b>-0.136*</b>	<b>0.046</b>	<b>-0.136*</b>	-0.152*
3.	Padlocks on all external doors	<b>-0.136*</b>	<b>0.046</b>	-0.015	0.827
4.	Outdoor security lighting	-0.123	0.072	-0.124	0.069
5.	Flyscreens on Windows	-0.023	0.740	-0.013	0.852
6.	Facility to connect landline telephone	-0.091	0.180	0.035	0.612
7.	Access to electricity	-0.108	0.113	0.058	0.395
8.	Access to water supply	-0.086	0.206	0.001	0.986
9.	Access to shower/ bathroom facilities	-0.608	0.321	-0.006	0.933
10.	Access to laundry taps or communal laundry facilities	-0.108	0.112	-0.065	0.338
11.	Access to cooking facilities (stove/ oven)	<b>-0.134*</b>	<b>0.049</b>	-0.096	0.311
12.	Paid channel access	-0.039	0.569	0.084	0.217
13.	Internet Facility	0.020	0.772	0.151	0.026

Note: \* and \*\* Correlation is significant at the 0.01 level (2-tailed). cc= correlation coefficient.

In terms of respondents' age, significant negative correlations were found with satisfaction regarding the gated community of the teachers' quarters (cc = -0.164, p = 0.015), car parking (cc = -0.136, p = 0.046), padlocks on all external doors (cc = -0.136, p = 0.046), and access to cooking facilities (cc = -0.134, p = 0.049). These findings indicate that older respondents tended to be less satisfied with these specific facilities. Regarding household income, significant negative correlations were observed with satisfaction toward the gated community (cc = -0.217, p = 0.001) and car parking (cc = -0.136, p = 0.046), with an additional significant correlation at the 0.01 level for car parking (p = 0.152). This suggests that respondents with higher household incomes were less satisfied with these facilities. However, no significant correlations were found between household income and satisfaction with other facilities. Overall, these results highlight how demographic factors—particularly age and household income—can influence satisfaction with specific aspects of the provided facilities, especially those related to security and parking.

## CONCLUSION

Based on the RII scores and the Spearman's Rho analysis, key insights emerged regarding the satisfaction levels of teachers residing in quarters. Essential utilities such as electricity, water supply, and bathroom facilities received high satisfaction ratings, whereas modern convenience and security-related facilities



were rated moderately to lower. Notably, laundry facilities, cooking amenities, and internet access received the lowest scores, indicating potential gaps in meeting contemporary housing expectations.

Furthermore, the analysis revealed that demographic factors—particularly age and household income—significantly influenced satisfaction with certain facilities. Older respondents and those with higher household incomes were less satisfied with aspects of security infrastructure, such as the gated community and padlocks on external doors, as well as with parking facilities. This suggests that as teachers' needs and expectations evolve, the current facilities may no longer adequately address their concerns regarding security, convenience, and accessibility.

Overall, these findings underscore the need for targeted upgrades to enhance the quality, safety, and modernity of teachers' quarters. Addressing the identified deficiencies in laundry services, cooking facilities, and internet access—along with improvements in security infrastructure—could help increase overall satisfaction and potentially boost occupancy rates in these quarters.

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## **A STUDY OF MAINTENANCE COMPETENCIES IN AIRPORT BUILDING FACILITIES**

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### **Abstract**

Airports function as global gateways and carry millions of people and tons of cargo each day. Therefore, maintaining and keeping them running is crucial. Thus, this study highlights the significant issues of insufficient maintenance and poor work quality in the airport building facilities, focusing on Kuala Lumpur International Airport (KLIA). Hence, these issues lead to inefficiencies in operations, safety concerns, and reduced passenger comfort, emphasising the importance of effective airport maintenance systems. This research aims to identify essential maintenance competencies, analyse maintenance employees' challenges, and make recommendations to enhance maintenance practices at KLIA. The data collection method involves collecting both primary and secondary data. Primary data is obtained through qualitative interviews with the KLIA building services department and related maintenance employees. These interviews employed both in-depth and semi-structured methods to ensure comprehensive data collection. Secondary data consists of information from existing papers, manuals, procedures, reports, and standards related to airport maintenance. The data collected from these interviews are systematically analysed to identify common issues as well as opportunities for improvement. This method ensures that the results are based on real-world experiences. Consequently, the analysis defines significant problems among KLIA maintenance employees, including skill gaps, challenges towards emerging technology, high reported costs, and inadequate training. Thus, this study implies that using new technology, preventive maintenance approaches, and providing regular training may considerably increase maintenance efficiency, safety, and passenger comfort in airport building facilities.

**Keywords:** Maintenance competencies, Airport building facilities, Kuala Lumpur International Airport (KLIA), Preventive maintenance, Qualitative interviews

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## **INTRODUCTION**

The condition of a structure tends to deteriorate over time. Hence, consistent maintenance emerges as a prudent and effective strategy for safeguarding the structure against costly replacements and extending its lifespan. Thus, several key factors influence the decision for maintenance, including cost, age, property condition, resource availability, urgency, current and future use, and societal considerations (Wiggins, 2020). In particular, maintenance is a vital aspect that contributes to the efficient operation of facilities, equipment, and buildings, as Reksoprodjo et al. (2022) highlighted. According to Wiggins (2020), maintenance is conceptually framed as a composite of technical and administrative measures, encompassing supervision, directed at maintaining an object in its designated operational state or reinstating it to such condition. Consequently, maintenance is divided into two principal categories: Planned Preventive Maintenance (PPM) and reactive maintenance. Initially, PPM is methodically scheduled and implemented with a proactive, controlled, and documented approach. It comprises identifying minor flaws based on the condition of the equipment, allowing for proactive replacements to prevent severe issues from occurring. Thus, the objective is to keep the premises in good condition. On the other hand, unplanned or reactive maintenance includes breakdowns, accidents, corrections, and emergency types of methods. It is usually implemented by issues like vandalism, brutalisation, or a general lack of regular maintenance.

However, in Malaysia, there are several main maintenance management issues, such as low service quality (Nizam Kamaruzzaman et al., 2010; Au-Yong et al., 2014). Furthermore, according to Au-Yong et al. (2019), two other significant maintenance issues have been documented in five and three documents. There is a lack of awareness of the importance of maintenance and high maintenance costs. Other than that, the frequent finding of maintenance schedules that fail to perform on-time results in maintenance being carried out unintentionally. This issue only resulted in wasting money on maintenance and making maintenance less effective (Reksoprodjo et al., 2022). At the same time, Hauashdh et al. (2020) asserted that building maintenance issues were categorised based on their characteristics and phases. Therefore, four distinct categories of issues have emerged. Firstly, challenges arise from inadequate management of maintenance procedures, teamwork, quality, and maintenance strategy. Secondly, there is a failure to leverage technology for communication and information, particularly during the building design phase or maintenance process. Thirdly, financial problems have surfaced, encompassing challenges in managing spending costs and allocating funds effectively to achieve maintenance objectives. Lastly, human resource problems persist, encompassing issues related to workers' competence and job performance in the realm of maintenance.

Various issues highlight the importance of addressing the structural and financial aspects and the human and procedural elements within the broader context of facility management. For that reason, competencies play a vital role. The definition of competencies refers to individual characteristics such as motives, traits, self-concepts, attitudes, values, content knowledge, and cognitive or behaviour. These observable and reliable traits distinguish between excellent and average employees and between efficient and inefficient employees (Spencer et al., 1993; Wong, 2020). Meanwhile, Parry (1996) and Wong (2020) mentioned that competencies represent interconnected knowledge, abilities, and attitudes essential to an individual's job responsibilities and roles. They are related to job performance and can be improved through training and education. Additionally, Draganidis et al. (2006) and Wong (2020) explained that competencies involve direct and indirect skills and behaviours, enabling individuals to execute assigned tasks or responsibilities effectively.

A systematic approach to maintenance becomes critical given Malaysia's complex landscape of facility management difficulties and the relevance of competencies. In the case of maintenance (i.e., PPM), various tasks, including preventive measures like painting and boiler servicing, corrective actions such as roof replacement every 15 years, and annual inspections, are conducted. These inspections assess the building's condition, the building services, and the surrounding area. This method allows for the oversight and management of whether the tasks outlined in the long-term plan are genuinely necessary. That is, whether any work might need to be pushed due to unexpected deterioration or failure and identifying items not initially considered in the long-term plan (Wiggins, 2020).

The perspective of maintenance could be expanded in the context of airport infrastructure. As defined by Waris, Adisasmita and Ramli (2019), an airport functions more than just a place to land and take off; it also serves various other purposes. This includes passenger and cargo handling, intermodal transit, and different support facilities. The main functions of an airport are categorised into two types: aeronautical and non-aeronautical. Both of them require different sorts of appliances. Aeronautical facilities can be characterised by technical complexity, encompassing instruments like landing systems, air traffic management systems, runways, taxiways, and aircraft stands. On the other hand, non-aeronautical facilities are diverse, including hotels, restaurants, shops, and parking lots (Tarudin et al., 2020). Airport facilities serve diverse users and necessitate specific amenities for optimal functioning. The two primary types of airport components are landside and airside. The airside manages aircraft operations, while the landside oversees passenger operations. The planning and design of airport components guarantee seamless connections between relevant activities, facilitating precise transit from one location to another (Hamid et al., 2021). The quality of facility services plays a vital role in determining the overall

quality of airport services. This refers to the various facilities that serve passengers, from getting checked in at the airport to passing through security checks and boarding. This also includes amenities utilised for various activities, such as restrooms, lavatory facilities, and participating in other airport-provided activities (Mainardes et al., 2021; Ma & Ma, 2022).

Hitherto, Malaysia had a total of 58 airports, 37 of which had regular scheduled passenger services. Among all the airports, 36 airports are located in East Malaysia, while 22 airports are in Peninsular Malaysia (Kok et al., 2023). In Malaysia, two different organisations are responsible for the construction and operation of the airports. The government oversees the development of airport infrastructure, while Malaysia Airports Holdings Berhad (MAHB), a private company, currently manages airport operations and maintenance. Except for Kerteh Airport in Terengganu and Senai Airport in Johor, all airports in Malaysia are operated and managed by MAHB (Hamid et al., 2021). Prior to the establishment of MAHB, Malaysia Airport Berhad (MAB) was formed in 1992 to serve as the airport operator. Initially, MAB was granted a concession to manage and operate 33 airports with scheduled traffic for 30 years. In November 1999, MAB transformed into a public limited company, now known as MAHB. In 2019, MAHB extended its operating contracts for 35 years, valid until 2069. MAHB's primary business activities are divided into five key categories: airport services, duty-free hotels, agricultural and horticulture, and project and repair maintenance (Kok et al., 2023). The objectives of this study are twofold: (i) to explore the maintenance routine in airport building facilities and (ii) to investigate the challenges associated with maintenance work.

## **RESEARCH METHODOLOGY**

The data was collected by in-depth, semi-structured interviews. As defined by Fox (2000), semi-structured interviews use open-ended questions to define the topic being studied and allow the interviewer and interviewee to gain more insight into specific issues. Additionally, in-depth interviews come with several advantages:

- Allow for comprehensive data collection from the interviewees.
- This will allow researchers to study respondents' responses more thoroughly, delivering a deeper understanding of their experiences than a more organised interview.
- Can analyse the experiences of different interviewees chosen to examine a variety of perspectives.
- Allow the interviewees to "speak for themselves," increasing the validity of the data.

This strategy enables researchers to oversee more complicated issues related to research, resulting in higher validity and reliability in the findings (Aberdeen, 2013). Therefore, the study collected data using a semi-structured questionnaire that served as the interviewer's guideline. Specific questions were initially established to guide the interview and fulfil the study objectives. The interviews took around 40 to 50 minutes. Throughout the interviews, the researcher audio-recorded the whole discussion with their permission to help study the collected data. Respondents were allowed to express their thoughts on the questions raised during the interview. Overall, the interviews were enjoyable and interesting to comprehend.

## ANALYSIS

### *Respondents' profile*

Table 1 summarises brief profiles of the interviewees. The data collected state that four interviewees were between the ages of 21 and 30, four were between the ages of 31 and 40, and two was between the ages of 41 and 50.

**Table 1:** Profile of the interviewees

Age Group	Number of Respondent	Percentage (%)
21 – 30	4	40
31 – 40	4	40
41 – 50	2	20
Total Number of Respondents	10	100

All of the participants were male. One was responsible for maintaining the airport's seating, plumbing, signage, and painting. Another participant was a technician who maintained the electrical works and Air Handling Unit (AHU). Another participant was a baggage service technician for MAHB. Lastly, two participants operated in building services, primarily operating and maintenance for MAHB Sepang, mainly at Kuala Lumpur International Airport 1 (KLIA 1).

### *Normal Maintenance Routine*

This section provides an in-depth analysis of routine maintenance operations in KLIA based on perspectives from individuals directly involved in those operations. By evaluating the viewpoints of respondents working in airport building and maintenance, the researcher gains a better knowledge of the procedures being utilised. Each respondent provides an individual perspective to the researcher's specific analysis of routine maintenance practices. It helps to develop our understanding of standard procedures and identify improvement opportunities. Perspectives from several maintenance professionals and specialists allow the researcher to identify throughout procedures and better understand the standard of maintenance of building facilities in KLIA.

The maintenance technicians focused on monitoring two particular conveyor systems. The first one is the cross belt and the tilt tray machine. Both of which can manage up to 4,000 bags per hour. Therefore, this huge capacity requires proper and regular maintenance procedures. Additionally, they use Programmable Logic Controllers (PLC) for maintenance operations. PLCs help automate control operations, increase the efficiency of maintenance work, and reduce the risk of errors.

The different viewpoints of maintenance experts and specialists lead to a better understanding of maintenance routine procedures. The answers include understanding systematic approaches, PPM plans, the implementation of advanced technology, and the significance of asset replacement for maintaining airport facilities operable and safe, as summarised in Table 2.

**Table 2:** Key findings and emerging discoveries in maintenance strategies, highlighting the role of preventive maintenance, modern technologies, and effective resource management.

Finding	Description	Emerging Discoveries
Viewpoints of Maintenance Experts	Different perspectives enhance understanding of maintenance procedures.	Emphasis on systematic approaches, preventative maintenance, and the role of advanced technologies in keeping airport facilities safe.
Planned Preventative Maintenance (PPM)	PPM is a key strategy for KLIA, focusing on scheduled inspections to prevent major issues.	Proactive PPM helps in detecting minor issues early, ensuring optimal facility conditions and prolonging facility lifespan.
Combination of Maintenance Strategies	A mix of short-term and long-term maintenance strategies is used.	PPM and annual maintenance activities are complemented by corrective and breakdown maintenance, ensuring timely response (24-48 hours) to issues.
PPM's Role in Budgeting	PPM is beneficial for long-term budget planning and resource allocation.	Helps in forecasting maintenance needs, ensuring smooth operation and resource efficiency.
Use of Modern Technologies	Systems like BMS and SCADA play critical roles in maintenance operations.	BMS improves energy efficiency, while SCADA monitors and controls



Finding	Description	Emerging Discoveries
		systems in real-time, boosting response time and reducing human errors.
Asset Replacement	Regular asset replacement, particularly for critical components like lighting and firefighting systems, is a key practice.	Scheduled asset replacement (every 5 years) minimizes risks and ensures that facilities remain functional and safe.

Firstly, the researcher acknowledged that PPM is a crucial method used within the KLIA's maintenance routine. It encompasses scheduled inspections and planned maintenance operations to prevent machinery issues and ensure smooth operation. According to Wiggins (2020), the PPM method focuses on detecting and solving minor problems before they become major ones. Notably, by eliminating those little problems early on, PPM helps to keep the building in excellent condition, thus ensuring that everything functions properly and remains in optimum condition for everyone who uses the area. Therefore, this proactive strategy helps with the early detection and resolution of potential issues in the future, minimising delays and increasing the life of the facilities.

Next, the findings reveal the combination of short-term and long-term maintenance strategies. Long-term planning through PPM and yearly maintenance activities is complemented by short-term corrective and breakdown maintenance. Major issues are addressed within 48 hours, while minor issues are fixed within 24 hours, thus ensuring full consideration of maintenance obligations. As stated by Wiggins (2020), the PPM method is also beneficial for developing a long-term maintenance budget plan. Furthermore, it assists with allocating resources effectively by assessing future requirements and ensuring smooth operations throughout time.

The analysis emphasises the importance of modern technologies like BMS and SCADA systems in maintenance operations. According to Rey-Hernández et al. (2020), the use of BMS is essential for maintaining and continually improving interior areas and significantly minimising the cost of electricity. Meanwhile, as stated by Basu and Debnath (2019), SCADA frequently functions as a main controller, monitoring set points, overseeing the system and coordinating operations immediately. These systems provide real-time data and control, improving the ability to identify and manage problems quickly. In addition, using PLCs facilitates management operations, boosting productivity and lowering the possibility of human mistakes. Additionally, regular asset replacement, particularly for essential components like lighting, AHUs, and firefighting systems, is an essential routine. Scheduled asset replacement every five years ensures the facilities are presentable and functional, significantly lowering the risk of serious accidents.

These findings emphasise the need for deep and well-planned maintenance processes to ensure the effectiveness, smooth operation, and safety of airport building infrastructure.

### **Challenges In Maintenance Work**

Throughout this data analysis phase, the researcher focuses on the challenges encountered by maintenance workers at KLIA to ensure that the workers explain valuable experience in the parts of their jobs. By considering the opinions of respondents participating in the maintenance processes, the researcher understands the challenges related to their productivity and effectiveness. Each of the responses offers an individual perspective, which contributes to an entire assessment of the multiple issues faced by the maintenance personnel. The different perspectives affect the discussion on these topics, allowing the researcher to find common themes, identify various points of view, and better understand the challenges that KLIA maintenance workers encounter.

The research study highlights the complex nature of maintenance work in such a challenging and dynamic workplace by investigating their experiences in detail. The findings reveal significant challenges to productivity and effectiveness, emphasising the importance of specialised skills, safety regulations, cooperation among stakeholders, and the continuous ability to adapt to shifting circumstances in Table 3.

**Table 3:** Major findings and emerging discoveries related to the challenges faced by KLIA's maintenance operations, emphasising the need for specialised skills, safety measures, coordination, and efficient resource management.

Finding	Description	Emerging Discoveries
Complex Nature of Maintenance Work	Maintenance at KLIA involves handling fragile materials, safety risks, and adapting to changing circumstances.	Maintenance workers require diverse, specialized skills, particularly in handling materials like glass, and must adapt to various scenarios.
Challenges with Fragile Materials	Working with fragile materials like glass in terminal buildings requires precision and attention to detail.	Damage to glass surfaces can pose safety risks to workers and visitors, demanding specialized skills to avoid accidents.
Working at Heights	Maintenance of high structures like lighting systems and towers involves significant safety risks.	Safety protocols, training, and equipment like belts and scaffolding are essential to prevent accidents such as falls and electrical shocks.
Safety Protocols	Ensuring worker safety in high-risk environments is	Adherence to safety standards, proper training, and use of

	critical to prevent injuries and fatalities.	appropriate equipment are crucial for maintaining safety and productivity.
Coordination with Stakeholders	Effective communication and coordination with stakeholders are vital for maintenance planning and operations.	Coordinating system shutdowns and minimizing disruptions require approval and careful planning to ensure smooth airport operations.
Aging Equipment and Systems	Aging equipment demands frequent inspections and repairs, increasing maintenance workload.	Proactive management and resource allocation are required to balance operational efficiency with the limitations of outdated equipment.
Conveyor System Maintenance	Maintaining KLIA's 42 km conveyor system involves complex logistical planning and team management.	Repairing damaged conveyors can take hours, and effective communication among the large maintenance team is crucial for operational efficiency.
Role of Modern Technologies	Technological advancements, such as computerized systems for data management, can improve maintenance efficiency.	Stakeholders depend on technology to manage maintenance data, but challenges in implementation slow down decision-making processes.

One of the challenges is working with fragile materials like glass. KLIA's use of glass in terminal buildings, windows, and landscaping necessitates precise and skilled handling to prevent damage. Maintenance tasks involving glass, such as repairing broken panels, require careful attention and skills to detail to avoid further issues, including safety hazards for maintenance employees and visitors. Additionally, maintenance procedures vary significantly depending on the specific issue and place, requiring a diverse set of skills from the crew.

Furthermore, significant challenges are associated with working at heights. Maintenance tasks on high structures, such as lighting systems and communication towers, require strict adherence to safety protocols and the use of specialised equipment like belts and scaffolding. As stated by Hauashdh et al. (2022), the most common risks during executing maintenance work include falling from high places, electrical shock, and dealing with flammable substances. These incidents are normally caused by a lack of training, inadequate equipment, or poor safety precautions. Some maintenance personnel may not have had adequate training in safety measures, correct equipment operation, or managing dangerous chemicals. Additionally, lowering expenses, rushing to finish work, inadequate safety standards, and the use of defective equipment, like damaged stairs or electrical tools, can increase the possibility of injuries and incidents. Thus, ensuring worker safety while performing these tasks is

paramount, and the complexity of operations at KLIA necessitates a versatile approach to maintenance procedures, whether for routine inspections or emergency repairs.

According to Simeon and Aliu (2023), various factors can influence the efficient execution of safety standards, including organisational culture, commitment from managers, staff training, availability of resources, advancements in technology regulations, and the work environment. Accordingly, maintaining these standards is essential for ensuring the safety of employees and visitors. Moreover, implementing these safety standards is vital to avoid any incidents, fatalities, and injuries, enhance optimism among staff members, improve productivity, and lower the expenses related to workplace incidences.

In addition, dealing with various stakeholders presents another major challenge. Coordinating system shutdowns for maintenance requires approval from relevant parties and careful planning to minimise disruptions. Effective stakeholder communication and scheduling are crucial to maintaining smooth airport operations during maintenance activities. As per Zhao et al. (2022) and Hauashdh et al. (2020), a collaboration involving several building facilities maintenance stakeholders involves a considerable amount of data that is sometimes unorganised and difficult to manage. This slows down the decision-making process for maintenance activities. Nevertheless, Gao and Pishdad-Bozorgi (2019) also stated that some maintenance organisations are still trying to fully implement technology for good data management, which could enhance connectivity while offering beneficial perspectives. Therefore, they depend on manuals with complicated procedures, increasing the risk of human mistakes and reducing maintenance efficiency.

Other than that, as equipment deteriorates over time, it demands more frequent inspections and repairs. This increases the maintenance workload and necessitates a balance between maintaining operational efficiency and addressing the limitations of outdated equipment. The need for regular maintenance of ageing systems underscores the significance of proactive management and resource allocation.

Apart from that, maintaining KLIA's extensive 42 km conveyor system presents significant challenges, including managing the departure and arrival conveyors, where repairing a damaged conveyor can take up to five hours and requires the availability of proper tools and equipment. Additionally, effective communication is crucial among the large maintenance team, particularly in the luggage department, which consists of 130 employees, with 20 assigned to each shift. As mentioned by Rahman and Rahman (2023), the authorities should emphasise improving airport quality by enhancing luggage handling capacity and speeding up the cargo process. This can be achieved by utilising efficient machinery, executing strict assessments, and establishing computerised

systems for data management. Therefore, it is crucial to ensure coordinated and efficient maintenance operations. The scale and complexity of the conveyor system highlight the need for robust logistical planning and team management.

Addressing these challenges requires specialised skills, adherence to safety protocols, proactive management, and efficient stakeholder coordination. Nevertheless, the insights gained from this research contribute to a deeper understanding of the critical role maintenance workers play in ensuring airport facilities' safety, comfort, and operational efficiency.

## **DISCUSSION**

The research outcomes of the study on maintenance routine in airport building facilities, with a particular focus on KLIA in Sepang, Malaysia, provide significant insights into current maintenance approaches for operational efficiency. Accordingly, this study provides an extensive evaluation of the current state of maintenance operations. It highlights several important points that require monitoring and improvements.

Firstly, one of the key findings in this study is the normal routine of maintenance activities. The study indicates that KLIA's maintenance procedures primarily operate as reactive rather than proactive, leading to inefficiencies and increased expenditures. Furthermore, a significant concern has been identified: a knowledge and competence gap among maintenance workers. Furthermore, employees' lack of proper training and skills limits their ability to effectively conduct maintenance tasks, indirectly affecting work quality and causing safety issues. In addition, this study also analyses the challenges that maintenance employees encounter, including the high expenses of maintenance operations, the inability to perform well in implementing new technologies, and insufficient training programmes. These challenges significantly impact both the efficiency and safety of airport operations, thus leading to increasing stress and work frustration among maintenance employees. Also, hesitancy to use new technology, commonly due to a lack of training and understanding, contributes to these issues.

Finally, the findings of this study reveal the need for improvements in KLIA's maintenance approaches. Thus, by emphasising improved training, adopting new technology, and implementing preventative maintenance measures, the airport may significantly enhance its operational efficiency while providing a safer and more comfortable environment for workers and visitors.

## **CONCLUSION**

In conclusion, this study underscores the critical importance of effective maintenance practices at KLIA, emphasising how they impact operational efficiency, safety, and passenger comfort. The research reveals significant issues stemming from insufficient maintenance and poor work quality, primarily due to

reactive maintenance strategies and skill gaps among employees. These challenges lead to operational inefficiencies, increased costs, and safety concerns, highlighting the urgent need for improvement. In addition, the key findings indicate that practical knowledge and job-specific training are essential for maintenance staff to adapt to new technologies and perform their roles effectively. The study advocates for proactive training programmes and preventive maintenance approaches to address identified gaps, such as the reliance on ageing infrastructure and the complexities of communication among stakeholders. Moreover, integrating BMS with maintenance operations can enhance monitoring and management, thereby minimising downtimes and improving safety protocols. The study further suggests that investing in continuous training and adopting new technologies will elevate maintenance competencies and significantly enhance the passenger experience and overall operational efficiency. Ultimately, by prioritising these areas, KLIA can improve its maintenance strategies, ensuring a safer, more efficient environment for staff and travellers. Nevertheless, this research contributes valuable insights into the critical role of maintenance practices in airport operations, setting a foundation for future enhancements that benefit all airport stakeholders.

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**BARRIERS AND SOLUTIONS OF BUILDING INFORMATION  
MODELLING (BIM) IN CONSTRUCTION SITE SAFETY IN  
MALAYSIA**

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**Abstract**

The construction industry faces a high fatality rate due to its hazardous work environment and the inherent risks associated with construction activities. These challenges result in numerous incidents, injuries, and illnesses among workers, highlighting the urgent need for enhanced safety measures. Building Information Modelling (BIM) has shown considerable promise in improving safety on construction sites. This study explores the challenges of adopting BIM for construction site safety and suggests potential solutions within the Klang Valley, Malaysia. A questionnaire survey was conducted to evaluate ten major barriers and ten corresponding solutions to BIM adoption. The survey targeted 250 construction professionals with BIM experience, and the collected data were analysed using descriptive statistics in SPSS Version 27. The findings identified interoperability limitations, resistance to change, and lack of knowledge and skills as the primary barriers to adopting BIM for construction site safety. On the other hand, appointing a BIM Safety Manager or Coordinator, integrating BIM with real-time monitoring technology, and enhancing safety planning and visualisation through BIM were identified as the top solutions for implementing BIM in building projects within the Klang Valley.

**Keywords:** BIM, Barriers, Solutions, Site Safety, Building Projects

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## **INTRODUCTION**

Construction site safety can be enhanced by adopting Building Information Modelling (BIM). However, several barriers continue to impede its widespread implementation. BIM technology enables the adoption of safety protocols during the planning and building phases, yielding benefits such as identifying spatial conflicts, evaluating project hazards, and supplying parametric data throughout a building's life cycle (Rodrigues et al., 2022; Alaloul et al., 2023). Nevertheless, insufficient experience, massive costs for implementation, and change opposition generally prevent its widespread adoption. Integration of BIM with Geographic Information Systems (GIS) and construction scheduling elevates safety hazard identification across project stages.

BIM offers visualization tools aid in identifying safety requirements, standardizing measures, and integrating procedures into project timelines (Ismail, 2023). Safety planning and administration are improved by BIM's 4D, modelling (Doroshin et al., 2023). The use of spatial-temporal data in BIM increases hazard avoidance, site layouts, and safety communication (Ghaffarianhoseini et al., 2017). Construction sites frequently report incidents, illnesses, and injuries, with the industry recording the highest injury rates among industries (Afzal et al., 2021). Data from the Social Security Organisation (SOCSO) indicates that the construction sector's fatality rate is over three times higher than those in manufacturing, mining, and quarrying (Halim et al., 2020). Furthermore, The Malaysian Department of Occupational Safety and Health (DOSH) reported that more than half of the 141 fatalities in 2023 were in construction and manufacturing.

Although BIM has shown promise in improving site safety, limited expertise, high implementation costs, and reluctance to change frequently preclude its widespread use. Despite these challenges, BIM offers opportunities to improve safety practices, foster a positive safety culture, and mitigate risks through enhanced planning, visualisation, and management tools. This paper explores the barriers to BIM adoption in construction site safety and proposes potential solutions for its effective implementation in building projects.

## **LITERATURE REVIEW**

### **Overview of BIM for construction site safety**

Safety in construction is a critical factor influencing overall productivity. Working on construction sites is hazardous, making it one of the most injury-prone jobs (Venkatesh & Ergon, 2023). BIM is utilised to improve construction site safety through better design techniques and work method statements (Azhar & Behringer, 2013). BIM is essential to site safety, minimizing occupational accidents, and improving project management efficiency (Rodrigues et al., 2022). Advanced technology and design modifications help prevent construction

accidents. By providing effective platform for proactive safety design, BIM helps mitigate potential future hazards (Shukri et al., 2023; Afzal et al., 2021).

BIM offers various definitions depending on the observer's perspective and the organisation's goals (Golizadah et al., 2023). According to (Malekitabar et al., 2016) and Afzal et al. (2021), pairing BIM with other visualisation tools during the design phase is critical for discovering, analysing, and minimising safety concerns. Similarly, clients, consultants, and contractors may easily collaborate using BIM's integrated virtual model of facility elements, disciplines, and systems (Abed et al., 2019). Moreover, BIM enhances building designs by integrating extensive information, including safety management (Shukri et al., 2023). Despite government attempts to promote BIM, several organisations endure to fully use BIM throughout all project phases (Al-Ashmori et al., 2020). The constantly shifting BIM process provides information-rich models that support all project phases.

### **Barriers to the adoption of BIM in construction site safety**

#### **Resistance to change**

Zahrizan et al. (2014) noted that some organizations unwilling to adapt their business processes owing to cost and risk concerns. Due to a lack of managerial skills with technological change, personnel often contend technology will replace their duties, resulting in anxiety when new systems arrive. Implementing BIM often requires hiring specialists to manage and operate the software, which can discourage organization from embracing it (Memon et al., 2014).

#### **High cost**

Memon et al. (2014) highlighted that adopting BIM requires substantial initial investments in employee training, technological upgrades, and software updates. Small construction enterprises are often hesitant to adopt BIM due to the significant costs associated with acquiring BIM-based solutions (Rafindadi et al., 2020). According to Othman et al. (2021), BIM's ability to decrease money and time is still unclear, discouraging construction companies from adopting it.

#### **Lack of Knowledge and Skills**

In Malaysia, many Small and Medium-Sized Enterprise (SME) construction firms are reluctant to adopt BIM due to their limited capability to implement it in projects (Rafindadi et al., 2020). Furthermore, construction personnel often lack BIM understanding and knowledge (Haron et al., 2017). This knowledge gap is visible as 10.8% of public and private sector respondents were uncertain once their organisations employed BIM (Othman et al., 2021).

### **Time Required in Training Personal**

According to the Criminale and Langar (2017), staff training time is a key obstacle to adopting BIM. Additionally, construction companies must allocate a substantial time and resources to running the training programs (Haron et al., 2017). Rafindadi et al. (2020) noted that the learning process requires both training and considerable time, which increases organizational expenses and effort in mastering new software.

### **Lack of BIM Contract Documents**

Lack of BIM-specific contract agreements and paperwork makes project operations unpredictable and decreases effort to document participant roles. Standard contracts to promote risk distribution and combine dispute resolution, risk compensation, and insurance are lacking (Eadie et al., 2013).

### **Insufficient External Motivation**

BIM adoption depends on external motivation (Ding et al., 2015). Malaysia's BIM incentive systems are inadequate, and construction stakeholders generally lack sufficient motivation to embrace BIM (Cao et al., 2017). This absence of external assistance might make BIM adoption less appealing.

### **Lack of Standardized Procedures for Work Collaboration**

Collaboration with external team members is difficult without standardised methods (Shen et al., 2010). BIM integration with subcontractors is complicated by the construction industry's division (Ku & Taiebat, 2011). Third parties' refusal to share the contractor's BIM model typically causes this issue. Failure to innovate and industry self-interest can also cause data interchange issues (Porwal & Hewage, 2013).

### **Limitation on Interoperability**

Interoperability challenges develop between construction professionals, software, and shared data. Modern BIM tools struggle to integrate various construction businesses during early design (Forgues et al., 2012). Most of the software is developed by a single organisation, thus not all construction team members comprehend it (Anker Jensen & Ingi Jóhannesson, 2013).

### **Difficulty in Adapting to the BIM Process**

Elmualim and Gilder (2014) noted that adapting to BIM technology and processes is a major impediment to BIM adoption in building projects. Stakeholders, particularly in developing markets, face substantial challenges in reengineering existing processes, which greatly hinders the effective implementation of BIM (Yan & Demian, 2008).

### **Lack of BIM Standards**

Lack of government-mandated BIM rules hinders implementation (Li et al., 2018). Adopting BIM requires clear standards for its procedures, activities, and deliverables. Government agencies have established BIM guidelines in recent years, although their coverage is restricted compared to the US, Australia, and other OECD nations.

### **The solution for implementing BIM in a building project**

#### **Support from the Government**

BIM adoption is driven by government funding and assistance, enabling Architecture, Engineering, and Construction (AEC) businesses encompass training, consultation, and software and hardware costs (Rafindadi et al., 2020). In order to encourage wider BIM adoption, the government could subsidize BIM software licenses and offer incentives such as free training for companies implementing BIM in their projects (Zambri et al., 2021). For instance, the Malaysian government requires BIM for all public projects exceeding RM 100 million (Rafindadi et al., 2020).

#### **Promote Safety in BIM Training Program**

Staff safety training ought to start immediately, best before the project begins, using BIM-based tools or other easily accessible ways (Rafindadi et al., 2020). Events like seminars and workshops may be organised by the government to increase awareness and motivate industry players. Malaysian higher education institutions ought to provide BIM courses that prepare graduates for BIM implementation (Haron et al., 2017).

#### **Provide a National Standard Guidelines**

A standardized BIM code of regulations and guidelines is essential for unifying project outputs, facilitating effective communication, and ensuring seamless integration among stakeholders, thereby simplifying deployment and management (Haron et al., 2017). Zambri et al. (2021) highlight the need for the government to establish a national BIM guideline encompassing the entire project lifecycle, including planning, design, construction, and defect liability.

#### **Appoint a BIM Safety Manager or Coordinator**

Assign a BIM Safety Manager or Coordinator to monitor BIM-related operations, ensure compliance with BIM standards, and foster communication among stakeholders (Borrmann et al., 2018). This expert is vital for integrating BIM with construction safety management throughout the project to resolve safety concerns using BIM technologies. It allows the project team to identify and minimise safety issues using BIM (Garzia & Lombardi, 2018).

### **Define Roles and Responsibilities for BIM-Based Safety Management**

Define team members' BIM-based safety management responsibilities, including hazard identification, risk assessment, and safety planning. Designating roles helps project stakeholders including the BIM Manager, BIM Coordinator, Model Manager, Information Manager, and BIM Facilitator work together to identify and minimise safety concerns (Akram et al., 2022).

### **Develop BIM-Based Safety Analytics and Reporting**

Leveraging Building Information Modelling's data-rich capabilities, BIM-based safety analytics and reporting monitors, analyses, and reports on construction project safety (Dadashi Haji et al., 2023). Construction projects may create complete safety reports and dashboards using BIM and real-time data from wearable devices, sensors, and site cameras (Dadashi Haji et al., 2023). Consequently, it enhances overall site safety performance while minimizing the risk of accidents (Hire et al., 2024).

### **Utilize BIM for Automated Safety Rule Checking**

Using BIM to automate safety hazard detection and rule-based safety inspections to reduce risk as well as to identify dangers and assure safety compliance before construction (Gao & Chen, 2017). The 2010 Georgia Institute of Technology safety-checking system emphasizes early danger identification using BIM models with safety-specific data including construction equipment, access points, and materials (Hossain & Ahmed, 2022). Integrating BIM with automated safety systems streamlines safety management, enhances decision-making, and foster a safer work environment on construction sites (Hossain & Ahmed, 2022).

### **Enhance Safety Planning and Visualization with BIM**

BIM technology lets project teams produce 3D visualisations of temporary structures, traffic routes, and material storage facilities. This helps identify bottlenecks, congestion, and layout problems, enabling safer solutions (Akram et al., 2022). BIM also facilitates the strategic placement of safety equipment, such as guardrails, safety nets, and personal protective equipment (PPE), through virtual simulations. This method provides educated decision-making and incorporation of safety measures into the building site plan. This makes workplaces safer and lowers accidents (Wettewa & Hadikusumo, 2023).

### **Integrate BIM with Safety Risk Management Processes**

BIM detects, analyses, and reduces project dangers. This connection offers precise 3D models with safety-specific data on building materials, equipment, and access points for early hazard detection and risk mitigation (Chatzimichailidou & Ma, 2022). Incorporating BIM into safety risk

management processes allows construction projects to proactively address safety hazards, ensure compliance with health and safety regulations, and foster a safety-conscious culture among stakeholders (Zou et al., 2017).

### **Integrate BIM with Real-Time Monitoring Technologies**

Integrate real-time monitoring technologies, such as wearable devices and sensors, with BIM to track and analyse safety-related data on-site (Devaiah & Keshav, 2022). By comparing real-time data from these monitoring technologies with the BIM model, teams can accurately track construction progress, identify deviations from the plan, and make timely, informed decisions to address emerging issues. Additionally, overlaying real-time data onto the BIM model enhances visualization of construction progress, fostering improved collaboration and communication among stakeholders (ElQasaby et al., 2022).

## **RESEARCH METHODOLOGY**

This research explores the challenges hindering the adoption of BIM to enhance construction site safety and examines possible solutions, focusing specifically on building projects within the Klang Valley. A quantitative research methodology was utilized, incorporating a questionnaire-based survey to fulfil the objectives of the study. The survey was conducted between January and April 2024, and the survey gathered responses from 250 professionals in the construction industry with BIM experience. The questionnaire was divided into demographic details, barriers to BIM implementation in construction site safety, and potential strategies for overcoming these barriers. The second and third sections featured ten items each, assessing challenges and suggested solutions, with responses gauged on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The collected data were analysed using descriptive statistical methods via SPSS Version 27, and the findings were systematically ranked and presented.

## **ANALYSIS AND DISCUSSION**

### **Demographic profile**

Table 1 summarises the demographic characteristics of the respondents. Among the participants, 62.4% are male and 37.6% are female. The age distribution is as follows: 25.2% are aged 19-24 years, 34.8% are 25 - 34 years, 27.2% are 35 - 44 years, 12.8% are 45 - 54 years, and 27.2% are over 54 years. Regarding educational qualifications, 3.2% hold a technical certification, 36% have a diploma, 45.2% possess a degree, 15.2% hold a master's degree, and 4% have a PhD. In terms of job roles, 23.2% are Architects, 0.8% are Project Managers, 19.6% are Engineers, 5.6% are Site Planners, 0.8% are Safety and Health Officers, 16% are Site Safety Supervisors, 9.2% are Quantity Surveyors, 21.6% are Site Supervisors, and 3.2% did not specify their roles. Regarding work experience, 4.4% have less than 1 year of experience, 46% have 1 - 5 years, 32%

have 5 - 10 years, 16.8% have 10 - 15 years, and 0.8% have over 15 years of experience.

**Table 1: Respondents' Demographic Profile**

Items	Description	Frequency	Percentage
<b>Gender</b>	Female	94	37.6
	Male	156	62.4
<b>Ages</b>	19 – 24 years	63	25.2
	25 – 34 years	87	34.8
	35 – 44 years	68	27.2
	45 – 54 years	32	12.8
	Above 54 years	64	25.2
<b>Qualification</b>	Sijil	8	3.2
	Diploma	90	36.0
	Degree	113	45.2
	Master	38	15.2
	PhD	1	0.4
<b>Position</b>	Architect	58	23.2
	Project Manager	2	0.8
	Engineer	49	19.6
	Site Planner	14	5.6
	Safety and Health Officer	2	0.8
	Site Safety Supervisor	40	16.0
	Quantity Surveyor	23	9.2
	Site Supervisor	54	21.6
	Surveyor	8	3.2
<b>Working Experience</b>	Less than 1 year	11	4.4
	1 – 5 years	115	46.0
	5 – 10 years	80	32.0
	10 – 15 years	42	16.8
	More than 15 years	2	0.8

#### **The barriers to the adoption of BIM in construction site safety**

The group factors of "barriers" consist of ten components, namely: (i) limitation on interoperability; (ii) resistance to change; (iii) lack of knowledge and skills; (iv) lack of BIM contract documents; (v) difficulty in adapting to the BIM process; (vi) time required in training personnel; (vii) high cost; (viii) insufficient external motivation; (ix) lack of standardized procedures for work collaboration; and (x) lack of BIM standards. The analysis results, presented in Table 2, report the following mean (M) and standard deviation (SD) values: limitation on interoperability (M = 4.24, SD = 0.692); resistance to change (M = 4.16, SD = 0.691); lack of knowledge and skills (M = 4.14, SD = 0.689); lack of BIM contract documents (M = 4.13, SD = 0.724); difficulty in adapting to the BIM process (M = 4.08, SD = 0.782); time required in training personnel (M = 4.07, SD = 0.783); high cost (M = 4.02, SD = 0.816); insufficient external motivation (M = 4.02, SD = 0.556); lack of standardized procedures for work collaboration



( $M = 3.88$ ,  $SD = 0.762$ ); and lack of BIM standards ( $M = 3.79$ ,  $SD = 0.699$ ). The average mean value is 4.05, indicating that all barriers are significant. Additionally, the standard deviation (SD) values are below 1.000 for all components, reflecting minimal variability in respondents' perceptions.

**Table 2:** The barriers to the adoption of BIM in construction site safety

Descriptive Statistic	N	Mean	Std. Deviation
Limitation on Interoperability	250	4.24	0.692
Resistance to change	250	4.16	0.691
Lack of Knowledge and Skills	250	4.14	0.689
Lack of BIM Contract Documents	250	4.13	0.724
Difficulty in Adapting to the BIM Process	250	4.08	0.782
Time Required in Training Personal	250	4.07	0.783
High Cost	250	4.02	0.816
Insufficient External Motivation	250	4.02	0.556
Lack of Standardized Procedures for Work Collaboration	250	3.88	0.762
Lack of BIM Standards	250	3.79	0.699

Based on the data analysis in Table 2, only three (3) main barriers will be discussed. The following are the three (3) primary barriers to BIM adoption for construction site safety in building projects.

#### **Limitation on Interoperability**

The most significant challenge in the implementation of BIM for construction site safety in building projects in Klang Valley is the limitation on interoperability. The mean value 4.24 indicates that majority of respondents believe that limitation in interoperability is the primary barrier to implementing BIM for construction site safety. Respondents noted that organizations employ diverse software systems, which make communicating with construction stakeholders complicated. This absence of smooth data transmission might lead to insufficient or erroneous data, decreasing safety planning and risk reduction.

#### **Resistance to Change**

Many construction organisations are reluctant to change their business processes related to expense and risk. Fears include technology replacing their jobs. The respondent stated that BIM necessitates substantial modifications to work processes, which can be difficult for certain individuals and organisations to adjust to. Construction organisations may favour simpler, more known procedures over a sophisticated system.

#### **Lack of knowledge and skills**

Lack of knowledge and skills ranks as the third highest barrier. BIM software is complex and requires knowledge. These instruments might overwhelm

construction professionals without the right knowledge and abilities. The respondents stated building companies may oppose BIM since they are used to traditional ways. Fear of change or desire for familiarity may cause this reluctance.

### **The solutions for implementing BIM in a building project**

The solutions for implementing BIM in building projects encompass ten key strategies: (i) appointing a BIM Safety Manager or Coordinator; (ii) integrating BIM with real-time monitoring technologies; (iii) enhancing safety planning and visualization with BIM; (iv) utilizing BIM for automated safety rule checking; (v) providing national standard guidelines; (vi) ensuring government support; (vii) defining roles and responsibilities for BIM-based safety management; (viii) promoting safety in BIM training programs; (ix) integrating BIM with safety risk management processes; and (xii) developing BIM-based safety analytics and reporting. The analysis results, presented in Table 3, report the following mean (M) and standard deviation (SD) values: appointing a BIM Safety Manager or Coordinator (M = 4.36, SD = 0.749); integrating BIM with real-time monitoring technologies (M = 4.33, SD = 0.754); enhancing safety planning and visualization with BIM (M = 4.33, SD = 0.710); utilizing BIM for automated safety rule checking (M = 4.31, SD = 0.796); providing national standard guidelines (M = 4.31, SD = 0.785); ensuring support from the government (M = 4.31, SD = 0.748); defining roles and responsibilities for BIM-based safety management (M = 4.23, SD = 0.623); promoting safety in BIM training programs (M = 3.99, SD = 0.591); integrating BIM with safety risk management processes (M = 3.80, SD = 0.687); and developing BIM-based safety analytics and reporting (M = 3.73, SD = 0.611). The average mean value is 4.14, suggesting that the proposed solutions are widely regarded as effective. Furthermore, all standard deviation (SD) values are below 1.000, indicating consistency in respondents' views on these solutions.

**Table 3:** The Solution for implementing BIM in a building project

<b>Descriptive Statistic</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>
Appoint a BIM Safety Manager or Coordinator	250	4.36	0.749
Integrate BIM with Real-Time Monitoring Technologies	250	4.33	0.754
Enhance Safety Planning and Visualization with BIM	250	4.33	0.710
Utilize BIM for Automated Safety Rule Checking	250	4.31	0.796
Provide a National Standard Guidelines	250	4.31	0.785
Support from the Government	250	4.31	0.748
Define Roles and Responsibilities for BIM-Based Safety Management	250	4.23	0.623
Promote Safety in BIM Training Program	250	3.99	0.591

Descriptive Statistic	N	Mean	Std. Deviation
Integrate BIM with Safety Risk Management Processes	250	3.80	0.687
Develop BIM-Based Safety Analytics and Reporting	250	3.73	0.611

From the data analysis in Table 3, three (3) main solutions have been identified for discussion. These are the primary strategies for BIM adoption to enhance construction site safety in building projects.

#### **Appoint a BIM Safety Manager or Coordinator**

Respondents indicated that the BIM Safety Manager or Coordinator is responsible for overseeing the application of BIM to identify, analyse, and mitigate safety hazards. These professionals ensure seamless real-time communication between the virtual models and the construction site, ensuring that safety measures are effectively integrated and consistently implemented throughout the construction process.

#### **BIM with Real-Time Monitoring Technologies.**

Respondents noted that BIM's predictive capabilities and real-time data allow construction teams to rapidly detect and mitigate problems before accidents. Real-time monitoring alerts of structural instabilities and equipment failures.

#### **Enhance Safety Planning and Visualization with BIM**

Respondents highlighted that BIM helps to enable comprehensive and thorough safety studies both before and during building. Early in the project life, BIM helps to foresee and minimise safety hazards, therefore improving general project efficiency and ensuring greater safety compliance.

### **CONCLUSION**

The construction industry is known for its elevated rate of fatalities, mostly attributable to the hazardous work environment and inherent dangers associated with the profession. Construction site workers are involved in a lot of accidents, illnesses, and injuries. The findings revealed that interoperability limitations, resistance to change, and lack of knowledge and skills are the primary barriers to BIM adoption for construction site safety. The top solutions were hiring a BIM safety manager or coordinator, integrating BIM with real-time monitoring, and improving safety planning and visualisation. Future studies needs to concentrate on these areas, particularly BIM applications in facility management, to strengthen this research. Expanding the survey to include non-Klang Valley respondents would offer a more complete picture of the building sector. Addressing these difficulties and applying the suggested techniques would help the industry maximise BIM's safety benefits on building projects.

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## **PERCEPTIONS OF SAFETY AMONG ELEMENTARY SCHOOL CHILDREN AND ITS SURROUNDINGS DURING SCHOOL COMMUTES: CASE STUDY FUKUOKA, JAPAN**

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### **Abstract**

This study looks at how elementary school students in Fukuoka, Japan, perceive the safety of their commutes. It employs a mixed-methods approach, integrating observational research of school routes with quantitative questionnaires. 165 kids between the ages of 6 and 12 participated in surveys to gauge how safe they thought they were. Real-time insights into environmental risks, such as sidewalk conditions, traffic patterns, and safety infrastructure, were made possible by observational data. Traffic accidents, strange people, and dimly lit streets are the main issues cited; there are also higher risks on the trip home, especially in dim alleys. The existence of "few people" was another common worry. The results underscore the necessity of safer school routes and the significance of cooperation between transportation authorities, educators, and legislators. The report emphasises the need for better illumination, monitoring, and community engagement to improve kids' commute safety and provide a safer environment for school transportation.

**Keywords:** Fukuoka, Children, Safety, Walkability, Community

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## **INTRODUCTION**

Previous studies have highlighted a positive correlation between active school travel and various neighbourhood characteristics, including physical and social environments, safety, walkability, and social interactions (Ikeda et al., 2018; Martin et al., 2021). While much research has focused on traffic safety, fewer studies have addressed concerns related to criminal activities or potential risks posed by strangers (Bendak, S., 2005; Valentine, G., 1997; Pain, R., 2006). For example, Harumain et al. (2022) explored how the built environment influences mothers' perceptions of their children's independence in walking to school, while Ibrahim et al. (2024) examined broader patterns of children's independent mobility in Malaysia, revealing how environmental and social factors shape commuting behaviours. These findings underscore the need for safe, walkable, and socially interactive neighbourhoods to promote active school travel. This study focuses on a city in Japan where a Japanese school children's perceptions on safety when commuting to school are examined based on the current perception of children in a safe country like Japan.

The study was conducted in Fukuoka, Japan, and it is observed that the school personnel and community volunteers commonly monitor road crossings in areas with high vehicular activity to ensure children's safety. A higher proportion of mothers remaining at home compared to other affluent nations has historically facilitated direct returns from school to home. However, this trend has shifted over the past two decades, with more women entering the workforce, resulting in diversified arrival times and fewer community volunteers overseeing children's commutes. Despite Japan's global reputation for high rates of active school travel, there is limited research on the school travel patterns of Japanese children (Mori et al., 2012), including disparities in transportation modes between journeys to and from school (Trapp et al., 2011; Waygood & Taniguchi, 2020). This study investigates the correlations between neighbourhood-built environments, safety conditions, and social factors, and their influence on school travel among elementary schoolchildren in Fukuoka City, Japan. By examining the walkability of school routes and the perceptions of children regarding unsafe factors, the study contributes to the growing body of research on the interplay between urban environments and children's mobility (Hino et al., 2021; Fallah Zavareh et al., 2023). The case study explores the influence of pedestrian infrastructure, safety measures, and urban planning on shaping school commutes. It also investigates the perceptions of elementary schoolchildren in Fukuoka regarding unsafe factors encountered during their journeys to and from school – an aspect critical to their overall welfare. By analysing the relationship between the urban physical environment and children's walking experiences, the study highlights the importance of fostering collaboration among communities, educational establishments, and urban planners. Such partnerships are vital for

developing pedestrian-oriented school routes that prioritise safety and promote active, sustainable transportation for children. Ultimately, this research underscores the need to create pedestrian-friendly environments that support the well-being and security of young commuters.

## **LITERATURE REVIEW**

The concept of walkability, particularly in relation to school routes, has become a focal point in urban planning. Promoting walking to school not only encourages physical activity but also alleviates traffic congestion and reduces environmental pollution. This literature review examines the walkability of school routes in Japan, exploring the factors that influence it, the benefits of walking to school, and insights drawn from Japanese practices. Numerous studies in Japan and internationally demonstrate the multifaceted nature of walkability. Mori et al. (2012) highlights the significance of safety initiatives and local characteristics in promoting walking to school, while Barati et al. (2021) underscores the influence of built environment features, socio-economic factors, and parental concerns at the route level. Similarly, Su et al. (2013) identifies key determinants such as proximity between home and school, age, traffic density, land use mix, and school-specific characteristics. These findings underscore the importance of implementing tailored interventions – such as safety measures, land use changes, and infrastructure improvements – to improve the walkability of school routes.

### ***Factors Influencing Walkability***

Walking rates are positively associated with proximity to school, older age, and living in neighbourhoods with lower traffic density (Su et al., 2013). Cole et al. (2007) observed that parents who walked for at least 10 minutes during the school journey were more likely to live within two kilometres of the school, have only one car, lack a driver's licence, and send their children to government schools. Su et al. (2013) further noted higher walking rates among children from families enrolled in government subsidy programs and found that schools located within residential neighbourhoods encouraged walking. Conversely, a greater land use mix in surrounding neighbourhoods was associated with lower walking rates, suggesting that updating street designs could better promote walking to school. Additional factors influencing walking rates include physical activity levels, safety concerns, traffic conditions, parking convenience, children's preferences, age and road sense (Cole et al., 2007). Consistent correlates of walking to and from school also include route safety and family time constraints (Trapp et al., 2011). Walkability to school – the ease and safety with which children can walk to and from their schools – is critical for encouraging physical activity among children (Lee et al., 2022). Key factors include proximity to residential areas, pedestrian infrastructure, and environmental conditions, all of which significantly

influence children's ability and willingness to walk. Schools located within walking distance of homes reduce reliance on motorised transportation, making walking a feasible option. Safe and well-maintained infrastructure, such as sidewalks and crosswalks, is essential for ensuring children's safety, instilling confidence in students and parents, and promoting walking as a mode of transport. Environmental factors, including air quality, traffic congestion, and natural surroundings, also shape walkability. For instance, busy roads and poor air quality discourage walking due to safety and health concerns, whereas green spaces, parks, and tree-lined streets create more appealing walking environments. Furthermore, walkability factors may differ by gender, with boys and girls influenced by distinct challenges (Trapp et al., 2011). Addressing these barriers requires comprehensive urban planning strategies that prioritise safe, healthy, and attractive walking environments for schoolchildren, emphasising the importance of proximity, pedestrian safety, and environmental quality.

Socio-cultural factors also significantly affect walkability. Parental concerns about traffic hazards and stranger danger often determine whether children are allowed to walk independently. Social norms that view walking as a healthy and sustainable mode of transport can foster a culture of walking among families. Community-led initiatives, such as walking school buses and pedestrian advocacy groups, are instrumental in promoting walkability by raising awareness, advocating for safer infrastructure, and fostering community cohesion around active transportation. Addressing these multifaceted factors is crucial for developing walkable school environments that promote physical activity, safety, and overall well-being among schoolchildren. Understanding the diverse influences on walkability is vital for crafting effective interventions and policies that encourage active transportation among school-aged children. Further exploration of the interplay between environmental, social, and cultural factors will aid in designing supportive environments that prioritise the health, safety, and mobility of young individuals.

### ***Benefits of Walking to School***

Walking to school provides numerous benefits to individuals and communities alike. From a public health perspective, regular physical activity improves cardiovascular health, reduces the risk of obesity, and enhances mental well-being among school-aged children. Walking also fosters independence and social interaction, allowing children to develop essential life skills and form meaningful relationships with peers. Furthermore, encouraging walking to school supports sustainability goals by reducing carbon emissions and fostering community cohesion. Despite these advantages, concerns about traffic safety, risks posed by strangers, and unsafe environmental conditions deter many families from promoting walking as a viable commuting option. This research addresses these

safety concerns by examining children's perceptions of commuting risks, providing evidence to inform policies that enhance the safety and appeal of walking to school. Addressing these challenges is essential for ensuring children can safely enjoy the physical, social, and cognitive benefits of walking. Walking to school has proven benefits for physical and mental health, social and cognitive development, and even local government finances (Lee et al., 2022). Investigating the interactions between environmental, social, and cultural factors is crucial for creating supportive environments that prioritise the well-being and physical activity of children and while encouraging walking to school. Programs such as walking school buses and safe routes to school initiatives have demonstrated a positive impact on children's ability and willingness to walk to school. Cooper et al. (2005) found that children who walked to school exhibited higher overall physical activity levels throughout the day compared to those who were driven. This underscores the potential of walking to school not only to increase daily physical activity but also to establish lifelong healthy habits. Moreover, walking to school has been linked to improved academic performance and enhanced concentration in the classroom, highlighting its cognitive benefits. Beyond individual benefits, walking to school has broader implications for public health and environmental sustainability. By reducing car traffic around schools, walking helps lower air pollution and supports sustainable transportation practices. This aligns with the increasing focus on environmentally friendly initiatives in urban areas. The advantages of walking to school are multifaceted and extend beyond physical activity. Cole et al. (2007) highlights its potential to reduce costs, improve fitness, and contribute to environmental benefits. They also note that walking to school fosters health-enhancing physical activity, particularly among parents with specific characteristics. Similarly, McDonald et al. (2020) emphasise the economic benefits of promoting active school travel, including decreased transport and injury-related costs. Collectively, these findings underscore the importance of encouraging walking to school to promote healthier lifestyles for children. As Knollenberg et al. (2016) argue, fostering physical activity through walking can significantly contribute to the development of lifelong health and wellness habits.

### ***Lessons from Japanese Practices***

Japan's approach to promoting walkability provides valuable insights for policymakers and urban planners globally. Its compact urban design, extensive public transportation network, and pedestrian-friendly infrastructure foster an environment conducive to walking. Emphasising safety, cleanliness, and community engagement, Japan has cultivated a culture where walking is practical, enjoyable, and integral to daily life. By prioritising pedestrian needs and implementing traffic-calming measures and school zone safety initiatives,

Japan serves as a model for creating walkable school routes. However, social changes such as declining birth rate, a reduction in public elementary schools, and increasing after-school activities may influence parental attitudes and children's walking habits over time (Hino et al., 2021). For instance, a study in Chiba, Japan, found that factors like crime safety, neighbourhood connections, and CCTV presence significantly shaped children's walking behaviours (Hino et al., 2021). They noted that social changes, such as declining birth rate and increasing after-school activities, could influence children's walking habits over time. Consequently, collaborative efforts among education, public health, and urban planning sectors are crucial to preserving the high prevalence of walking to and from school in Japan.

Japanese practices regarding walking to school offer valuable lessons for policymakers and urban planners worldwide. Since its establishment in 1953, this approach has successfully promoted regular physical activity and addressed childhood obesity (Mori et al., 2012). Its success is largely attributed to the availability of schools within walking distance, robust safety measures, and the involvement of parents, school staff, and local volunteers (Mori et al., 2012). Moreover, the practice supports children's autonomy, psychological well-being, and social interactions (Waygood & Taniguchi, 2020). Neighbourhood factors such as crime safety, community connections, and school location play a significant role in influencing walking habits to and from school (Hino et al., 2021). Walking is strongly associated with physical activity, with a minimum of 45 minutes per day being key to meeting physical activity recommendations (Sasayama et al., 2021). Addressing elements like urban design, pedestrian infrastructure, and cultural attitudes can help create environments where walking to school is not only encouraged but becomes standard practice. Embracing walkability principles improves public health, mitigates environmental impacts, and fosters vibrant, interconnected communities where children can thrive. As the global momentum towards building sustainable and healthy cities continues, the lessons learned from Japan's approach to walkability remain particularly relevant and impactful.

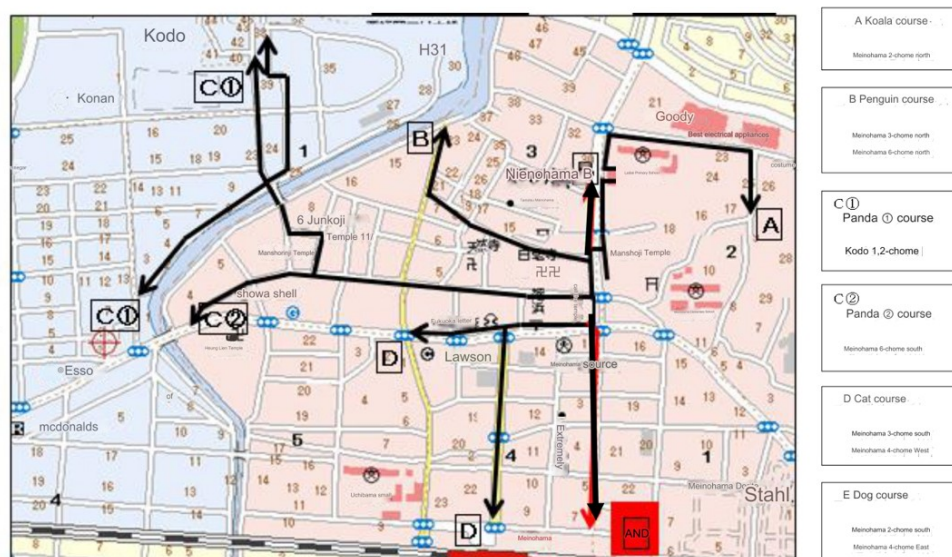
## **RESEARCH METHODOLOGY**

This study employs a mixed-methods approach, integrating quantitative surveys and qualitative observations to examine school route walkability and safety for children in Fukuoka, Japan. Quantitative data were collected from 165 elementary schoolchildren aged 6 to 12, focusing on their perceptions of safety during their commutes to and from school. Qualitative observations provided real-time, objective data on environmental factors, including the condition of sidewalks, traffic patterns, crosswalk availability, and safety infrastructure. This

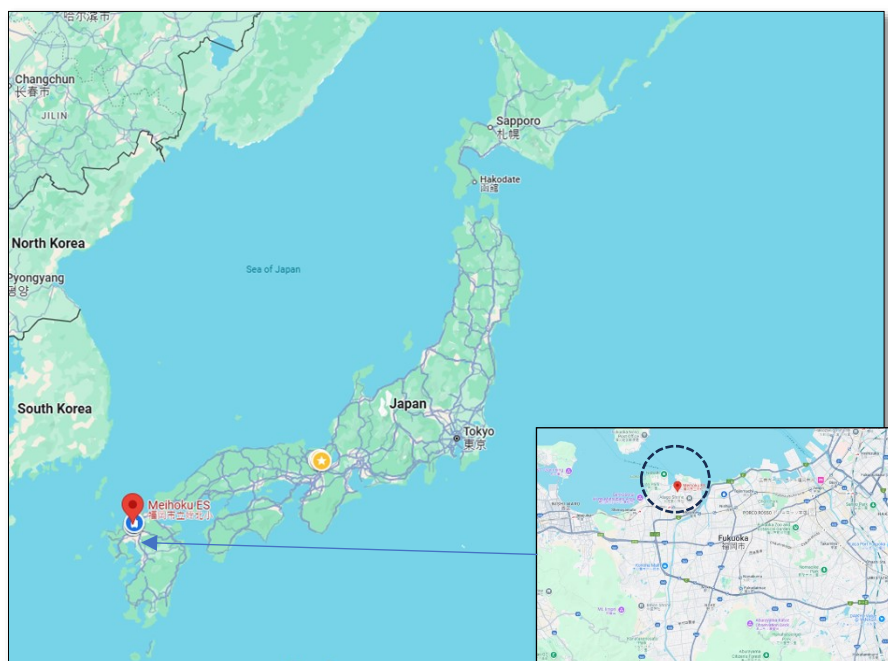
dual-method approach ensures a comprehensive understanding of both subjective experiences and objective environmental conditions.

The study was conducted at Meihoku Elementary School, Meinohama of Fukuoka City, chosen through purposive sampling to target children who commute on foot. Fukuoka, the fifth-largest urban area in Japan with a population of 1.6 million, is known for its extensive public transportation network, including buses, JR lines (JR Kyushu and JR West), subway systems, private railways, and ferries. Minami Ward, one of Fukuoka's seven wards, served as the geographical focus of the study. A total of 165 elementary schoolchildren aged between 6 to 12 years from Meihoku elementary school participated in the study. Respondents were selected using a non-probability purposive sampling technique, specifically targeting students who commute on foot. This method was chosen to provide valuable insights into the safety and environmental challenges of walking to and from school, aligning directly with the study's research objectives. By focusing on children who walk to school, the approach emphasised their unique experiences and perceptions of navigating urban school routes. The observation method complemented the survey data by offering a detailed, real-time, objective assessment of the physical environment along the school routes. Researchers directly observed and documented key factors, including the condition of sidewalks, the frequency and visibility of crosswalks, traffic flow patterns, lighting, and the presence of safety measures such as pedestrian signals and barriers. This observational approach captured critical environmental factors influencing the walkability and safety of school routes, providing a layer of detail that might not be fully captured through survey responses alone (Bendak, 2005; Ikeda et al., 2018). By directly experiencing and documenting the conditions children face, the study provides valuable insights into how environmental factors influence children's perceptions of safety during their commute. The descriptive analysis method systematically categorises these observations, enabling researchers to present a clear overview of the findings and highlight areas requiring improvement (Mitra & Buliung, 2011; Hino et al., 2021). By combining observations with descriptive analysis, the study creates a comprehensive picture of the walkability and safety of school routes in Fukuoka. Descriptive analysis was applied to both the survey and observational data, offering a detailed understanding of the safety challenges and infrastructure issues that impact children's active school travel.

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*Perceptions Of Safety Among Elementary School Children and Its Surroundings During School Commutes:  
 Case Study Fukuoka, Japan*



**Figure 1:** Map routes of schoolchildren in Meihoku elementary school



**Figure 2:** Case study location, which is in Meinohama, Fukuoka, Japan.  
 (Source of map: Google Map)

## **RESULTS AND DISCUSSION**

The questionnaire survey was given to 165 primary schoolchildren aged 7 to 12 years old ( $n = 165$ ) in Fukuoka, Japan. The gender distribution was nearly equal, with 47.9% male and 46.7% female respondents, while a small percentage did not specify their gender. The respondents were spread across six grades, with Grades 1 and 2 having the highest representation at 21.2% each. Grade 4 followed with 16.4%, Grade 6 with 13.3%, Grade 5 with 12.7%, and Grade 3 with 11.5%. A small portion (3.6%) did not indicate their grade (see Figure 1 and Figure 2). The survey collected data on travel times to school, identifying mobility patterns and challenges. The largest group (27.3%) reported a travel time of 6 to 10 minutes, predominantly male (53.3%). A similar group (25.5%) indicated a travel time of 11 to 15 minutes, evenly distributed between males and females (21 respondents each). Other significant groups included 17 females and 13 males reporting a travel time of 16 to 20 minutes, while 21 respondents (12.7%) reported a travel time of 0 to 5 minutes, with a slight female majority (52.3%). Smaller groups reported longer travel times, with 5.5% taking 21 to 25 minutes, 4.8% taking 26 to 30 minutes, and 0.6% taking more than 30 minutes. Nine respondents (5.5%) did not report their travel time. To assess traffic safety, the survey addressed children's experiences with traffic, pedestrian infrastructure, and any traffic accidents they had witnessed. It also inquired about encounters with suspicious individuals during their commutes to gauge perceptions of personal safety and the frequency of such incidents. The final section examined environmental factors that made children feel uneasy, including poorly lit streets, isolated areas, and other conditions affecting their comfort and safety on the way to school. To better understand the traffic safety and mobility challenges faced by children on their way to school and in their neighbourhoods, a questionnaire survey was conducted. The survey aimed to gather direct insights from the children about their experiences during their commutes. It included questions about their interactions with traffic, the modes of transportation they used, encounters with suspicious individuals, and environmental or social factors in their neighbourhoods that made them feel uncomfortable or unsafe. The following section provides a summary of the key findings from the survey.

The survey findings reveal significant safety concerns for children during their commute to and from school. Among the 21 respondents, most children (57.1%) did not provide an answer regarding whether they had witnessed traffic accidents on their route to school. However, 38% of respondents (8 children) reported witnessing traffic accidents, with Grade 2 students (4 respondents) accounting for most of these incidents. When asked about traffic accidents on their way home from school, 60.9% (14 out of 23 respondents) reported witnessing accidents, with Grade 2 students (5 respondents) and Grade 1 students (4 respondents) again being the most frequent reporters. Notably,



81.25% of those who witnessed traffic accidents used walking as their primary mode of transportation. These findings align with previous research by Mori et. al (2012), who emphasised the importance of policies and infrastructure that ensure safe commuting for children in Fukuoka, Japan. Their study highlighted that safe school routes are critical for promoting both traffic safety and public health, underscoring the need for continued improvements in infrastructure and community awareness to minimise risks for children. In addition to concerns about traffic safety, the survey also explored encounters with suspicious individuals. Male respondents reported encountering suspicious behaviour, such as chasing, abuse, hiding, staring, wandering, and voyeurism. The highest frequency of these incidents occurred during commutes from school to home (7.5%), followed by 1.3% from home to school and 1.3% after school and during school holidays. For female respondents reported encountering suspicious behaviour such as chasing, strangers staring from cars, calling, voyeurism, or individuals loitering at the roadside and staring at them. These incidents were reported during commutes from school to home (3.9%), from home to school (2.6%), as well as after school and during school holidays (7.8%). According to Komiya (2017), 74% of Japanese parents experience anxiety about their children being in the public spaces. The Japanese National Police Agency also reported approximately 4,000 crimes involving elementary schoolchildren that occurred on the street, with most of these incidents happening when children were alone. In addition to encountering suspicious individuals in public spaces, children also expressed concerns about certain places along their school routes that make them feel uneasy. Male respondents reported that 6% felt uncomfortable passing through paths far from the main street, while 7.8% of female respondents were concerned about their safety when choosing routes with fewer people. Both groups expressed concerns about heavy traffic as well. Regarding the surrounding neighbourhoods, both male and female respondents identified roads with few people, quiet roads, dark areas, and heavy traffic as major safety concerns, and they tended to avoid these routes. These results align with Lin et al.'s (2017) research, which found that among NZ European, Mori, Samoan, and other Pacific parents, the most common concern was remote or hidden streets that were less visible to passers-by and less accessible by pedestrians. However, for Asian and Indian parents, "traffic danger" was the primary concern regarding children's safety. According to Valentine (2017), most parents surveyed agree that elementary schoolchildren are particularly vulnerable to dangers like kidnapping (45%) and road accidents (34%), with many believing that female children are more likely to encounter peril than male children. As a result, female children are more often restricted from entering public spaces compared to their male counterparts.

## **CONCLUSION**

The findings of this study offer valuable insights into the factors that elementary schoolchildren perceive as unsafe during their commutes, addressing the research objective of understanding these perceptions to inform safety improvements. The study identified several key risks, including traffic accidents, encounters with suspicious individuals, and feelings of unease, particularly in environments characterised by "dark" streets and alleys. Notably, children reported observing more unsafe factors on their way home from school, highlighting the need for targeted interventions during this part of their commute. These findings reinforce the importance of prioritising pedestrian safety and designing secure school routes. The study successfully met its objectives by systematically analysing the children's perceptions through a structured quantitative approach, complemented by direct observations and comprehensive data collection. The evidence underscores the necessity of incorporating children's perspectives into urban planning and policymaking to create environments conducive to safe and enjoyable walking experiences. However, the study is not without limitations. The non-probability sampling method and the focus on a single elementary school in Fukuoka may limit the generalisability of the findings to other regions or contexts. Future research could expand the sample size, include schools from diverse geographical and socio-economic settings, and explore longitudinal changes in children's safety perceptions. Additionally, integrating qualitative methods, such as interviews or focus groups with parents and educators, could provide a richer understanding of the underlying factors influencing these perceptions. In conclusion, this study provides crucial lessons from Fukuoka that emphasise the importance of addressing safety concerns in school routes to enhance walkability and promote active transportation among children globally. Policymakers, urban planners, and educators should collaborate to design interventions that not only improve safety but also foster children's independence and engagement with their urban environments.

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## **ETHICAL STATEMENT**

This study has received ethical approval UM. TNC2/UMREC\_1954 from UMREC. Parental or guardian consent was obtained for children's participation, ensuring voluntary involvement, anonymity, and confidentiality. No personally identifiable data was collected. Consent to publish findings was also secured. The

study adheres to UMREC's ethical guidelines and regulations for research involving children.

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## **STRATEGIES TO OVERCOME UNETHICAL ISSUES OF ESTATE AGENCY PRACTICES IN MALAYSIA**

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### **Abstract**

The real estate sector contributes significantly to economic growth by providing investment opportunities that influence the social and financial environment worldwide. However, this industry has also faced ethical issues, particularly in estate agency practices, even though there are acts, rules, standards, and bodies governing real estate professionalism in Malaysia. This has vast implications for consumers and the real estate industry. Hence, this study aims to explore strategies and recommendations from the perspective of estate agents to improve estate agency practices and prevent such unethical behavior. To understand the strategies for unethical practices in the Malaysian real estate market, this research employs a qualitative approach involving semi-structured interviews with 15 participants from diverse Registered Estate Agent (REA) practices. This study identified eight strategies to overcome unethical issues of estate agents' practices in Malaysia. This includes regular audits and inspections, encouragement for strict law enforcement, extended periods of comprehensive training, increased awareness through campaigns, limitations of Real Estate Negotiator (REN) recruitment, collaboration with community organizations, reporting mechanisms, and enhanced monitoring by REA. Accordingly, the real estate industry can apply these strategies to reduce unethical behavior and increase the ethics of real estate agents in Malaysia.

**Keywords:** Real Estate Agent, Real Estate Negotiator, Unethical, Misconduct

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## **INTRODUCTION**

Ethics is a fundamental discipline of philosophy that examines human conduct concerning values such as goodness, badness, righteousness, wrongness, conscience, virtue, and justice (Velasquez et al., 1996). Over time, ethical concerns in professional practices are becoming increasingly vital in all industries worldwide. In the real estate industry, ethical conduct is an essential aspect of professionalism that wins over clients' trust and establishes strong business relationships that may result in more sales. Notably, there are several studies worldwide on real estate that examine unethical issues from various aspects (Markoc & Cizmeci, 2021; Olayinka et al., 2010; Brinkmann, 2009; Chun-Chang, 2007; Larsen et al., 2007; Pheng & Tan, 1995).

A real estate agency in Malaysia is a licensed professional service that facilitates the buying, selling, renting, and managing of real estate properties. These agencies serve as intermediaries between property owners and prospective buyers or tenants, ensuring that transactions are conducted smoothly and in accordance with legal regulations. Correspondingly, Malaysian real estate agencies must be registered with the Board of Valuers, Appraisers, Estate Agents, and Property Managers (BoVAEP), governing their practices and ensuring adherence to ethical standards.

Unethical and wrongdoing issues in real estate agencies in Malaysia refer to actions and behaviors that breach the ethical guidelines and legal standards set by regulatory bodies, primarily the BoVAEP. It regulates the Valuers, Appraisers, Estate Agents and Property Managers Act 1981 (Act 242), Valuers, Appraisers, and Estate Agents Rules 1986, and professional standards the Malaysia Estate Agency Standards (MEAS) to govern the estate agents' professionalism. Despite that, unethical behavior is still an issue for the BoVAEP. According to the Malaysian Institute of Estate Agents (MIEA), the number of complaints has increased up to thirty percent (30%), especially during the periods of the Movement Control Order (MCO) and Conditional Movement Control Order (CMCO) (Jason, 2020).

These issues typically involve conduct that undermines the integrity, transparency, and fairness expected in real estate transactions. Such unethical practices compromise the trust between agents and their clients, leading to potential financial losses, legal disputes, and damage to the profession's reputation. Notably, these wrongdoings can arise from a lack of adherence to professional responsibilities, manipulation of information, or exploitation of a client's lack of knowledge. Thus, addressing and mitigating these unethical practices is essential for maintaining public confidence and ensuring the equitable functioning of the real estate market in Malaysia.

Unethical behavior in the real estate sector also includes the deliberate omission or distortion of critical property information, which can mislead clients

and affect their decision-making processes (Ting & Ahmad, 2024). As such, agents may provide incomplete or false data about a property's condition, legal status, or market value to secure a transaction. Additionally, unethical practices encompass failing to disclose conflicts of interest, such as personal stakes in a property or undisclosed relationships with other parties involved in the transaction. These actions violate the fiduciary duty agents owe to their clients: acting in the client's best interests with honesty and full disclosure.

The persistence of unethical practices in the real estate industry can have far-reaching consequences. In particular, it erodes consumer confidence, which is vital for the real estate market's health. It can lead to increased regulatory scrutiny and imposing stricter laws and penalties. According to Ahmad et al. (2024), strengthening the real estate industry's ethical conduct involves collaboration, a commitment to ethical standards, and ongoing education. Hence, the main objective of this study is to explore the strategies to overcome unethical issues based on the recommendations of the estate agent's perspective. This can help improve estate agency practices and prevent such unethical behavior.

## **LITERATURE REVIEW**

### **Overview of Board of Valuers, Appraisers, Estate Agents and Property Managers**

The BoVAEP is a statutory body established in Malaysia in 1981 under the purview of the Ministry of Finance. The operation is governed under the provision of the Valuers, Appraisers, Estate Agents, and Property Managers Act 1981 (BoVAEP, 2024). The board members consist of the Director General, who shall be the President of the Board, six Registered Valuers from the Public Service, four Registered Valuers who have at least six years of professional experience as valuers and have been nominated by ISM, three Registered Estate Agents (REA) with at least six years experience as estate agents, three Registered Valuers nominated by the President of the Board. Three Registered Property Managers were nominated by the President of the Board (Section 9, Act 1981).

Its primary role is to regulate the professions of valuers, appraisers, estate agents, and property managers to ensure professionalism and ethical conduct within the industry. Moreover, BoVAEP is responsible for registering, licensing, and disciplining practitioners in these fields, promoting integrity and transparency in property transactions. Table 1 summarizes the number of registered members of BoVAEP as of August 2024.

**Table 1:** The number of registered members of BoVAEP as of August 2024

Types of Registration	Number of Members
Register Valuers (V)	1351
Probationary Valuers (PV)	3156
Register Estate Agents (E)	3122
Probationary Estate Agents (PEA)	4090
Real Estate Negotiators (REN)	56355
Property Management (PM)	3184
<b>Total</b>	<b>71,258</b>

Sources: BoVAEP (2024)

Despite BoVAEP's efforts to uphold ethical standards, unethical practices continue in the real estate sector. Issues such as misrepresenting property values, undisclosed conflicts of interest, and coercive sales tactics have raised significant concerns. For instance, estate agents may inflate property valuations to secure higher commissions or fail to disclose their dual agency roles, representing both buyer and seller, leading to potential conflicts of interest.

The emergence of these unethical practices has prompted BoVAEP to strengthen its regulatory framework and enhance its enforcement capabilities. The Board hopes to encourage ethical practices among estate agents and other property professionals by imposing stricter guidelines and penalties for misconduct. Nonetheless, the Board is still facing unethical issues with estate agencies, as many practitioners may not fully understand the ethical implications of their actions or the consequences of non-compliance. The presence of unethical practices highlights the need for continuous awareness, education, and enforcement to safeguard the interests of consumers and maintain the integrity of the estate agency industry.

### **Overview of Registered Estate Agents (REAs) and Real Estate Negotiators (RENs)**

In the real estate sector in Malaysia, REAs and Real Estate Negotiators (RENs) serve as intermediaries or third parties in property transactions. REAs and RENs must obey all the guidelines under the Valuers, Appraisers, Estate Agents, and Property Managers Act 1981, Rules 1986 and MEAS. The services offered by these agencies typically include marketing, negotiation, and the preparation of necessary documentation, providing clients with comprehensive support throughout the transaction process.

However, they have multiple roles and qualifications. REAs have fully licensed professionals who register under BoVAEP to supervise transactions and ensure compliance with legal standards. Meanwhile, RENs work under the supervision of REAs, facilitating negotiations and client interactions.

From the perspective of qualification, according to the Act 1981, only candidates that possess a diploma or degree in a related field recognized by the



BoVAEP, complete training, and pass an oral exam under the Test of Professional Competence (TPC) qualified to be REA. Conversely, REN is not required to have formal education as REA. They are only required to complete two days of Negotiator Certificate Courses (NCC) endorsed by the Board and certification. Only then can REA register its negotiator with the Board as a REN. Once approved by the Board, REN will be provided with a REN number to practice. This is where all the action taken by the REN is under the responsibilities of the REAs. Subsequently, the REAs need to ensure the point of hiring RENs is according to the criteria set by the BoVAEP as stipulated in Standard 2, Negotiators (MEAS).

### **Unethical Issue Reported**

Estate agents act as middlemen during the property selling and purchasing process. Most estate agents serve their clients to the best of their ability. Unfortunately, certain common trends among unethical agents make the sales process difficult for their clients. Any disciplinary cases reported that relate to ethical conduct in real estate transactions comprising breaching the Valuers, Appraisers, Estate Agents and Property Managers Act 1981 or Rules 1986 made thereunder, including the MEAS, BoVAEP is the responsible body to take such action. The circular issued by the BoVAEP on the website illustrates each misconduct case together with the charges under respective regulations and the penalties. It suggests that the Board is taking serious action to uphold the profession's integrity.

There are several unethical issues and misconduct committed by the estate agency (Circular, BoVAEP), such as:

- (i) Failure to ensure that all REN(s) employed/engaged by the REA are registered with the Board.
- (ii) Failure to protect the public against misrepresentation and unethical practices.
- (iii) Failure to obey the advertisement requirement stated in the Rules 1986, such as:
  - Placed advertisements without the negotiator's registration number,
  - Solicitation for instructions on their advertisements,
  - Displayed a billboard without obtaining prior consent of the Board,
  - Advertisements that contain a self-laudatory statement.
- (iv) Unethical practices in overseeing clients' money in real estate transactions.

## **RESEARCH METHODOLOGY**

This study aims to determine the strategies and recommendations for unethical issues of estate agents to improve estate agency practices in Malaysia, with a particular focus on Selangor. To gain in-depth insights into these practices and formulate effective strategies for reform, a qualitative research approach was adopted via semi-structured interviews with estate agents in Selangor. It thoroughly assesses participants' perceptions and experiences on the unethical issues of estate agents and perceptions, which may not be captured through surveys or quantitative methods.

This study utilized semi-structured interviews to facilitate a comprehensive exploration of these issues. This format provides a flexible framework to ensure that core topics are covered while allowing participants to express their views on their own terms. This approach is particularly valuable for exploring sensitive topics like unethical practices, where the depth of understanding is crucial.

## **DATA COLLECTION**

The target population for this study includes estate agents operating in Selangor. According to the latest data from the BoVAEP (BoVAEP, 2024), there are approximately 3,122 REAs in Malaysia. A purposive sampling strategy was employed to select participants actively engaged in estate agency work in Selangor and had diverse experiences.

A sample size of 15 estate agents was targeted in this study. This number is sufficient to achieve data saturation, where additional interviews yield minimal new information. According to Guest, G., Bunce, A. and Johnson L. (2006), 12 interviews can be sufficient to reach saturation in qualitative research. The shortlisted participants are selected based on criteria that fit the purpose of this study. It includes a mix of agents from various agency sizes, experience levels, and areas within Selangor to ensure a representative perspective. In addition, semi-structured interviews were conducted in person via face-to-face and online platforms. The researcher conducts the interviews from May 2024 until Jun 2024. Each interview is audio-recorded with participants' consent and transcribed verbatim for analysis.

## **DATA ANALYSIS**

The content of interview transcripts was analyzed using a thematic analysis approach. This approach involves four stages of analysis, starting with familiarization with the data through reading and re-reading transcripts. Secondly, initial codes from the transcript were generated using qualitative data analysis software such as QSR NVivo version 14 software. During the coding process, phrases and keywords were evaluated and encoded with appropriate

category labels (Saldana, 2009). The data is separated into entities and categorized (Miles & Huberman, 1994), and themes are developed.

Thirdly, codes are aggregated into themes that capture the key points of the strategies to overcome unethical issues in estate agency practices in Malaysia. Lastly, themes are refined to ensure that the data accurately represent the objectives of this study.

## ANALYSIS AND DISCUSSION

The perspectives and experiences of the REAs in Selangor were analyzed using thematic analysis, utilizing verbatim quotes from 15 participants. The study's findings highlighted the main strategies for improving the unethical practices of estate agencies in Malaysia. Table 1 provides the summary responses from the 15 participants regarding the strategies for improving the unethical practices of estate agencies.

**Table 1.** Response on Strategies to Overcome Unethical Practices by EA Practices

Strategies/ Participants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Audit & Inspection	/	/		/	/			/		/	/	/			/
Law Enforcement	/			/		/			/	/			/		
Training	/	/	/	/			/	/	/		/			/	/
Awareness Campaign	/		/		/	/	/					/			/
Recruitment		/			/		/	/				/			
Community organizations				/				/	/				/	/	/
Reporting						/				/			/		
Monitoring			/								/				

Sources: Author's, 2024

In this study, eight main strategies were identified in improving the unethical practices by estate agency practices, which are:

### ***Audit and Inspection***

Regular audits and inspections by regulatory bodies such as BoVAEP play a crucial role in upholding ethical standards in the real estate industry. These audits should be rigorous and undertaken regularly to ensure that all firms comply with the regulatory framework. Thus, firms may avoid severe penalties and protect their reputations by identifying issues beforehand. REAs suggested that:

*“Appoint a specialized unit under the BoVAEP to identify any unethical actions in the real estate industry.”*

### ***Law Enforcement***

Encourages strict law enforcement strategies and increased penalties for non-compliance. Notably, implementing strict enforcement measures, such as rigorous monitoring, regular audits, especially on advertising, and swift response to violations, can deter self-laudatory statements and misleading claims. Accordingly, agents will be more cautious about making exaggerated claims if they know there is a high risk of detection and serious consequences. In line with this, enhanced enforcement can effectively decrease misleading advertising, promoting a more ethical environment where agents compete based on genuine merits rather than inflated claims. The REAs proposed that:

*“Review the marketing standards and regulations to ensure full compliance by the agents.”*

*“The BoVAEP should rigorously be enforcing the existing laws.”*

*“Foster closer collaboration between the regulatory bodies and real estate industry associations to align on competency standards and address any systemic issues that undermine the professionalism of estate agents.”*

### ***Training***

Extended the comprehensive training period and ongoing education progress for RENs (instead of two-day courses only). The regulatory bodies should ensure that REN receives thorough and ongoing training to develop the core competencies required for effective real estate practices. This should include modules and exam on communication skills, market knowledge, property evaluation, customer service, and compliance with industry standards and regulations. In addition, facilitating knowledge-sharing forums and encouraging ongoing education can empower RENs to expand their understanding of the transaction process and enhance their professional competence over time. REAs recommended that:

*“Comprehensive training and development for the RENs should be implemented to improve collaboration with industry associations by providing mentorship as peer-to-peer learning opportunities.”*

*“Ensure all the agents are thoroughly trained on the act and related law prohibiting discrimination.”*

*“Important for REAs to conduct training for RENs in their firm to ensure they understand the ethic and code of conduct as estate agency instead of fixed training duration.”*

### **Awareness Campaign**

Ensuring clients' protection through independent verification and public awareness campaigns. The clients themselves should independently verify information provided by agents prior to entering into transactions. This involves physically visiting the property, consulting multiple sources, and seeking professional advice to ensure informed decision-making. Additionally, buyers should verify if the agent possesses a REN tag or REA registration number to facilitate potential dispute resolution in court. Furthermore, it enhances clients' awareness campaigns by elucidating the roles of regulatory bodies like BOVAEP. According to the REA as follows:

*"Until now, the buyer is still being cheated by the illegal estate agents because they cannot differentiate the legal and illegal estate agents."*

*"Some of them are afraid to use our service because they have been cheated before."*

*"Should have an effective campaign on radio and television or any advertisement to the public."*

### **Recruitment**

Implement limitations on recruiting RENs in Malaysia to improve estate agency practice by maintaining the quality and ethical standards of the practice. New agents meet strict expertise, ethics, and integrity standards, promoting a more professional industry. Over-hiring leads to a competitive market that can encourage unethical behaviors, such as false advertising and property misrepresentation. REAs stated that:

*"Hiring more REN is an opportunity to REA, but to control the quality of the REN is difficult to control."*

*"Restricting recruitment requirement."*

*"Over-hiring leads to a competitive market that can encourage unethical behavior."*

### **Community organizations**

Collaborating with community organizations and strengthening fair housing compliances. This includes engaging with civil rights groups, community leaders, and advocacy organizations to better understand marginalized communities' experiences and develop real estate industry strategies. Furthermore, good

community communication techniques can enhance client satisfaction and trust, reducing misunderstanding and discrimination risks. This approach fosters inclusivity and respect in the real estate sector, enhancing companies' reputations as welcoming and reputable entities in the market. REAs recommended that:

*“Collaborate with the community organization by providing an educational program to society.”*

### **Reporting**

A robust improvement in the reporting mechanism could expose any cases of quota violations. Encouraging stakeholders, including customers and professional bodies, to report suspicious activities provides regulators with critical information against investigation processes. REAs proposed that:

*“Provide an easy link to access for the community to make a complaint on the estate agents.”*

### **Monitoring**

Enhanced management and monitoring by REA. To sustain real estate standards, REA must manage and monitor their RENs activities, provide guidance, and ensure that all regulatory compliances and professional standards are met. REAs suggested that:

*“REAs need to ensure that all their RENs follow the regulations set by the BoVAEP.”*

*“They (REAs) should monitor their own RENs, especially those that employ a high number of RENs in the firm and new RENs.”*

Lastly, despite the efforts to overcome this issue through legal arrangements, the extent to which these regulations will be successful is still a matter of intense debate among practitioners and regulatory bodies. The way forward to combat these issues involves commitment from the real estate professionals to adhere to a strict code of ethics, undergo continuous professional development, and regulatory bodies to enforce compliance rigorously. Therefore, promoting ethical conduct protects consumers and enhances the credibility and professionalism of the real estate industry in Malaysia.

## CONCLUSION

In conclusion, the implications of unethical practices could tarnish the industry's reputation and erode stakeholder trust. To address these issues effectively, regulatory bodies must enforce strict ethical standards and impose appropriate sanctions on violators. Additionally, comprehensive training programs should be implemented to enhance agents' understanding of ethics, cultural sensitivity, and the significance of building strong customer relationships. Notably, by promoting integrity and transparency, the industry can regain trust and foster a more ethical and sustainable real estate market.

This approach benefits consumers and agents and strengthens the overall reputation and reliability of the real estate sector in Malaysia. Thus, upholding ethical standards and preserving professionalism is critical for restoring confidence and sustaining the long-term viability of Malaysia's real estate business. This, in turn, will benefit both professionals and consumers, ensuring a fair and reliable real estate market in Malaysia.

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**DEVELOPING MALAYSIA MADANI: THE IMPACT OF GENDER AND STUDENT ORIGIN (URBAN VS. RURAL) ON LEADERSHIP, CITIZENSHIP, AND DEMOCRATIZATION IN MALAYSIAN UNIVERSITIES**

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**Abstract**

The impact of gender and origin on student leadership, citizenship, and democratisation in Malaysian Islamic universities is a critical yet underexplored area in advancing the Malaysia Madani agenda. This study aims to examine how these factors influence student interactions within the unique context of Islamic higher education institutions. Data were collected from a randomly selected sample of 593 students across three Islamic universities in Malaysia using a survey methodology. Specialised questionnaires measured student leadership, citizenship, and the democratisation process, alongside demographic information. Ethical guidelines were strictly followed, and data analysis was conducted using SPSS version 26. T-tests were employed to compare mean differences across gender and origin groups. The findings indicate no significant gender differences in student leadership and citizenship. However, a slight disparity was observed in democratisation, where female students reported marginally lower scores. Similarly, no significant differences were found in leadership and citizenship between urban and rural students. Nevertheless, urban students demonstrated a notably higher engagement in democratisation compared to their rural counterparts. These findings underscore the importance of tailored educational strategies to address disparities and foster inclusive leadership and democratic values in Malaysian Islamic universities. The insights from this study can inform policies aimed at ensuring equitable educational opportunities and outcomes for all students.

**Keywords:** Student Leadership, Citizenship, and Democratisation; Islamic Studies; Al-Quran and Al-Sunnah; Student Gender & Student Origin

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## **INTRODUCTION**

The impact between gender and its impact on student leadership, citizenship, and Democratisation in Islamic colleges in Malaysia is an intricate and diverse subject that necessitates thorough investigation (Mokhtar et al., 2024). The exploration of the influence of gender dynamics on the development of leadership characteristics, civic participation, and democratic principles among students in Islamic educational institutions has not received sufficient attention, despite the growing global focus on gender equality. The study conducted by Lau et al. in 2016. This study seeks to fill this void by examining the impact of gender on student leadership, citizenship behavior, and views towards Democratisation in the distinct cultural, religious, and educational contexts of Islamic colleges in Malaysia (Mohammad et al., 2016). The study aims to offer valuable insights into the efficacy of existing educational practices and policies in fostering inclusive leadership and democratic principles among male and female students. This will contribute to the progress of gender-inclusive educational strategies in Islamic higher education institutions (Haron et al., 2020).

The impact between urban and rural students in terms of student leadership, citizenship, and Democratisation at the Islamic University in Malaysia is an intricate and diverse subject that necessitates thorough investigation. Students in Malaysia, whether they live in urban or rural areas, frequently encounter noticeable differences in socio-economic, cultural, and educational aspects. These discrepancies can have a substantial impact on their involvement in leadership positions, participation in civic activities, and adherence to democratic norms while studying at university. Comprehending the ramifications of these disparities is essential for formulating efficacious instructional tactics that accommodate the unique requirements of students from different geographical origins. In order to tackle this problem, it is crucial to take into account the distinct cultural and educational contexts of Islamic universities in Malaysia. The study conducted by Malek et al. (2021) highlights the significance of involving citizens in decision-making processes and their obligations in constructing smart cities that prioritize the needs of the residents.

The research offers valuable information on inclusive practices that may be applied to the interplay between urban and rural areas within a university environment. In addition, the research conducted by Mohammad et al. (2016) provides insight into how dispositional variables operate as modifiers in relation to citizenship behavior. This is relevant for understanding how cultural and environmental factors influence students' civic involvement. In addition, the research conducted by Zainulabid et al. (2023) reveals the genetic makeup of tap water in an intensive care unit at the International Islamic University of Malaysia. This study emphasizes the importance of environmental factors in educational environments, which may contribute to our understanding of the disparities in

environmental conditions between urban and rural areas and how they affect students' experiences (Mokhtar et al., 2024; Dahlan et al., 2024; Jubba et al., 2024). Furthermore, the study examines the university's involvement in citizenship education, offering valuable perspectives on how educational institutions can impact students' civic engagement and democratic participation (Pérez-Rodríguez et al., 2022). Furthermore, Winter et al. (2006) highlights the community's role in revitalizing civil society and citizenship, underscoring the importance of community involvement in promoting democratic participation among students of various backgrounds. Moreover, the study conducted by Wahab et al. (2022) offers valuable perspectives on potential areas for future research, including the green economy and halal management. These areas of study could be particularly pertinent in meeting the distinct requirements of students hailing from urban and rural backgrounds in Islamic universities.

## **LITERATURE REVIEW**

The relationship between gender and student leadership, citizenship, and Democratisation has been a subject of extensive research and critical examination (Md Rami, A. et al., 2023). Existing literature has provided an overview of the impact of gender on student development and leadership, highlighting key opportunities for educators to broaden their understanding of gender and student leadership (Haber-Curran & Tillapaugh, 2017). Studies have sought to evaluate the relationship between individual characteristics, including gender, and leadership thinking among students (Ho & Odom, 2015).

Furthermore, the influence of gender and sexual orientation on self-perceptions of leadership has been explored, emphasizing the role of academic self-concept in mediating these relationships (Miles & Naumann, 2021). This research addresses a gap in the field by integrating conflicting research streams and proposing that academic self-concept underlies the relationship between gender, sexual orientation, and self-perceptions of leadership (Miles & Naumann, 2021). Moreover, the impact of gender on leadership aspiration has been a topic of interest, with studies inviting consideration of moderating influences in the relationship between gender and leadership aspiration (Fritz & Knippenberg, 2019).

Additionally, literature has integrated research related to leadership and identity development, gender, and feminisms to provide context and possibilities for student leadership development (Irwin, 2020). The influence of gender on students' career aspirations and leadership roles has been examined, with findings indicating that students with higher confidence and self-esteem are more likely to aspire to leadership positions (Castro & Armitage-Chan, 2016). Furthermore, the relationship between gender and leadership styles has been explored, with studies examining the differences in leadership perceptions related to students' gender

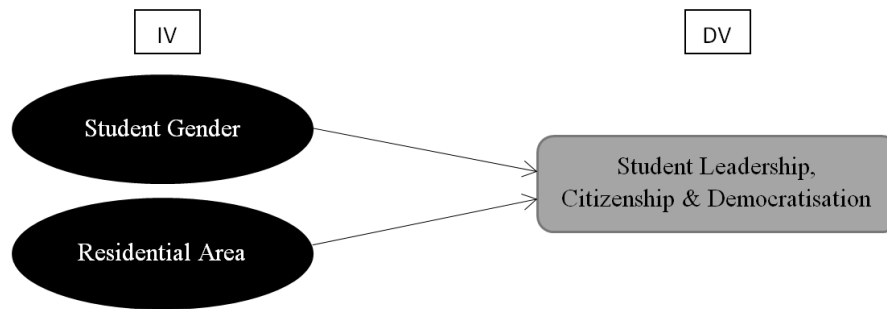
within educational contexts (Yarrish et al., 2010; Anas et al., 2020). The influence of gender on instructional outcomes and leadership behaviors has been a subject of investigation, with studies reporting varying relationships between contingent reward and active management-by-exception leadership behaviors and outcomes (Walumbwa et al., 2004). Additionally, the impact of gender on leadership styles and decision-making has been examined, with findings indicating that girls in female-majority groups exhibit more behaviors related to relationship-focused leadership (Ahyar et al., 2024; Yamaguchi & Maehr, 2004).

The relationship between urban and rural students and its impact on student leadership, citizenship, and Democratisation is also has been a subject of scholarly inquiry, shedding light on the diverse dynamics and implications within educational contexts (Ponrahono, Z. et al., 2015). have explored the conditionality of the impact of personality on civic engagement and attitudes, two indicators of democratic citizenship, revealing variations in nature and scope (Dinesen et al., 2013). This research contributes to understanding the nuanced relationship between individual personality traits and civic engagement among urban and rural students. Furthermore, Waterson & Moffa (2016) have highlighted the disjuncture between formal policy strategies aimed at fostering citizenship and residents' informal tactics to perform citizenship in urban neighbourhoods, emphasizing the need to rethink the mismatch between formal policy strategies and informal citizenship tactics (Verloo, 2016).

This study provides insights into the complexities of citizenship practices and narratives within urban settings, offering implications for educational strategies aimed at promoting effective citizenship among urban students. In addition, the convergence of literature on citizenship education, rural communities, and rural education has been examined by (Waterson & Moffa, 2016), extrapolating the challenges and possibilities of rural citizenship education for proactive democratic life (Waterson & Moffa, 2016). This study underscores the unique challenges and opportunities in fostering citizenship and democratic values among rural students, providing valuable insights for educational practices in rural communities.

Moreover, Gianni (2023) has emphasized the need for a political conception of multicultural citizenship, highlighting the empirical and normative dimensions of democratic citizenship that must be appropriately considered in a normative theory of democratic citizenship (Gianni, 2023). This research contributes to understanding the complexities of citizenship within diverse urban and rural contexts, offering implications for inclusive citizenship education.

From the literature review, this is the theoretical framework for this study.



*Figure 1: Theoretical framework*

There are six (6) research hypotheses that will be tested for this study as follows:

- H<sub>1</sub>: Student gender has significant influence on student leadership.
- H<sub>1</sub>: Student gender has significant influence on citizenship.
- H<sub>1</sub>: Student gender has significant influence on democratisation.
- H<sub>1</sub>: Student origin has significant influence on student leadership
- H<sub>1</sub>: Student origin has significant influence on citizenship.
- H<sub>1</sub>: Student origin has significant influence on democratisation.

## RESEARCH METHODOLOGY

This study aims to analyse variables such as student leadership, citizenship, and democratisation within a particular setting. The selected research methodology for this study is a survey. The selected research methodology for this study is a survey, which facilitates the systematic gathering of data from a substantial number of students, guaranteeing that the conclusions drawn are indicative of the broader population (Artino et al., 2018). We utilised random sampling methodology, specifically referring to the Krejcie and Morgan (1970) table, to select a total of 593 samples from a population of 55,783 students enrolled at Universiti Sultan Zainal Abidin, Universiti Sains Islam Malaysia, and International Islamic University Malaysia (Malaysia Higher Education Statistic, 2021). The large sample size used in our study guarantees that the results can be regarded as representative and indicative of the broader population (Etikan et al., 2016).

We utilised a custom-designed questionnaire (Nikiforova et al., 2021) as our main tool for gathering data. The survey was accessible online, enabling participants to provide ideas and feedback without the requirement of being physically present. Aside from the fundamental data pertaining to the key

variables, we also gathered data on participant demographics, encompassing age, gender, educational background, and other pertinent particulars. This enables more comprehensive examinations relying on individual attributes (Hayun et al., 2023).

The study places significant emphasis on ethical considerations. In our research, we rigorously followed ethical norms, which encompassed getting informed consent from participants, maintaining data confidentiality, and ensuring the absence of damage caused on participants (Dolnicar, 2019). We employed SPSS version 26 for data analysis.

The methodology employed in our study involved the utilization of the t-test, a widely recognized statistical method, to compare the means of two distinct groups. This methodological choice is rooted in its effectiveness in determining whether observed differences between groups are statistically significant or if they could have arisen by chance (Lance, 2014). We meticulously followed established procedures for hypothesis testing and determining statistical significance throughout the analysis. This entailed the careful formulation of null and alternative hypotheses, with the null hypothesis representing the absence of a difference between groups and the alternative hypothesis positing a significant difference (Keselman, 1974). In line with conventional practice, we selected a significance threshold ( $\alpha$ ) of 0.05, indicating a 5% probability of incorrectly rejecting the null hypothesis (Kibria & Saleh, 2006).

Our data collection procedures ensured the acquisition of independent data sets from each group under investigation, preventing interdependence between observations (Khaliq & Ouarda, 2006). Subsequently, we computed the t-statistic, a pivotal measure quantifying the degree of difference between group means relative to the variability within the data (Wellek, 2017). Interpretation of results involved comparing the calculated t-value against critical values from the t-distribution to ascertain statistical significance (Fenton & Inglis, 2007). References to prior works by Smith (2015) and Brown & Jones (2018) underscore our adherence to established statistical protocols and contribute to the robustness and validity of our analytical approach (Fox, 2005). Through these methodological endeavors, we aimed to rigorously assess the significance of observed differences between groups while upholding the standards of scientific inquiry.

## ANALYSIS AND DISCUSSION

### Factors Reliability

**Table 1:** Reliability Test by Cronbach's Alpha

Factor	Cronbach Alpha value	Item number
Student Leadership	0.967	30
Citizenship	0.960	37
Democratisation	0.922	23

The data shown in Table 1 displays the Cronbach's Alpha coefficients for three factors: Student Leadership, Citizenship, and Democratisation. These coefficients indicate the level of internal consistency for each item. Cronbach's Alpha quantifies the degree of correlation across items within a component, evaluating their ability to independently evaluate the same underlying notion (Maiyaki & Mokhtar, 2010). A reliability coefficient equal to or greater than 0.70 indicates a high level of reliability (Sekaran & Bougie, 2016).

The Cronbach's Alpha coefficient for the 30 items in the Student Leadership assessment is 0.967, which indicates a good level of internal consistency. The measure of citizenship exhibits a high level of internal consistency, as indicated by an Alpha coefficient of 0.960 for a total of 37 items. The factor of democratisation, measured by an Alpha coefficient of 0.922 over 23 questions, has slightly lower but still robust internal consistency in comparison to the other components. The assertions are corroborated by the research conducted by Hair and Lukas (2014) as well as Sekaran and Bougie (2016).

Overall, the high Cronbach's Alpha values suggest that the questions within each component accurately measure their respective concepts, assuring strong dependability for assessing Student Leadership, Citizenship, and Democratisation in research.

### Male and Female Influences

**Table 2:** T-Test Table

Group Statistics						
	Gender	N	Mean	Std. Deviation	Std. Error	
STUDENT_LEADERSHIP	Male	196	4.2187	.60476	.04320	
	Female	397	4.2184	.49914	.02505	
CITIZENSHIP	Male	196	4.0437	.62749	.04482	
	Female	397	4.0356	.50783	.02549	
DEMOCRATISATION	Male	195	3.9835	.61671	.04416	
	Female	395	3.9070	.54741	.02754	

The data shown in Table 1 displays Cronbach's Alpha coefficients for three distinct factors: Student Leadership, Citizenship, and Democratisation. These coefficients serve as indicators of the internal consistency of the factors. Cronbach's Alpha quantifies the degree of correlation across items within a component, evaluating their ability to independently evaluate the same underlying notion (Maiyaki & Mokhtar, 2010). A reliability coefficient equal to or greater than 0.70 indicates a high level of reliability (Sekaran & Bougie, 2016).

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Overall, the high Cronbach's Alpha values suggest that the questions within each component accurately measure their respective concepts, assuring strong dependability for assessing Student Leadership, Citizenship, and Democratisation in research.

**Table 3:** Independent Samples Test of Gender

<b>Independent Samples Test</b>		<b>Levene's Test for Equality of Variances t-test for Equality of Means</b>								
		<b>F</b>	<b>Sig.</b>	<b>t</b>	<b>df</b>	<b>Sig. (2-tailed)</b>	<b>Mean Difference</b>	<b>Std. Error Difference</b>	<b>95% Confidence Interval of the Difference</b>	
STUDENT LEADERSHIP	Equal variances assumed	9.094	.003	.006	591	.995	.00027	.04682	Lower	Upper
	Equal variances not assumed			.005	329.845	.996	.00027	.04994	-.09796	.09850
CITIZENSHIP	Equal variances assumed	11.277	.001	.169	591	.866	.00811	.04803	-.08623	.10244
	Equal variances not assumed			.157	324.780	.875	.00811	.05156	-.09333	.10954



DEMOCRATISATION	Equal variances assumed	3.063	.081	1.531	588	.126	.07653	.04999	-.02166	.17471
	Equal variances not assumed			1.470	348.314	.142	.07653	.05205	-.02584	.17889

An Independent Samples Test, supplemented by Levene's Test for Equality of Variances based on Table 3, was performed to examine any variations in means for three variables Student Leadership, Citizenship, and Democratisation across two unique groups based on gender: Male and Female.

Regarding Student Leadership, Levene's Test indicates the presence of unequal variances, both when assuming equal variances and when assuming unequal variances ( $F = 9.094$ ,  $\text{Sig.} = 0.003$ ). The subsequent Independent Samples t-test results, accounting for both equal and unequal variance scenarios, indicate t-values of 0.006 and 0.005, respectively, with around 591 degrees of freedom. The p-values ( $\text{Sig.} = 0.995$ ) suggest that there is no statistically significant disparity in Student Leadership between the male and female groups.

Similarly, the application of Levene's Test reveals significant differences in variances for Citizenship ( $F = 11.277$ ,  $\text{Sig.} < 0.001$ ). The Independent Samples t-test, assuming equal variances, produces a t-value of 0.169 with 591 degrees of freedom and a p-value of 0.866. When the assumption of equal variances is violated, the t-value remains at 0.157 with about 324.780 degrees of freedom, and the p-value remains at 0.875. The data indicate that there is no statistically significant disparity in Citizenship between the male and female groups.

However, in the context of Democratisation, Levene's Test indicates that there are unequal variances ( $F = 3.063$ ,  $\text{Sig.} = 0.081$ ). The Independent Samples t-test, assuming equal variances, yields a t-value of 1.531 with 588 degrees of freedom and a p-value of 0.126. When the assumption of equal variances is not made, the t-value remains constant at 1.470, although the degrees of freedom are approximately 348.314. Similarly, the p-value remains unchanged at 0.142. These data indicate a possible substantial disparity in Democratisation between male and female groups, while the level of significance is slightly higher than the customary threshold of 0.05 (Smith, J., 2015).

To summarise, the study indicates that there is no strong evidence to support major gender differences in leadership, citizenship, and democratisation, despite some subtle variations in average scores, as determined by the statistical tests done.

## Urban and Rural Influences

**Table 4:** Group Statistics of Origin

Group Statistics					
	KawasanKediaman	N	Mean	Std. Deviation	Std. Error Mean
STUDENT LEADERSHIP	Urban	292	4.2442	.52370	.03065
	Rural	301	4.1936	.54708	.03153
CITIZENSHIP	Urban	292	4.0657	.55434	.03244
	Rural	301	4.0117	.54485	.03140
DEMOCRATISATION	Urban	289	3.9852	.58714	.03454
	Rural	301	3.8814	.55299	.03187

The group data offers a comprehensive analysis of Student Leadership, Citizenship, and Democratisation in both Urban and Rural locations. The Urban group has a marginally higher mean score (4.2442) for Student Leadership compared to the Rural group (4.1936), with standard deviations of 0.52370 and 0.54708, respectively. Regarding Citizenship, the Urban group has a slightly higher score of 4.0657 compared to the Rural group's score of 4.0117. The standard deviations for the Urban and Rural groups are 0.55434 and 0.54485, respectively. The Urban group has a mean score of 3.9852 for Democratisation, while the Rural group has a little lower mean score of 3.8814.

The standard deviation for the Urban group is 0.58714, and for the Rural group it is 0.55299. The results suggest somewhat higher ratings for Urban regions in all factors. Additional statistical analyses, such as t-tests or ANOVA, are required to ascertain the significance of these discrepancies.

**Table 5:** Independent Samples Test of Origin

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
STUDENT LEADERSHIP	Equal variances assumed	.187	.665	1.149	591	.251	.05057	.04400	-.03585	.13699

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	Equal varian ces not assum ed			1.150	590. 896	.251	.05057	.04397	-.03579	.13693
CITIZENSHIP	Equal varian ces assum ed	.771	.380	1.196	591	.232	.05398	.04514	-.03467	.14264
	Equal varian ces not assum ed			1.196	589. 660	.232	.05398	.04515	-.03470	.14266
DEMOCRATISATION	Equal varian ces assum ed	1.099	.295	2.211	588	.027	.10380	.04694	.01161	.19599
	Equal varian ces not assum ed			2.209	582. 118	.028	.10380	.04700	.01150	.19611

An Independent Samples Test, in conjunction with Levene's Test for Equality of Variances, was performed to evaluate potential disparities in means for three variables: Student Leadership, Citizenship, and Democratisation, between two Origins, specifically Urban and Rural.

The Levene's Test for Student Leadership suggests that there are equal variances, regardless of whether they are assumed or not ( $F = 0.187$ ,  $\text{Sig.} = 0.665$ ). The results of the Independent Samples t-test, assuming both equal and unequal variances, indicate t-values of 1.149 and 1.150, respectively, with around 591 degrees of freedom. The p-values ( $\text{Sig.} = 0.251$ ) suggest that there is no statistically significant distinction in Student Leadership between the Urban and Rural groups.

Levene's Test indicates that the variances for Citizenship are equal, with a F value of 0.771 and a significance level of 0.380. The Independent Samples t-test, assuming equal variances, produces a t-value of 1.196 with 591 degrees of freedom and a p-value of 0.232. When the assumption of equal variances is not made, the t-value remains constant at 1.196, with degrees of freedom approximately equivalent to 589.660. Similarly, the p-value remains constant at 0.232. These data suggest that there is no statistically significant disparity in Citizenship between the Urban and Rural categories.

However, in the context of Democratisation, Levene's Test indicates that there are unequal variances ( $F = 1.099$ ,  $\text{Sig.} = 0.295$ ). The Independent

Samples t-test, under the assumption of equal variances, yields a t-value of 2.211 with 588 degrees of freedom and a p-value of 0.027. When the assumption of equal variances is not made, the t-value remains constant at 2.209, with degrees of freedom approximately equivalent to 582.118. Similarly, the p-value remains unchanged at 0.028. The results indicate a notable disparity in Democratisation between the Urban and Rural groups, with the Urban group demonstrating higher average ratings.

To summarise, the data indicates that there are no notable disparities in Student Leadership and Citizenship among Origins. However, there is a notable disparity in Democratisation, with the Urban group exhibiting greater scores.

## CONCLUSION

The study examined the influence of gender and origin on student leadership, citizenship, and democratisation in Islamic universities in Malaysia. It utilised survey methods and involved 593 students. The results indicated that there were no notable gender disparities in student leadership and citizenship. However, it was observed that females had slightly lower opinions of democratisation. Similarly, there were no significant differences observed between urban and rural students in terms of student leadership and citizenship. However, urban students had a more favourable perception of democratisation. The investigation revealed robust internal consistency and reliability in assessing these factors. In general, gender did not have a substantial impact on student performance. However, there were some differences depending on where students lived, especially in their views on democratisation. This emphasises the need to take into account varied backgrounds when promoting inclusive educational approaches. The study examined six hypotheses concerning the impact of gender and origin on student leadership, citizenship, and democratisation in Islamic universities in Malaysia. The results revealed that there were no statistically significant disparities between genders in terms of student leadership, citizenship, or democratisation. This suggests that gender may not have a substantial impact on these outcomes among students. Moreover, although there were no significant differences observed in student leadership and citizenship between urban and rural students, urban students exhibited a more favourable perspective of democratisation. This finding supports the notion that the residence location might impact one's perception of democratisation. These findings enhance our comprehension of the intricate dynamics present in educational environments and emphasise the significance of considering varied origins to foster inclusive educational practices.

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## ETHICAL STATEMENT

This study was conducted following ethical guidelines for research involving human participants. All participants provided informed consent, and their anonymity and privacy were strictly protected. They had the right to withdraw at any time without consequences. No formal ethical approval was required for this study, but all procedures adhered to standard ethical research practices.

## DISCLOSURE STATEMENT

The authors declare that there are no conflicts of interest related to this study. No financial, institutional, or personal affiliations influenced the research, data collection, analysis, or interpretation of findings. Additionally, no funding was received from external sources that could have impacted the study's outcomes.

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## **A REVIEW OF LAND ACQUISITION PROCEDURES AND COMPENSATION PRACTICES FOR THE PAN BORNEO HIGHWAY PROJECT IN SARAWAK, MALAYSIA**

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### **Abstract**

The Pan Borneo Highway is one of the mega projects in Malaysia aimed at improving the infrastructure and enhancing connectivity in Sabah and Sarawak. With over 2000 kilometres in span, the Pan Borneo Highway project required the government to conduct massive land acquisitions and pay a huge compensation amount. Although receiving the compensation, many landowners felt it was insufficient and remained unsatisfied. Some landowners had expressed their dissatisfaction in the newspapers, which gave a negative impression of the project. This paper seeks to understand the land acquisition procedures and fair compensation determination practice in Sarawak. The qualitative research method examines the legislative resources to determine the land acquisition procedures and compensation. The study also interviewed personnel from the Land and Survey Department, Sarawak, to confirm the practice. The study discovered that the legislation is in place and clear to standardize the practice. This legislation clearly sets out the principles for determining fair compensation. The land acquisition procedures in Sarawak differentiate between land with a title deed and land under the Native Customary Rights (NCR) gazette. The paper concluded with suggestions to explore compensation principles for communal rights.

**Keywords:** Land Acquisition, Procedures, Compensation, Pan Borneo Highway, Sarawak

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## **INTRODUCTION**

The Pan Borneo Highway connects major cities on the island of Borneo, which concentrates on the coastline of the states of Sarawak and Sabah in Malaysia, as well as Brunei and Kalimantan regions in Indonesia. Launched in 2015 under the 11<sup>th</sup> Malaysia Plan, the 2,239 kilometres Pan Borneo Highway is not entirely a new highway network system. Instead, it joins the existing road networks by upgrading, widening, realigning, and adding new stretches. It furnishes a previously Trans-Borneo Highway connection constructed in the 1960s and 1970s. Intentionally, the highway serves as a medium to balance up the regional physical and economic development of Borneo through better road connections between places and with no tolls (Bernama, 2023a; Che Rose & Imau, 2020).

While it brings positive impacts, but it was also unavoidable that the government needed to acquire lands from the people, which in quite a few cases had urged the people to relocate their activities on the land. All the reclaimed lands were compensated by the Federal Government based on the market value of the affected properties and the government's financial ability (I. Abdullah, 2022; Utusan Borneo Online, 2016). According to the Deputy Works Minister in 2016, the compensation cost to acquire lands for the construction of the whole Pan Borneo Highway was totalling RM2.8 billion, resulted from the estimation of RM2 billion for Sabah and RM800 million for Sarawak (Chen, 2016). However, at the end of the project, the costs for land acquisition in Sarawak escalated to RM900 million for various reasons (Lorna, 2023).

The study was motivated by the affected people who claimed they were not receiving a considerable amount of compensation compared to the suffering and losses they had experienced (Zacchaeus, 2017). This study chose the Pan Borneo Highway in Sarawak because, at the time of the study, many highway sections in Sabah were still ongoing and behind the targeted completion schedule. The study aims to establish an understanding of the land acquisition procedures and fair compensation based on the practices in Sarawak. It was guided by the objectives of exploring the land acquisition procedures for the Pan Borneo Highway in Sarawak, investigating the principles to determine adequate compensation based on the practices of Sarawak, and finally corroborating between the land acquisition procedures and practice with the responsible authority to confirm the practice in Sarawak. This paper intended to provide the public with insights into the general procedures for land acquisition in Sarawak and fill up the knowledge gap because of the abundance of previous literature were focusing on the land acquisition practice in Peninsular Malaysia.

## **LITERATURE REVIEW**

### **Pan Borneo Highway**

The Pan Borneo Highway is a mega project in the Eastern Malaysia territories to connect the states of Sarawak and Sabah from Sematan to Tawau. It is the effort

of the Federal Government under the Economic Transformation Programme (ETP) to transform Malaysia into a high-income country like other developed countries (Ikau, Rashid, Muhammad, & Wahi, 2019). The existence of this highway would complement the government's initiatives to balance development in both Western and Eastern Malaysian regions. Facilitating better transportation of goods and services to wider areas, the highway would spur economic growth and support businesses to expand into wider markets because travelling is faster, cheaper, and more comfortable.

The construction of the Pan Borneo Highway is divided into three (3) phases and many work packages in both the states of Sabah and Sarawak. It was designed as a four-lane dual-carriageway and does not impose any toll on its users. As of the end of 2023, Phase 1 of the highway in Sarawak has almost completed and already opened for traffic in staggered (Wong, 2023). This was contrary to the situation in Sabah, which was quite slow and had caught the attention of the Federal Government (Bernama, 2023b). The Minister of the Ministry of Works declared that the work progress in February 2024 had reached 98.91% in Sarawak. Meanwhile, in Sabah, the progress for Phase 1A has reached 87%, and Phase 1B is still in the tendering process (Bernama, 2024).

The project faced many challenges, including the topography, people, politics, movement control orders during the Covid-19 pandemic, and shortage of labours (Bernama, 2016, 2021; Wong, 2023). However, the most significant challenge was when the Federal Government changed the project implementation concept from the Project Delivery Partner (PDP) concept into the conventional project approach in 2019 (Povera & Yunus, 2020). Initially, the Government of Malaysia and the State Government of Sarawak established the Lebuhraya Borneo Utara (LBU) as a private entity to function as a special purpose vehicle (Akob, Zaidee, Hipni, & Koka, 2019). The LBU undertook the project as a Project Delivery Partner (PDP) for the Government of Malaysia and the State Government of Sarawak. The government had officially ended the PDP contract, which took effect on 20<sup>th</sup> February 2020 and passed the responsibility to the state Public Works Department as the implementing agency. This caused a serious delay to the project because all the involved parties were unclear on the implementation directions and needed to revise their works (Bernama, 2023b; Lorna, 2023).

### **Land Acquisition**

Sarawak Land Code [Cap. 81] 1958 Edition is the promulgated land statute for Sarawak and covers all land administration aspects, including the land acquisition provisions. It was enacted to consolidate all the previously enacted land-related laws in Sarawak (Adam, 1998). By consolidating the previous land laws and some amendments to date, the 1958 Land Code has become the most comprehensive land legislation in Sarawak and has been sustained until now. It

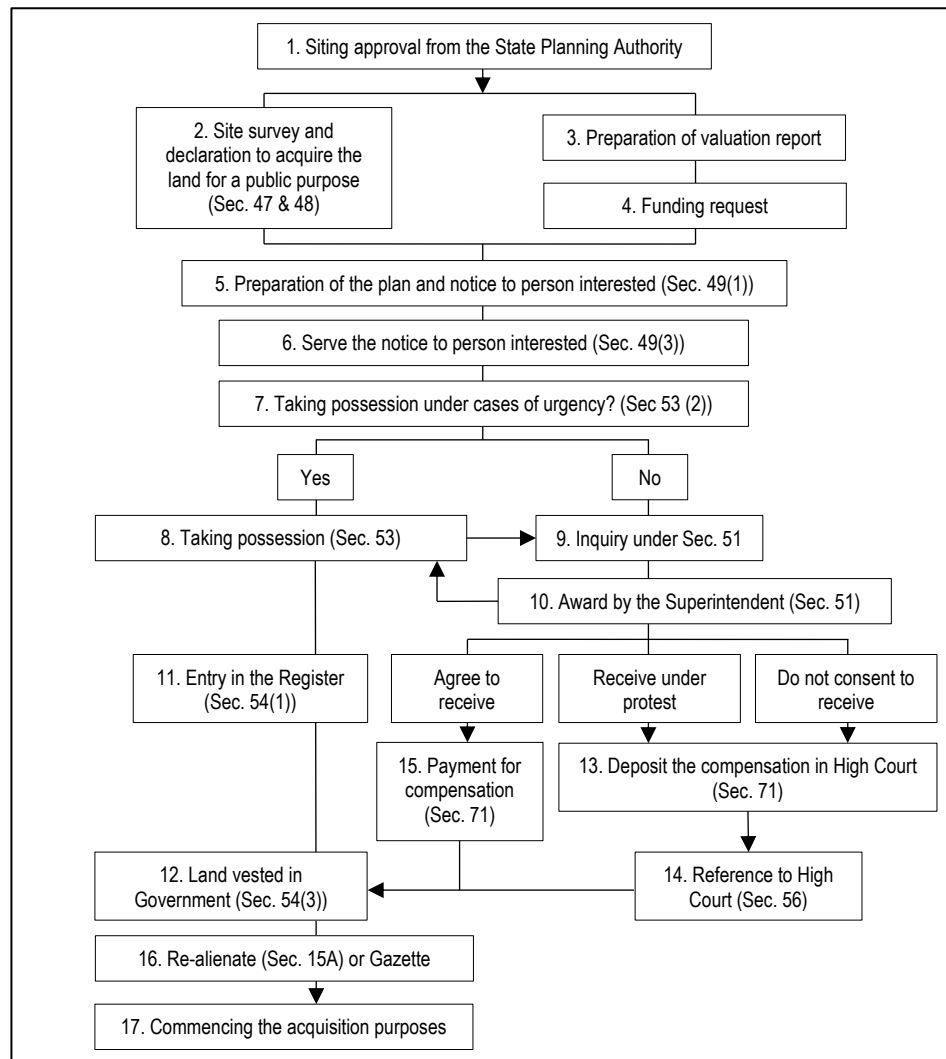
also becomes a strategic instrument to modernise its land system and facilitate Sarawak's development. On a different note, the Sarawak Land Code follows the Torrens system principles, which place the register at its core and grant the registered proprietor of the land with indefeasible rights once the interest is registered in the register and the document of title is issued (Buang, 2015; Osman & Kueh, 2010; Toh, Tan, Tan, Ujang, & Thoo, 2019). So, land registration is vital in every aspect of land administration.

Land acquisition is a process used by the government to acquire any land for the public, including developing infrastructure, utilities, and other necessary projects for the country. The basic principle of land acquisition is based on the reason that the interests of the public or country can override any interest or rights of a person over the ownership of his property (Alias, 2014). Land acquisition laws are also needed to help the government deal with hurdles such as first, the unwillingness of the owner to surrender the property regardless of the offered price and second, the situation where the land is subject to a certain category of land use that the authorities feel contrary to their plans (Buang, 2015, 2021). Land acquisition must be coordinated under the law because Article 17 of the Universal Declaration of Human Rights (UDHR) 1948 recognises property rights as part of human rights and prohibits property from being deprived arbitrarily (United Nations, 1948).

Sarawak includes the land acquisition in its Sarawak Land Code. It is unlike the Land Acquisition Act 1960 and Land Acquisition Ordinance (Sabah Cap. 69) for Peninsular Malaysia and the state of Sabah, which legislated as a piece of dedicated land acquisition statutes. The Sarawak Land Code provides the land acquisition provisions in Part IV, specifically in Section 45 until 83. Nevertheless, it does not fail to address the local concern about acquiring land under the status of Native Customary Rights, which makes it different from the other two land acquisition statutes.

According to the Sarawak Land Code, there are five classifications of land in Sarawak, namely the Mixed Zone Land, Native Area Land, Native Customary Land, Reserved Land, and Interior Area Land that the Minister can declare by notification in the Gazette. According to Sections 113 and 118 of the Land Code, every grant, lease, instrument, or dealings must be duly registered in the Register (Section 112), and the government will issue a document of title to the proprietor (Section 117). In Section 123, however, the issuance of the document of title may not necessarily be made for some reasonable causes. Still, the intended usage or interest can be effective through the Gazette. The state government will make declarations in the Gazette to reserve the land or to specify the communal rights and interest in the land for the usage of any intended community that deserves under the native customary rights (NCR) (refer to Sections 4, 5 and 6 of the Sarawak Land Code). Land acquisition procedures for

lands with the document of title and NCR lands under the Gazette are different, as depicted in Figure and Figure.

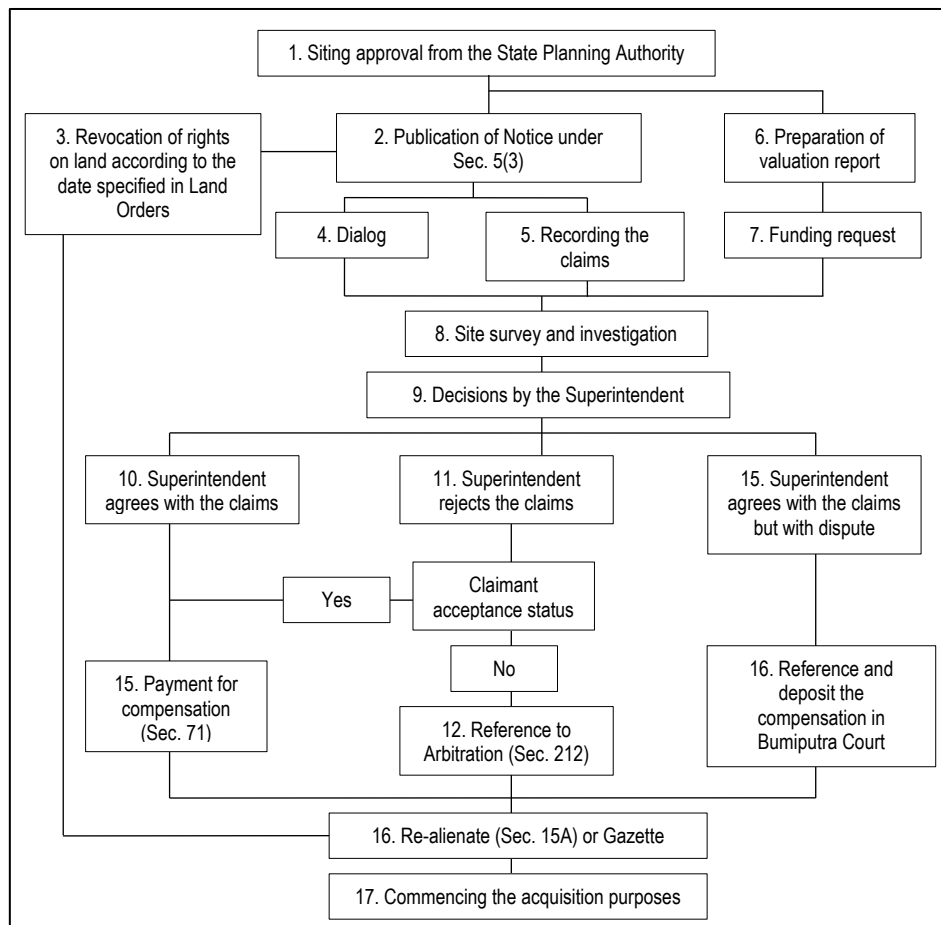


**Figure 1:** Process flow diagram for the compulsory acquisition of land with registered titles in Sarawak

*(Source: Adapted from the Sarawak Land Code and Department of Land and Survey, Sarawak)*

In brief, any intention for land acquisition by the state government or its agencies needs to get siting approval from the Sarawak State Planning Authority. After obtaining the siting approval, a declaration through the Gazette will be issued to inform the public about the intentions of land acquisition and

commencement of land surveying works. Once the land survey has confirmed the lands that will be needed, the Superintendent will notify the proprietors and persons interested through a notice and summon them for the inquiry session to determine the compensation claims. All acquired land will be vested to the government after entering the land register, and the proprietor and person interested will receive the compensation. Afterward, the government can alienate the land to the acquiring agencies or gazette for acquisition earlier.



**Figure 2:** Process flow diagram for the compulsory acquisition of land gazetted under the native customary rights (NCR) (without registered titles) in Sarawak  
 (Source: Adapted from the Sarawak Land Code and Department of Land and Survey, Sarawak)

There is a difference in the procedure for taking land that is gazetted under the NCR. The process begins with obtaining siting approval from the State Planning Authority. Then, the government will publish a cancellation notice for

native customary rights on the land along with the effective date using the clause under Section 5(3). It subsequently reverts the lands held under such rights to the State and can proceed with land surveying and investigation works. At this stage, all affected persons must take part in a dialogue and inquiry session to establish claims records. The government requires all affected persons to submit their claims in the prescribed form within the stipulated time (Sections 5(3)(b) and 5(3)(c) of the Sarawak Land Code) and record them. The Superintendent needs to decide on all compensation claims. If the Superintendent agrees to the claim, the person concerned will receive compensation accordingly. Suppose the Superintendent does not agree to the claim or agrees under dispute, the person concerned can take the matter to Arbitration as outlined in Section 5(4) and Section 212 or to the Bumiputra Court for a decision. Afterward, the government can alienate the land or gazette it to the acquiring agency to start the project.

The Sarawak Land Code has specified the required land acquisition procedures as guidance to standardise the process throughout the state. The Land and Survey Department may produce its internal process flow to improve efficiency, save cost, and reduce time. If facing any dispute, the Superintendent or any person interested may bring the matter concerned to the court to get elaborations on the procedures, clarify the issues, and get a decision.

Overall, all land acquisition statutes in Malaysia have the forcing power to acquire any land from the proprietor compulsorily. Although not exactly like the buying and selling concept, the land proprietor needs to surrender his proprietorship and be compensated fairly regardless of his willingness (Alias, 2014). The objectives of these statutes are to standardise the land acquisition procedures in the states and to provide a speedy mechanism for acquiring lands compulsorily while maintaining the balance between government needs and depicting justice to the deprived land owners (Buang, 2015). These three statutes carry the same legislative spirit, which protects the individual's rights on property in the land acquisition process. It is consistent with Article 13 of the Federal Constitution of Malaysia, which guarantees two things: first, to hinder the deprivation of an individual's rights to the property saved under law, and second, the need for adequate compensation in compulsory acquisition or use of property.

### **Compensation**

In line with Article 13 of the Federal Constitution, all legislation relating to land acquisition in Malaysia would constitute the provisions for compensation payment. The legislation helps to provide standard elements for the compensation process and considerations to ensure fairness and adequacy to the proprietors and persons interested. The compensation must include the value of the land taken as well as other losses suffered as a consequence of the acquisition because, fundamentally, the purpose of compensation is to achieve the principle of equivalence (Usilappan, 1999). This means placing the affected person in the

same position, no worse nor better than before the acquisition (Alias, 2014; Usilappan, 1999). It can be a challenging process to determine adequate compensation because it involves many factors to consider and demands from the landowners who want higher compensation for their losses. Many criteria needed to be considered in determining the compensation, including the level of nonconformity to the laws that denied the owners the full compensation amount.

Referring to the Sarawak Land Code, the authorities will determine the compensation for the acquired lands based on the market value. Although the land acquisition statutes in the country do not explicitly provide the meaning of market value apart from providing principles to derive compensation amounts based on market value, various references and sources, including court cases, have interpreted the market value. One of them, as taken from the Malaysian Valuation Standards, Sixth Edition, published by the Board of Valuers, Appraisers, Estate Agents & Property Managers in 2019:

*"The estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion."*

(Board of Valuers, Appraisers, Estate Agents & Property  
Managers, 2019).

Overall, the determination of market value must comprise the willing seller, willing buyer, and reasonable price, and it must allow for a bargaining process within a considerable time (Alias, 2014). Valuation by professional valuers is required to conduct the process according to what has been specified in the law. Although there is no hard and fast rule on the method to assess the market value for land acquisition purposes, the comparison method has become the most common valuation method because the courts in the country are inclined to use the sale evidence from the same land or similar land as the safest guide (A. H. Abdullah, 1999; Buang, 2021). However, other valuation methods such as cost method, investment method, residual method, and profit method are also being used. The valuation procedure for others usually takes the inspection date as the valuation date. Still, for the land acquisition, the authorities determine the valuation date at the notice publication date. In Sarawak, the market value is taken at the date of the publication of the notification under Section 47. If no publication has been made, the market value is taken at the date of the posting of the declaration made under Section 48.

The market value is determined by considering the matters that are outlined in Sections 60 and 61 of the Sarawak Land Code. Among other things



that should be taken into consideration are the increase in value of the other land of the person interested likely to accrue from the acquired land, the damage because of land severance or injuriously affecting the other land and property, disturbance such as moving out from the place or disruption to the owner's life or business, and any improvements made to land with the Superintendent consent.

Conversely, some matters such as the degree of urgency, personal attachment to the land, damages caused by a private person, any increase in land value that is likely to accrue result from the use in the future after the acquisition, and any speculative value are among the things that should not be considered and need to be disregarded in determining the compensation. Also included are any improvements made to the land after the declaration under Section 48 and without prior consent from the Superintendent. Apart from what has been specified in Sections 60 and 61, there are some other things that should be observed as well. According to Buang (2021), the considerations include the express and implied conditions on the land, the incapability of reaching mathematical accuracy on the compensation, sale transaction evidence from the locality, potential development value, post-acquisition damage, reinstatement value, principle of equivalence, method of valuation, business compensation, reasonable expenses, illegal or unlawful acts and payment of interest. These considerations would need scrutiny and deliberation to ensure all the details are validated and fair to the landowners.

It is also the reason for the Superintendent to conduct the inquiry session with the landowners and persons interested in inquiring into any objections to the land measurement, the value of the land, and any interests of the person claiming the compensation (Section 51). The inquiry session would be an appropriate platform to discuss and justify the compensation with the landowners.

## **RESEARCH METHODOLOGY**

This study aims to give an overview of the land acquisition process in Sarawak and compensation determination. For that, the qualitative method is suitable for this study because it explored the real-life system through multiple sources of information collection and analysis to present a case description and case themes (Hyett, Kenny, & Dickson-Swift, 2014). Direct involvement between the researchers and informants would get more accurate findings for the study.

This study, which took the Pan Borneo Highway project as the case, found that people expressed dissatisfaction with the compensation package offered by the government. Motivated by the expression of dissatisfied people, this study had set three objectives. It starts with exploring the land acquisition procedures in Sarawak. This study then set its second objective to investigate the adopted compensation principles and finally to corroborate the land acquisition procedures and practices with the responsible authority in Sarawak.

To achieve the objectives, the researchers did a document search on the land acquisition practice. They conducted semi-structured interviews with the

valuer from Sarikei Division of the Land and Survey Department, Sarawak. The selection of the informant was done through contacts, but with background checking and experience verification. To ensure the information was precisely gathered, the researchers prepared the questions for the interview in three parts. First to understand the background of the informant's organization. It was purposely done to understand the roles played by the Land and Survey Department of Sarawak. The second part discussed land acquisition procedures. This part was crucial because land acquisition involved many steps and would easily confuse the public. The third part was to rationalise the consideration of the compensation based on what has been outlined in the Sarawak Land Code. The interview session was conducted in the office, and audio was recorded. The recorded audio was then transcribed into text in preparation for the analysis.

The qualitative analysis for this study was done using document analysis and thematic analysis. Document analysis was scoped only to examine written documents, which in this study include statutes, journals, and other written references. It helped the study explore the land acquisition procedures together with the ruling laws. Meanwhile, thematic analysis was used to group the information in textual data as themes. Thematic analysis was suitable for this study because it helped to find, evaluate, and interpret patterns of meaning from the qualitative information obtained from the interview (Vaismoradi, Turunen, & Bondas, 2013). It greatly helped the study improve the understanding of the land acquisition practice in Sarawak.

## **FINDINGS AND DISCUSSION**

The focus of the interviews with the Land and Survey Department was mainly on the land acquisition procedures and compensation determination. Using thematic analysis, the study analysed the findings from the interview and grouped the information into three main findings as follows.

### **Administrative Matters**

The Land and Survey Department handles matters related to land acquisition in Sarawak. It involves two levels of process, which are at the division of the State and the Headquarters in Kuching. At the state's division level, the Land and Survey Department needs to conduct the land acquisition procedures, including gathering information about the acquired land and similar land comparable as evidence. It needs to prepare a compensation proposal and recommendations before being brought up to the Headquarters to finalise the decision.

At the Headquarters, a committee led by the Assistant Director of Valuation would study and do an inspection to verify the submitted compensation proposal. The Valuation and Property Services Department (JPPH) is not involved unless assessing the Federal Lands in Sarawak.

An inquiry session will be conducted to offer the compensation amount to the landowners and discuss any arising issues. It is consistent with Section 51 of the Sarawak Land Code, which needs to be conducted as specified by the Land Superintendent. There will be no earlier discussion with the landowners about determining the compensation. Private valuers can be involved in the inquiry session to represent the landowners. If there is an objection from the landowner, the case will be taken to court following the provisions in Section 56 of the Sarawak Land Code. Therefore, the landowner may appoint a lawyer and private valuer. According to the informant, only 3-5% of land acquisition cases were referred to the court mostly because the acquisition affected landowners' investments and businesses on the land.

The informant had informed that the organisation charters for the Land and Survey Department are to complete any land acquisition process within six months if it does not involve objections and references to the court. However, in the case of the Pan Borneo Highway, they were unable to finish the land acquisition cases within that period because many factors affected them when involved with such a big-scale project.

### **Principles for Compensation**

The determination of the compensation for land acquisition in Sarawak follows the principles set in Sections 60 and 61 of the Sarawak Land Code. The authority understands that the compensation must be adequate and is determined based on the market value of the land at the time of acquisition based on the date notified in the Gazette. It considers the possible market price if the land had been sold on the open market to a willing buyer and a willing seller.

There are three types of land use, namely agriculture, residential and industrial. Agricultural land refers to land with a size of below 100 hectares. Meanwhile, the estate land is 100 hectares and above. Besides that, the express and implied conditions of the land are also imperative. The same has been mentioned by Buang (2021) and cannot be ignored when determining compensation. Those available restrictions on the land will significantly affect the compensation amount in land acquisition because the authority must comply with the stated principles. This matter is hard for the public to understand and has become the reason for them to be dissatisfied with the compensation amount offered by the government.

The informant informed that 98% of the land acquisition for constructing the Pan Borneo Highway involved agricultural land. It was a directive from the government and the Public Works Department to avoid acquiring lands with buildings or built-up structures. It consequently minimises the hardship of the people from relocating their living and prevents the government from paying higher compensation amounts.

According to the informant, the authority typically relies on the comparison method as the preferred valuation method to assess the market value of the land. The evidence taken for comparison is from recent transactions of nearby properties with similar characteristics. This follows the court's preference for comparison as the primary valuation technique. The cost method will be applied to value the buildings and built-up structures, considering the materials, age, and depreciation. Under certain circumstances, other valuation methods need to be applied when the comparison and cost methods are unsuitable for assessing the property. It has also been informed that the principles of betterment, severance, and injurious affection are rarely applied in Sarawak. It shows the practice in Sarawak and Peninsular Malaysia is slightly different.

### **Adequacy of compensation**

The principle of determining the adequacy of the compensation is mainly based on the market value. However, it is always being questioned by dissatisfied landowners. The questions include the compensation amount for the whole acquired land, compensation for land with multiple ownerships that involved many people interested, the compensation for different rights on the land, and compensation for other losses.

The informant mentioned that the inquiry session, as specified in Section 51 of the Sarawak Land Code, is the platform for the authority to communicate with the landowners to seek adequate compensation. In brief, if the land has a document of title, the authority will examine the shares of ownership and rights attached to it. So, every landowner and person interested in the land will receive their compensation in fractions. Other than that, the authority also differentiates the compensation components for land, trees, and structures. There will be different valuation assessments for these three components before merging them as one value.

Meanwhile, the compensation for lands without the document of title under the Native Customary Rights (NCR) is determined either using the valuation method or granting the ex gratia. When the authority compensated the losses using the valuation exercise, they gathered the comparison evidence by capturing the transaction price from nearby lands with a document of title.

Suppose the government intends to give ex gratia. It must be decided before the acquisition because it is not a regular practice for the government to give ex gratia since the people who live on the state's lands do not have any rights to the land. In the acquisition of the Pan Borneo Highway project, however, the government agreed to give ex gratia to the residents. The amount of the ex gratia was determined by the Minister's discretion, not by the market value. It shows that the Government is concerned about the landowners and ensuring that the project can progress without much protest.

## CONCLUSION

This study has examined the Sarawak Land Code to study the provisions related to land acquisition in Sarawak. Although the provisions are not extensive, like the Land Acquisition Act 1960 and the Sabah Land Acquisition Ordinance (Sabah Cap. 69), the Sarawak Land Code still provides the fundamental provisions to acquire land. The authority would need to refine the acquisition process by introducing internal procedures or, when necessary, would refer to the court to ensure an effective and smooth land acquisition process.

The Sarawak Land Code has categorised lands in Sarawak into five categories. Still, it can be broadly distinguished by either the land possessing the document of title or the land declared under the Gazette, which has no document of title. In the land acquisition process in Sarawak, the authority would see these categories of land, especially lands under the NCR status, because they have different procedures and compensation approaches.

From the interview and analysis, this study identified three themes related to land acquisition in Sarawak, which were grouped into administrative matters, compensation principles, and adequacy of compensation. In terms of administrative matters, land acquisition involves the Land and Survey Department in both the state divisions and headquarters. The compensation principles would follow all the principles set in the Sarawak Land Code. Meanwhile, the determination of compensation adequacy will be based on the valuation and information gathered during the inquiry.

Examining the legislation and information gathered during the interview, this study would like to suggest exploring compensation principles for communal rights to be included in the land acquisition legislation. This study expects that exploring compensation principles for communal rights can solve some ambiguity in compensation and its adequacy. Also, it is high time for any land administrator to keep up with the latest technology in land administration to ensure the highest service standards for people and the country.

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## **WOMEN'S AGILITY IN COPING WITH CYCLONE AND CYCLONE-INDUCED HAZARDS: A CASE STUDY ON FEMALE-HEADED HOUSEHOLDS IN COASTAL BANGLADESH**

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### **Abstract**

Women's coping capacity and adaptation practices lead to transformed social roles and responsibilities, making them essential for building resilience against cyclones and cyclone-induced hazards. This study aimed to investigate the evolution and agility of women's coping mechanisms, adaptive capacities, and available resources in response to cyclones and cyclone-induced hazards. A mixed-method approach, comprising questionnaire surveys and semi-structured interviews, was adopted to collect data from women in female-headed households in Gabura Union, a coastal area of Bangladesh. The findings reveal these women's impressive and transformative adaptation capacity. Their local knowledge, skills, and resilience have helped their families cope with recurrent and intensified cyclone events. In the absence of husbands, female heads have taken on work outside the home, migrated for jobs, and performed full household responsibilities. They make decisions, maintain connections with communities and organizations, and gain self-empowerment through knowledge of the outside world. Consequently, their adaptive capacity in the face of cyclones and related hazards has increased. The results also indicate that response and adaptation transformations depend on the female heads' socio-economic condition. These findings are valuable for developing a sustainable and inclusive cyclone-resilient plan for women.

**Keywords:** Cyclone Resilience, Female Heads, Women's Role Transformation, Women's Adaptation Practices

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## INTRODUCTION

Bangladesh is no stranger to the devastating impact of tropical cyclones, with severe incidents occurring frequently throughout each year (Ahsan & Warner, 2014; Rahman et al., 2022). According to the World Risk Index (WRI) 2024, Bangladesh ranks 9th, with a score of 27.73, as one of the countries with the highest disaster risk (Bündnis Entwicklung Hilft & IFHV, 2024). Cyclones and their associated hazards have a particularly profound impact on women's health and well-being, significantly increasing their work burden, limiting their opportunities, and weakening their capacities. As such, women in Bangladesh face unique risks and vulnerabilities in the face of cyclones (Ikeda, 1995; March et al., 1999; Warren, 2007; Dankelman, 2008; Lane & McNaught, 2009; Khatun & Islam, 2010; Sultana, 2014; Alston, 2015).

In coastal Bangladesh, socio-cultural and religious norms have traditionally restricted women's roles. However, this began to shift following Cyclones Sidr in 2007 and Aila in 2009, which devastated the region with widespread loss of life, severe damage to property and infrastructure, and extensive livelihood disruptions. The aftermath of these cyclones exacerbated conditions through prolonged waterlogging, increased soil and water salinity, heightened food insecurity, and crises in water supply and employment. Additionally, local ecological and livelihood patterns were altered, disrupting the region's environmental and socio-economic fabric (Mallick & Vogt, 2012, 2014; Mallick et al., 2017; Khalil & Jacobs, 2021; Khalil et al., 2021; Mohibbullah et al., 2021; Ahsan et al., 2024).

As a result, many men migrated in search of work, leaving women to shoulder all household responsibilities (Islam & Walkerden, 2014; Khalil et al., 2021). This shift led to women gaining greater access to resources, involving more actively in decision-making, and participating in income-generating activities, thereby challenging patriarchal practices and attitudes (Milazzo & Walle, 2015; Bradshaw et al., 2017; Khan, 2019). In their husbands' absence, women's enhanced coping capacities and transformative adaptations have been crucial for the survival of female-headed households in cyclone-prone areas (Sultana, 2014; Khalil et al., 2021; Masud-All-Kamla & Nursey-Bray, 2024).

Therefore, this study sought to explore women's coping capacities, available resources, and adaptation strategies in response to recurring cyclones and cyclone-induced hazards in coastal Bangladesh. The evaluation period begins in 2009, when significant changes arose due to saline water intrusion after cyclone Aila (Mallick & Vogt, 2012, 2014; Mallick et al., 2017; Khalil & Jacobs, 2021; Khalil et al., 2021; Mohibbullah et al., 2021; Ahsan et al., 2024). Focusing on how women's knowledge, skills, actions, and practices have evolved over these past 15 years, this research addresses the following questions: How do women cope with cyclone-induced hazards using available resources? What

response and adaptation strategies are adopted by female heads of households? How have their capacities transformed over time with changing social circumstances? What motivates these transformations, and how do they reduce vulnerability to cyclones?

To answer these questions, a comprehensive analysis was conducted through a mixed-method approach, integrating both quantitative and qualitative data from female-headed households in Gabura, one of the most affected areas in the Satkhira District of Bangladesh's southwestern coastal region. Aligning with the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals (UNDRR, 2023), this study provides valuable insights for developing sustainable, inclusive, and cyclone-resilient strategies for women. The findings emphasize how women's capacity-building and resilience are central to their survival, highlighting the often-overlooked social transformations that occur in disaster contexts, particularly among female-headed households.

## **LITERATURE REVIEW**

### **Women's Disaster Coping, Adaptation, and Transformative Resilience *Capital to Cope, Respond, and Adapt***

The natural, physical, financial, human, and social dimensions of capital are most commonly associated with response, recovery, and adaptation in disaster contexts (DFID, 1999; Islam & Walkerden, 2022). Social capital, defined as the collective action of social networks among households, neighbors, and community organizations, plays a crucial role in resilience (Adger, 2010; Scheffran et al., 2012). There are three forms of social capital: bonding (i.e., immediate family, relatives), bridging (i.e., neighbors and friends), and linking (government or non-government organizations) (Putnam, 2000; Szreter & Woolcock, 2004). These social capital networks are crucial for enhancing women's adaptive capacity, empowering them, and reducing their vulnerability through robust connections.

### ***Indigenous and Local Knowledge in Coping and Adaptation Practices***

In disaster studies, the terms "indigenous knowledge" and "local knowledge" are often used interchangeably. This knowledge facilitates place-based, contextual, and experiential coping practices, transmitted orally and evolving through social learning across generations (Agrawal, 1995; Ellen et al., 2000; Sillitoe, 2006; Khalil et al., 2016). Such practices utilize the skills, resources, and knowledge systems of local communities to survive, cope, adapt, and adjust to natural hazards (Kates, 1978; UNISDR, 2008). Local knowledge aids in preventing, mitigating, preparing, responding, and recovering from disaster impacts, a concept known as "coping and adaptation strategy." Coping refers to short-term and immediate measures by individuals and communities, while adaptation

involves a long-term progression of livelihoods (Shafie & Rahman, 2009; Said et al., 2024).

Few studies have focused specifically on the indigenous and local knowledge of women in disaster coping and adaptation. Particularly, female heads of households have been underexplored despite their distinct vulnerabilities and experiences pertaining cyclones compared to women with husbands as primary providers (Nasreen, 1995; Islam, 2010; Abedin et al., 2013; Alam & Rahman, 2014, 2019; Khalil et al., 2020; Khalil & Jacobs, 2021; Rahman et al., 2022; Masud-All-Kamal & Nursey-Bray, 2024).

### ***Social Transformation Theory: Changes in Social Roles and Adaptation Transformation from the Perspective of Women Facing Disasters***

Evidence shows that disasters can change socio-economic, political, and gender dynamics within communities (Davis, 2014). Notably, disasters may help reduce women's vulnerability by creating "windows of opportunity" to challenge unequal gender structures and empower women (Horton, 2012; Bradshaw, 2013; Pacholok, 2013). Indeed, women's grassroots movements and resilience following disasters suggest that significant social changes can occur in such times (Enarson & Chakrabarti, 2009; Moreno & Shaw, 2018).

Social transformation theory views women as a group capable of altering their social status (Irwin, 2005; Mulinari & Sandell, 2009; Panday, 2016; Khan, 2019). Social transformation enhances women's ability to connect with others and strengthen their social capital in the form of mutual trust, understanding, respect, and recognition among different parties (Beck, 1992; Backer, 2001; Beck-Gernsheim et al., 2003; Giddens, 1991, 2009; Panday, 2016). At the community level, women's life transformations through their status, roles, knowledge, resource access, and capacity-building can make them significantly more capable (Puigvert, 2003). When their social taboos and economic barriers lessen, women are increasingly able to assume full household responsibilities and utilize their capacities independently to build resilience (Beck & Beck-Gernsheim, 2002; Chitkara, 2001; Irwin, 2005; Panday, 2016; Bradshaw et al., 2017; Moreno & Shaw, 2018; Khan, 2019).

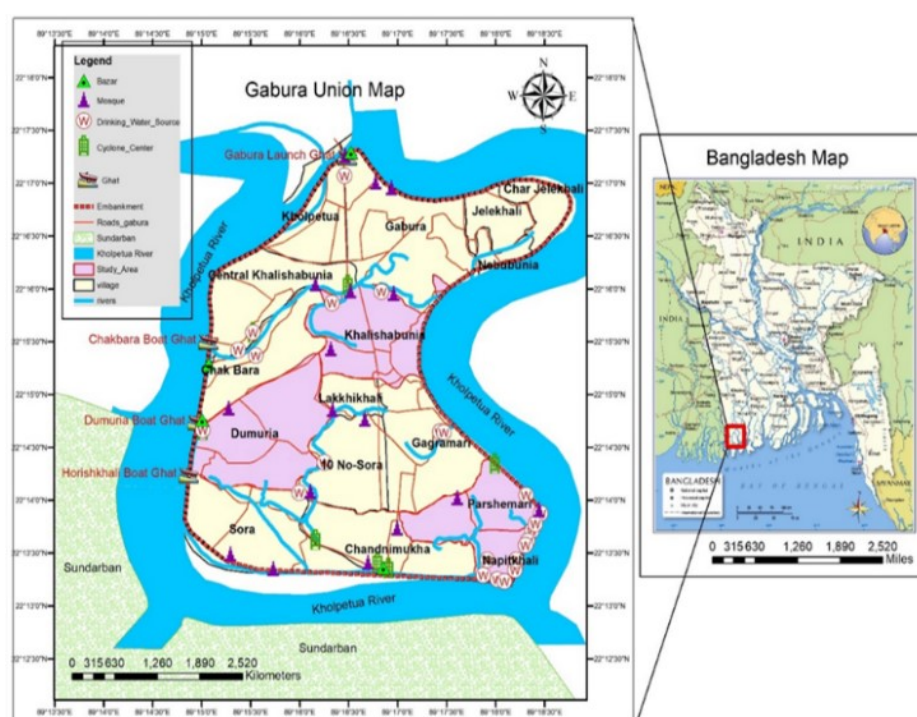
However, there is limited research on the changing patterns or transitions in adaptation strategies practiced by women over time, especially in response to disasters (Berman et al., 2012; Islam et al., 2017; Moreno & Shaw, 2018; Khan, 2019; Yadav et al., 2021; Masud-All-Kamal & Nursey-Bray, 2024).

## **RESEARCH METHODOLOGY**

### **Study Area**

The Gabura Union of Bangladesh's Satkhira District was chosen as the study area (Figure 1). Gabura is the most adversely affected union within the district's

Shyamnagar Upzila. It is located in the southwest coastal region of Bangladesh, adjacent to the Sundarbans. Four villages (Dumuria, Khalishabunia, Parsemari, Napitkhali) in the Gabura Union were specifically selected based on their high vulnerability to and severity of cyclones, economic conditions, and prevalence of female-headed households. Cyclones, cyclone-induced storm surges, salinity, and waterlogging are the most frequent and severe in this region. Consequently, residents in the area suffer from a scarcity of safe drinking water, food, employment, and sanitation (Islam, 2010; Mallick & Vogt, 2012).



**Figure 1: Map of the Study Area**  
 Source: Author's Contribution

### Methodology and Data Collection

A mixed-method approach, consisting of both questionnaire surveys and semi-structured interviews, was adopted for this study. First, household-level questionnaire surveys were conducted, focusing exclusively on female-headed households from the four villages. Based on a comprehensive list of 160 female-headed households provided by union council members, a total of 114 female heads were chosen for the survey using the stratified random sampling technique's proportional allocation method. Additionally, semi-structured

interviews were conducted with 44 female heads selected via purposive sampling. Table 1 provides details of the study sample.

<b>Table 1: Study Sample</b>			
<b>Household Questionnaire Survey</b>			
Villages	Number of female-headed households	Selected households	Selection criteria
Dumuria	62	44	Female heads of female-headed households (whose husbands had died/ are disabled/ had migrated/ had divorced/abandoned them), with personal experience of cyclones.
Khalishabunia	40	29	
Parsemari	30	21	
Napitkhali	28	20	
Total	160	114	
<b>Semi-structured Interview of Female Household Heads</b>			
Villages	Interviewed persons	Selection criteria	
Dumuria	15	Female heads from female-headed households that are extremely vulnerable to cyclones and had successfully adapted against cyclones.	
Khalishabunia	08		
Parsemari	10		
Napitkhali	11		
Total	44		

## RESULTS AND DISCUSSION

### Scenario of Cyclone-induced Hazards

The Gabura Union area has been frequently impacted by cyclones over the past 15 years, leading to significant changes. Long-term saline water inundation and the expansion of shrimp farming have rendered much of the land agriculturally unproductive. Consequently, those who once relied on agriculture and fishing have been forced to abandon their traditional occupations, driving widespread male migration out of the area due to job scarcity (Islam & Walkerden, 2014; Khalil et al., 2021; Mallick & Vogt, 2012). Ultimately, residents continue to struggle to regain their previous quality of life following severe cyclones such as Sidr (2007), Aila (2009), and Amphan (2020).

<b>Table 2: Cyclone &amp; Cyclone-induced Hazards in the Study Area</b>				
Severe cyclones (in last five years)	Cyclone occurrence (in last five years)	Frequency of cyclone (in a year)	Cyclone-induced hazards	Severity (compared to 15 years ago)
Yaas (May 2021), Amphan (May 2020), Bulbul (Nov 2019), Foni (Apr 2019)	5 times	Once a year	Storm surge, salinity, water logging, and erosion	Increased frequency and intensity

Table 2 illustrates the impact of cyclones and cyclone-induced hazards in the study area. Over the past 5 years, respondents reported experiencing

cyclones five times, with an average frequency of once per year. Participants noted that the frequency and intensity of cyclones and associated hazards—such as storm surges, salinity, waterlogging, and erosion—have increased over the past 15 years.

### Socio-demographic Characteristics of Female Household Heads

Table 3 provides socio-demographic information on the sampled female heads in the study area. Approximately half of the respondents are widows (49.1%), while the remainder are divorced, abandoned, or left by their husbands (47.4%). In most cases (66.6%), their husbands had initially migrated temporarily for work due to employment shortages caused by cyclones. Over time, these temporary migrations became permanent as the men remarried in their new locations, leaving their previous families behind, a pattern noted in other studies (Islam & Walkerden, 2014; Khalil et al., 2020). The majority of female heads live on extremely low incomes of 1,500-4,999 BDT per month (76.3%) and rely on multiple income sources for survival (75.4%). They work as laborers in shrimp or crab farms (64%) and catch fish in the river (73.7%), while a considerable number are also employed as household help in affluent families (57.9%). Indeed, women in this area rely on multiple income-generating activities yet face wage discrimination, earning less than men for similar work (Fauzi et al., 2022). For instance, women typically earn 250 BDT per day, while male workers earn 350 BDT per day, as documented in other studies (Enarson, 2000; Saha, 2015). Finally, most of the women are illiterate (78.1%), aged between 36 and 59 years (64.9%), and live alone (34.2%).

**Table 3:** Socio-demographic Characteristics of Female Household Heads

Socio-demographic characteristics	Pct. (%)	Socio-demographic characteristics	Pct. (%)
<b>Main Occupations</b>		<b>Educational status</b>	
Fishing	73.70	No education	78.1
Shrimp/crab farm labor	64	Primary & above	21.9
Household help	57.90		
Cattle/poultry rearing	31.60		
Brickfield labor	14.90		
<b>Monthly Income</b>		<b>Living alone</b>	
Extremely low income (1500-4999 BDT)	76.3	Yes	34.2
Low income (5000 BDT & above)	23.7		
<b>Age</b>		<b>Partner Information</b>	
Young women (20-35)	23.7	Died	49.1
Middle-aged women (36-59)	64.9	Divorced/abandoned/	47.4
Elderly women (60 & above)	11.4	left forever	

Income options		Main Reasons for leaving/ divorce
1 to 3 income options	75.4	Went for work, didn't return/ married there 66.6
4 to 6 income options	24.6	

Note: 1 USD= 121.82 BDT

### Activities Performed by Women in Two Situations: 'Before' and 'After' the Incident of Husband's Death, Permanent Abandonment, or Divorce

In traditional divisions of labor, men are typically responsible for tasks outside the home, while women handle daily household duties. This arrangement is disrupted when husbands die, migrate temporarily or permanently, or abandon their families. In such cases, wives assume the role of household heads, taking full responsibility for their families (Beck-Gernsheim et al., 2003; Bradshaw et al., 2017). Figure 2 illustrates this shift, comparing the responsibilities undertaken by women when their husbands are present versus when they are absent. The terms 'Before' and 'After' represent the periods preceding and following a husband's death, permanent departure, or separation/abandonment, respectively.

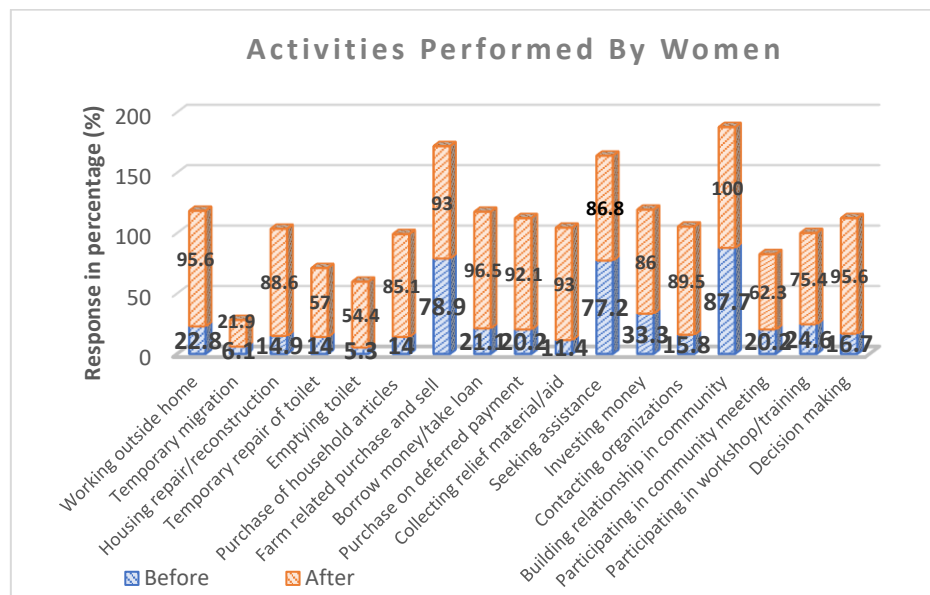


Figure 2: Activities Performed by Women



One abandoned woman related her situation this way:

*“When my husband was with me, I did not do any work outside the house. His income supported family expenditures. Now, I have to work as a daily wage worker outside the house. Even then, work is not available in the area. I have to go without food. So, I work as a maid in a brick kiln for six months of the year. After six months, I used to get fifty thousand BDT. With that money, I pay off the debt and run the family. When my hands are again empty, I have to go back to the brick kiln.”* Another female household head added, *“I have to fulfill all the responsibilities in the household because I don't have a husband. Shopping, repairing the house, tarring the roof tins, cleaning the toilets---I have to do them all. Other than those, I have many other things to do in the household.”*

When a husband is present, women primarily engage in three activities: farm-related purchase and sales (78.9%), relationship-building (87.7%), and community assistance (77.2%). Their involvement is minimal in tasks such as work outside the home, house repairs and maintenance, relief collection, money borrowing, decision-making, and contacting organizations. In contrast, the absence of a husband leads to a notable shift in activity patterns, with drastically increased involvement in work outside the home (95.6%), house repair and maintenance (88.6%), decision-making (95.6%), and aid or relief material collection (93%). In this situation, female heads are required to make all decisions independently. As one respondent explained:

*“Since I don't have a husband, I must make all the family decisions. I have to go outside for work and to bring any help if available. I understand reality now more than before. My awareness about everything has now increased.”*

This finding corroborates those of other studies (Islam & Walkerden, 2014; Islam et al., 2017; Khan, 2019; Khalil et al., 2020; Khalil & Jacobs, 2021; Masud-All-Kamal & Nursey-Bray, 2024; Sultana, 2014).

### **Adaptation Transformation of Female Heads in the Last 15 Years**

Women's adaptation practices have evolved in response to changing cyclone hazards and socio-economic circumstances. A large majority (89.5%) of respondents agreed that there is a notable difference between their current adaptation practices and those they followed 15 years ago. Table 4 lists these differences in detail.

**Table 4:** Adaptation Transformation of Female Household Heads

Difference in adaptation practice	Strongly disagree (1)	Disagree (2)	Neither agree or disagree (3)	Agree (4)	strongly agree (5)
Didn't preserve rainwater	1%	2%	3.9%	34.3%	58.8%
Didn't preserve dry food	-	2.9%	9.8%	49.0%	38.2%
Didn't evacuate to shelter center/safe places	-	2.9%	4.9%	38.2%	53.9%
Didn't collect & preserve cooking fuel	-	1%	4.9%	47.1%	47.1%
Didn't preserve valuables	-	11.8%	10.8%	54.9%	22.5%
Improved awareness and understanding of cyclone response strategies	1 %	1%	5.9%	43.1%	49%

Previously, most respondents lacked awareness of cyclone preparedness and adaptation strategies, as cyclones were less frequent and severe. They relied on their husbands for decisions and actions regarding cyclone preparedness. However, in their husbands' absence, these women have assumed full responsibility for their families, including working outside the home and maintaining community communication, increasing their awareness of current issues and the broader world. This shift is evident in six key adaptation practices: 'preserving rainwater,' 'storing dry food,' 'saving cooking fuel and valuables,' 'evacuating to cyclone shelters or safe places,' and 'improved awareness and understanding of cyclone response strategies.' According to Table 4, most female heads 'agreed' (score 4) or 'strongly agreed' (score 5) that they had not engaged in these adaptation practices in the past. An elderly female head explained:

*“Before Cyclone Aila, I was not aware of the danger of cyclones. We used to have cyclones but never had storm surges like this. The natural pond water was drinkable then. We never needed to hold rainwater and didn't even have a water container. But saltwater intrusion after Aila has destroyed our freshwater sources. Water shortage has become severe. Now, I store water in a water tank during monsoons, which can be used in times of crisis. Moreover, when I get cyclone signals, I store water in bottles and take them to cyclone shelters with me.”*

**Table 5:** Significant Attributes Influencing Adaptation Transformation

Socio-demographic characteristics	Significance (p-value)
Income	.012 a **
Extremely low income (74)	55.50 (mean score)
Low income (24)	38.50 (mean score)
Age	.645 b*
Education	.305 a *
Living alone	.621 a*
Partner information	.925 a*

Note: a. Mann-Whitney test b. Kruskal Wallis Test \* $p > 0.05$  \*\* $p < 0.05$

Mann-Whitney U and Kruskal-Wallis tests (Table 5) were conducted to examine whether changes in adaptation practices among female-headed households over the last 15 years are linked to their socio-demographic characteristics. The average scores for adaptation changes were compared against factors such as income, age, education, partner status, and solo living status. The analysis showed a significant relationship ( $p = .012$ ) between income and changes in adaptation practices. Specifically, the mean adaptation transformation score for extremely low-income households (55.50) was higher than that for low-income households (38.50), suggesting that adaptation transformations are more pronounced among economically disadvantaged groups. In other words, female heads with lower incomes report more significant changes in their cyclone response activities compared to those with higher incomes.

### Preparedness and Adaptation Practice Transformation of Female Heads

Table 6 outlines the transformative adaptation practices, available coping capital, and related challenges of female heads without husbands in response to cyclones.

**Table 6:** Coping Capital and Adaptation Practices of Female Heads

Area	Response & adaptation activities	Coping capital
Income & employment	Work outside home, migrate for work, depend on multiple income options	Local skills, natural resources, bridging capital
Housing & toilet	Repair, protect, and maintain (i.e., tying roof, putting tar, emptying toilet) house & toilet by themselves using locally available materials like polythene, paper, branch/leaf, blanket, cement bag, jute rag, etc.	Local knowledge & skills
	Take assistance for repairing house-toilet as labor, material, money	Bonding, bridging & linking capital
Water	Travel long distances to collect water, travel with neighbors for water collection, borrow water from neighbors/relatives	Human capital & social capital
	Consume less water or use contaminated water	Human capital (negative adaptation)
	Preserve rainwater	Local knowledge & skill, linking capital

Sanitation	Share toilet, use hanging toilet	Local knowledge & bonding & bridging capital
Fuel	Collect fuel by themselves from river using nets, dry and preserve fuel using basket (dry on roof and store on elevated shelf/platform)	Local knowledge, natural resources (forest)
	Cook once in two days to save fuel. Use portable oven, tin container & brick as temporary oven	Local knowledge & skill
Food	Purchase food on deferred payment	Bridging capital
	Consume less, skip meals, only consume watered rice and potato	Human capital (Negative adaptation)
	Preserve dry food, medicine	Local knowledge
	Borrow food, accept food assistance from neighbors & relatives	Bonding and bridging capital
Cattle rearing	Rear cattle in enclosed areas to avoid the impact of salinity	Local knowledge
Vegetation	Try to grow vegetables in the rainy season, use rainwater, apply different techniques like hydroponics, integrated vegetation	
Material/ goods preservation	Preserve goods/materials on raised platform, improvised shelves on walls, or wooden/bamboo false ceiling underneath the roof	Local knowledge & skills
Evacuate to safe places	Cyclone shelters, relatives' houses, embankment/road/boat	Bonding, bridging & linking capital
Cyclone awareness	Awareness regarding cyclone preparedness, response, recovery activities, information regarding cyclone signal, relief & assistance	Bonding, bridging and linking capital
Decision making	Take all vital decisions by themselves including evacuation. This has increased their awareness and capacity to respond.	Bonding & bridging capital
Maintaining Communication	Maintain communication for formal & informal assistance	Bonding, bridging & linking capital

Note: Local knowledge and skill are considered human capital; bonding, bridging and linking capital are considered social capital; and natural resources are considered natural capital.

A significant number of women in the study area are widowed, divorced, or abandoned. In the absence of a husband, these women are compelled to work outside the home, migrate for employment, and independently manage all household responsibilities. They make decisions autonomously and engage actively with their communities and various organizations, which enhances their awareness of broader issues. Consequently, their coping strategies and adaptation practices have evolved to address these challenges, making them more capable, knowledgeable, and effective in responding to cyclones. Moreover, to mitigate employment crises, female heads often rely on multiple income sources, a finding reported by Khan (2019) as well.

Additionally, women have adapted by preserving rainwater, fuel, dry food, and medicine; evacuating to cyclone shelters; and expanding their awareness of cyclone preparedness and response activities (see photographs in the Appendix). Over the past 15 years, these adaptation practices have undergone significant transformation to better address cyclonic adversities. This transformation is more noticeable among economically disadvantaged groups compared to those with more resources. Ultimately, this study's results validate

that the absence of a husband significantly impacts women's ability to adapt, aligning with prior findings (Islam et al., 2017; Khalil, Jacobs, & Kuruppu, 2016; Khan, 2019; Masud-All-Kamal & Nursey-Bray, 2024; Sultana, 2014). Despite the additional vulnerabilities and burdens that female heads face, they effectively leverage their skills, resources, and capabilities to adapt to challenging conditions.

## CONCLUSION

The transformative adaptation practices of female heads—characterized by heightened awareness, coping strategies, and adaptation capacity—are essential for their survival in cyclone-prone environments. These women have cultivated self-reliant communities where they earn livelihoods, seek community assistance, and confront environmental challenges using innovative measures and the social, natural, and human resources available to them. However, when male partners migrate for better opportunities, often resulting in bigamy or polygamy, women are left in vulnerable positions, bearing the entire burden of household responsibilities and child-rearing.

To build resilience in the face of these adversities, women have developed effective survival strategies using their invaluable practical knowledge, skills, social networks, and adaptive practices. Yet, these efforts alone are insufficient, as societal, governmental, and non-governmental support remains limited. In fact, most interventions offer only short-term relief, failing to deliver lasting solutions. Strengthening the capacities of female heads is more impactful than providing temporary aid. Specifically, women require sustainable employment opportunities that uphold their dignity. Government and non-governmental organizations active in the region should therefore introduce comprehensive social safety nets, food security initiatives, insurance schemes, and employment opportunities, and skill development programs for women. At the same time, creating local employment opportunities for men could reduce migration and the subsequent abandonment of women. Policies discouraging second marriages and divorce are also vital to protect these vulnerable women.

In summary, this study's findings are crucial for understanding the evolution of women's adaptability over time. These insights can guide efforts to empower women and drive positive change within communities. By examining the social, human, and natural resources available to female heads and the challenges they encounter, researchers, practitioners, and policymakers can design and implement development projects that genuinely improve their lives.

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## ETHICAL STATEMENT

This study adhered to the Universiti Malaya Research Ethics Guidelines and was approved by the Universiti Malaya Research Ethics Committee (UM.TNC2/UMREC\_3017). Informed consent was obtained from all participants, and confidentiality was strictly maintained. The authors declare no competing interests and confirm that the study is original, unpublished, and not under consideration elsewhere.

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## **URBAN HEAT ISLAND DYNAMICS IN RESPONSE TO LAND COVER CHANGE IN URBAN AREA: A CASE STUDY OF MEDIUM-SIZED CITY, MAJENE, INDONESIA**

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### **Abstract**

The urbanization process often results in reduced green space, increased electricity consumption, and the use of fossil-fuel vehicles. It triggers urban heat islands (UHI)—a phenomenon characterized by increasing surface temperatures in urban spaces. This impacts thermal comfort, quality of life, and the environment. This study aims to identify UHI based on the land cover change in Majene Urban Area, a medium-sized city that acts as a center for educational activities in the province of West Sulawesi in Indonesia. Interpretation of satellite imagery in 2011 and 2022 was carried out to determine land cover changes, including built-up land, open land, agricultural vegetation, non-agricultural vegetation, and waters. Then, UHI is analyzed by measuring brightness temperature, normalized difference vegetation Index (NDVI), the proportion of vegetation, land surface emissivity, and land surface temperature. The UHI calculation is divided into four temperature classes: Non-UHI ( $<0^{\circ}\text{C}$ ), UHI I ( $0-2^{\circ}\text{C}$ ), UHI II ( $2-4^{\circ}\text{C}$ ), and UHI III ( $>4^{\circ}\text{C}$ ) to simplify the spatial analysis of affected areas. The results indicate that while land cover in Majene City has not changed significantly, UHI dynamics are evident in temperature class. This supports previous studies in larger cities, where increased built-up areas raise surface temperatures, though the effect is less pronounced in Majene. However, Majene still experiences temperature rises of over  $4^{\circ}\text{C}$  due to expanding land use for settlements, offices, and services. Therefore, it is crucial to develop strategies that balance built-up areas with green spaces and promote sustainable urban planning to mitigate the impacts of climate change.

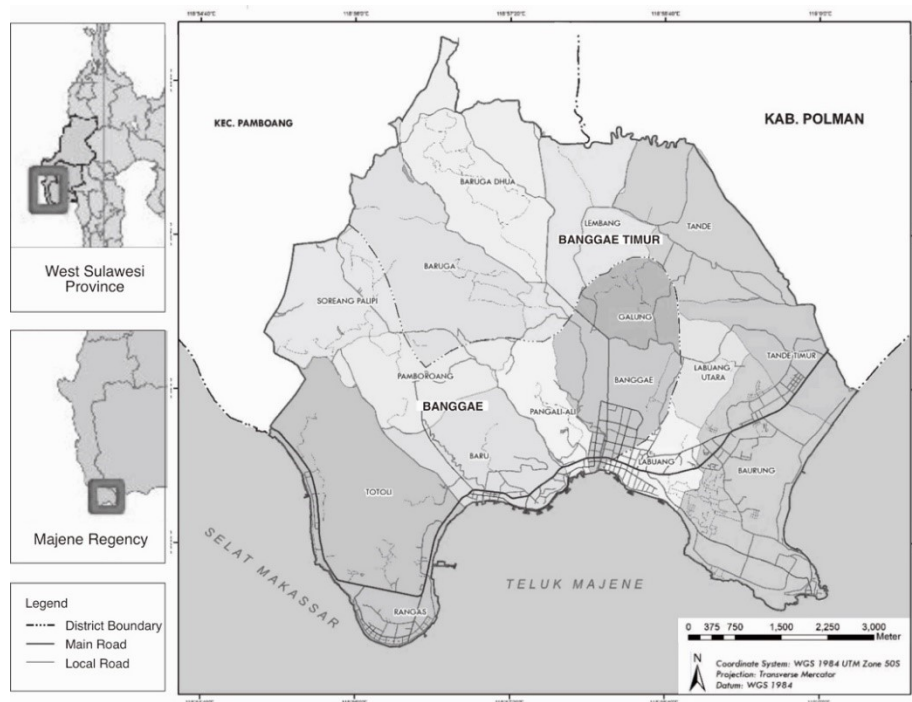
**Keywords:** Urban heat island (UHI), land cover change, land surface temperature, normalized difference vegetation index (NDVI), Majene

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## INTRODUCTION

Urban areas globally are experiencing increasing temperatures due to the Urban Heat Island (UHI) effect, where urban regions are warmer than their rural counterparts as a result of human activities and alterations to land cover. The UHI effect is particularly intensified by rapid urbanization, which transforms natural landscapes into built environments, leading to significant modifications in local climate systems, including higher urban temperatures, altered air circulation patterns, increased energy consumption, and health risks (Tsou et al., 2014; Ranagalage et al., 2017). These impacts underscore the importance of understanding the relationship between urban development and UHI to formulate effective mitigation strategies.

In Indonesia, cities are categorized based on population size and functional dynamics, as outlined in the Government Regulation 26 of 2008 on National Spatial Planning. These categories include Megapolitan (multiple interconnected metropolitan areas), Metropolitan (urban areas with populations exceeding 1 million), Large Cities (over 500,000 people), Medium Cities (100,000 to 500,000 people), and Small Cities (50,000 to 100,000 people). Majene, with 177,390 residents, is classified as a medium-sized city.



**Figure 1:** Study Area: Majene Urban Area

Majene, a coastal city in West Sulawesi Province, was selected as the study area due to its relevance in examining UHI effects in medium-sized cities (Figure 1). It serves as a hub for office, commercial, and residential activities, which are expanding and contributing to significant land use changes, particularly the conversion of vegetated areas into impervious surfaces. These changes exacerbate UHI and emphasize the need to preserve green spaces as a mitigation strategy, as highlighted by Rushayati et al. (2018). The relevance of this study is further strengthened by Majene's inclusion in the West Sulawesi development corridor, where sustainability and climate resilience are regional priorities. Large cities constitute a common discussion in UHI study literature; therefore, this research will attempt to contribute to a better understanding of UHI phenomena dynamics in medium-sized cities.

## **LITERATURE REVIEW**

UHI effect, where urban areas are warmer than rural surroundings, is largely driven by land cover changes that are associated with urbanization. Replacing natural surfaces such as vegetation with impervious materials increases heat retention and reduces cooling processes, exacerbating the UHI effect (Zhou et al., 2015). As cities expand, this transformation significantly reduces evapotranspiration while increasing heat storage, contributing to the intensification of UHI (Keeratikasikorn & Bonafoni, 2018).

Several studies have demonstrated that land use and land cover changes are primary drivers of UHI intensity. For instance, research in Kota Bharu, Malaysia, found that urban expansion led to significant temperature increases, particularly in areas where vegetated landscapes were replaced with built-up areas (Ibrahim & Ash'aari, 2023). A study in Kuching, Malaysia, also revealed that a rise in land surface temperature is associated with a reduction in green areas due to growth in urban development (Ali et al., 2021). These findings underscore the importance of urban vegetation in cooling the environment and mitigating UHI effects, as supported by remote sensing studies that show vegetation's role in reducing local temperatures (Luan et al., 2020).

UHI intensity varies spatially and temporally, with higher temperatures typically found in urban centers and diminishing toward rural areas (Zhou et al., 2015). UHI is most pronounced at night when built surfaces release stored heat more slowly than natural landscapes. Additionally, seasonal factors, particularly during summer, can exacerbate the UHI effect due to increased solar radiation (Wang et al., 2019).

As Majene continues to grow, with increasing urban and commercial activities, land cover changes will likely amplify the UHI phenomenon. This aligns with findings that emphasize the critical role of land use planning in

controlling UHI through the preservation of green spaces and sustainable urban design (Rushayati et al., 2018).

## **MATERIALS AND METHOD**

This study was conducted in an urban area in Majene Regency, a medium-sized city located in the Eastern Indonesia region. Using two different data from satellite imagery for 2011 and 2022, dynamics are performed on the urban heat islands in Banggai and the Banggai Timur District. These satellite images are the major data source, identifying land cover types such as water bodies, built-up areas, bare land, non-agriculture vegetation, and agricultural vegetation. Temporal change analysis in land cover classes was realized through a decade's change in land cover.

The assessment of Urban Heat Island (UHI) can be effectively conducted using satellite-derived environmental indicators, including Top of Atmosphere (TOA) radiance, Brightness Temperature (BT), Normalized Difference Vegetation Index (NDVI), Proportion of Vegetation (PV), Land Surface Emissivity (E), and Land Surface Temperature (LST). The measurement of UHI typically begins with the acquisition of satellite imagery, which provides the necessary data for calculating various thermal and vegetation indices. TOA radiance is the first step in this process, as it represents the amount of solar radiation reflected from the Earth's surface back to space. This data is crucial for deriving LST, a key indicator of UHI intensity (Liu & Zhang, 2011). Brightness Temperature (BT) is derived from the thermal infrared bands of satellite data, allowing researchers to estimate the surface temperature of urban areas (Liu & Zhang, 2011). The NDVI is another critical indicator for assessing vegetation cover in urban areas. It is calculated using the reflectance values in the red and near-infrared bands of satellite imagery, providing insights into the health and extent of vegetation (Anurogo et al., 2022). The Proportion of Vegetation (PV) is derived from NDVI and indicates the fraction of an area that is covered by vegetation, which inversely correlates with UHI intensity; areas with higher vegetation cover typically experience lower temperatures (Liang et al., 2022). Land Surface Emissivity (E) is also essential for accurate temperature measurements, as it accounts for the ability of different surfaces to emit thermal radiation. This factor varies significantly between urban materials (e.g., concrete, asphalt) and natural surfaces (e.g., vegetation, water bodies) (Montaseri et al., 2022). Finally, LST is calculated using the previously mentioned indicators, providing a direct measure of surface temperatures that can be compared across urban and rural areas to quantify UHI intensity (Han et al., 2014). The following sections illustrate the analytical stages that are undertaken to establish the relationship between UHI and land cover changes (Figure 2).

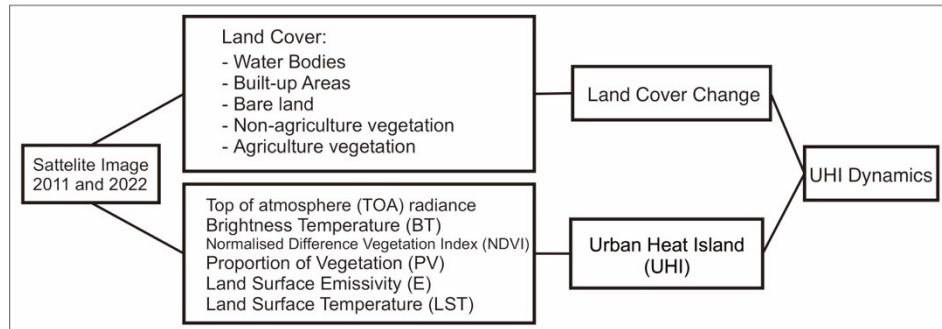


Figure 2: Framework of UHI Dynamics

### Remote Sensing in Identifying Land Cover Change

Remote sensing techniques have been widely used to analyze land cover change through a supervised classification approach. For multitemporal analysis, this study selected Landsat 7 ETM images from 2011 and Landsat 8 OLI/TIRS images from 2022. The data were radiometrically corrected based on reflectance values using ENVI 5.3 software, which is essential for ensuring the accuracy of the spectral data used in classification (Chi et al, 2011). The land cover classification was done using composite bands 1 to 7, starting with identifying 30 training samples per class. The supervised classification was performed using the maximum likelihood classification method, which is a common approach for land cover studies due to its effectiveness in handling multi-spectral data. The validation process employed kappa validation, with the overall accuracy and kappa coefficient calculated using the following formulas:

$$\text{Overall Accuracy} = \frac{TCS}{TS} \times 100 \dots\dots\dots(1)$$

$$\text{Kappa Coefficient } (T) = \frac{(TS \times TCS) - \sum (\text{Column Total} \times \text{Row Total})}{TS^2 - \sum (\text{Column Total} \times \text{Row Total})} \times 100\% \dots \quad (2)$$

Where TCS = Total Correct Sample  
TS = Total Sample

Land cover change and its validation were further analyzed spatially using the Calculate Geometry tool in the attribute table within ArcGIS 10.5.

### Measuring Urban Heat Island

The Urban Heat Island calculation utilized Landsat 7 satellite imagery recorded on July 26, 2011, and Landsat 8 imagery recorded on April 11, 2022. Initially, the digital number values from Landsat 8 band 10 imagery were converted into radiance data through top-of-atmosphere (TOA) radiance calculations. The following formula was employed for this process.

$$L\lambda = ML * Q_{cal} + AL - O_i \dots\dots\dots(3)$$

Where  $L\lambda$  : Top of Atmosphere (TOA) spectral radiance  
 $ML$  : Band-specific multiplicative rescaling factor from the metadata (RADIANCE\_MULT\_BAND\_x, where x is the band number); The radiance multiplicative value of Band 10, as seen from the metadata information on Landsat 8 satellite imagery  
 $Q_{cal}$  : Digital number in the band 10 image  
 $AL$  : Band-specific additive rescaling factor from the metadata (RADIANCE\_ADD\_BAND\_X, where x is the band number); value of radiance add Band 10, as seen from the metadata information on Landsat 8 satellite imagery  
 $O_i$  : the correction for Band 10, that is: 0.29

To measure Land Surface Temperature (LST), the radiance values from TOA are then used to derive the brightness temperature. The inversion of the Planck Law equation is used, assuming that the Earth's surface behaves like a black body with an emissivity value of one. The calculation for brightness temperature is as follows:

$$BT = \left( \frac{K_2}{\ln\left(\frac{K_1}{L\lambda}\right)} \right) - 273.15 \dots\dots\dots (4)$$

Where  $BT$  : Brightness temperature (°C)  
 $L\lambda$  : Top of Atmosphere (TOA) spectral radiance  
 $K_1$  : Constant value

Normalized Difference Vegetation Index (NDVI) is one of the parameters used to analyze the vegetation condition of an area. The formula used to calculate NDVI is as follows:

$$NDVI = \frac{NIR-RED}{NIR+RED} \dots\dots\dots (5)$$

Where  $RED$  : the reflection in the red range of the spectrum (band 4)  
 $NIR$  : the reflection in the near-infrared spectrum (band 5)

In this study, land surface emissivity data was obtained by utilizing NDVI values. To determine the emissivity value in mixed areas, the proportion of vegetation (PV) formula was used, calculated as follows:

$$PV = \left( \frac{NDVI-NDVI_{min}}{NDVI_{max}-NDVI_{min}} \right)^2 \dots\dots\dots (6)$$

Where  $PV$  : Proportion of Vegetation  
 $NDVI$  : Normalised Difference Vegetation Index  
 $NDVI_{min}$  : NDVI minimum  
 $NDVI_{max}$  : NDVI maximum

Next, the emissivity value was obtained through the following calculation:

$$E = 0.004*PV + 0.986 \dots\dots\dots (7)$$

Where PV : Proportion of Vegetation  
E : Land Surface emissivity

The Land Surface Temperature (LST) is obtained by calculating the brightness temperature (BT) along with the emissivity value. The calculation used is as follows:

$$LST = BT / (1 + (\lambda * BT / c^2) * \ln(E)) \dots\dots\dots (8)$$

Where  $\lambda$  for Landsat 8 satellite imagery, band 10: 10.8  
LST : Land surface temperature  
BT : Brightness temperature  
E : land surface emissivity  
 $C^2$  :  $1.4388 * 10^{-2}$  mK = 14388 mK

The Urban Heat Island (UHI) is determined by observing land surface temperatures exceeding a given area's average temperature. The calculation used for UHI is as follows:

$$UHI = Tr - (\mu + 0,5 \alpha) \dots\dots\dots (9)$$

Where Tr : the temperature in the urban area  
 $\mu$  : mean temperature of the reference area  
 $\alpha$  : Standard deviation

## RESULTS AND DISCUSSION

### Land Cover Change in Majene Urban Area

Land cover change was assessed through satellite image interpretation, utilizing data from 2011 to 2022. The classification method employed was supervised classification with maximum likelihood classification. The land cover classification results can be seen in Table 1 and Figure 3. Based on Table 1, there is a noticeable change in the land cover area, including an increase in built-up areas in the Urban Areas of Majene, where the development of built-up areas extends northward following the main road pattern. Conversely, other land covers experience a decrease in area. This is consistent with the increasing trend of built-up land development.

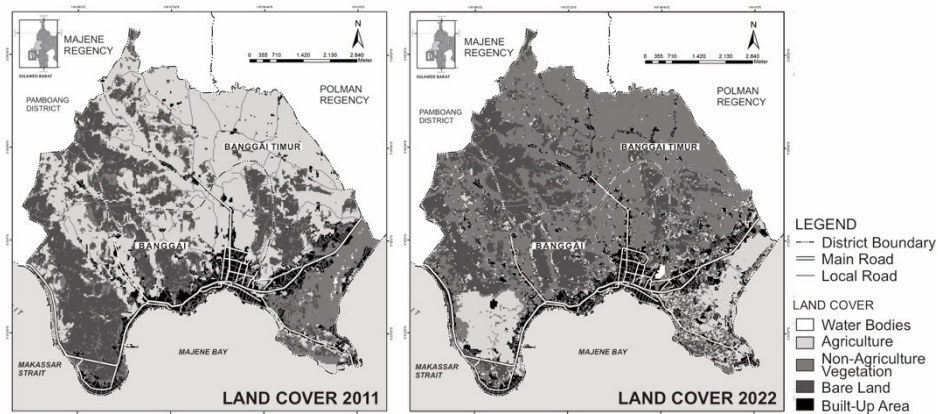
**Table 1:** Land Cover Change in Majene Urban Areas in 2011 and 2022

Land Cover	Area in 2011		Area in 2022	
	(Ha)	(%)	(Ha)	(%)
Water Bodies	12.78	0.25	10.53	0.20
Built-up Areas	574.19	11.09	636.27	12.30
Bare land	1367.86	26.43	1357.38	26.25
Non-agriculture vegetation	2390.70	46.19	2371.30	45.85
Agriculture vegetation	829.92	16.04	799.97	15.47
Total Area	5175.45	100	5175.45	100



### **The Dynamic of Land Surface Temperature in Majene Urban Areas**

The LST in the Majene urban area from 2011 to 2022 varied and increased. Based on LST calculations, the temperature in 2011 ranged from 20.26°C to 27.49°C, with an average of 22.41°C. By the end of the study in 2022, these figures had changed drastically: the minimum increased to 11.16°C, the maximum to 33.01°C, and the average to 26°C.



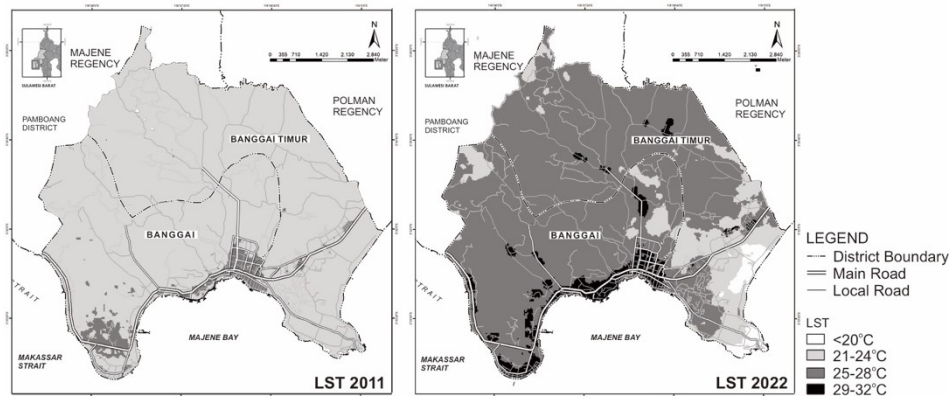
**Figure 3:** Land Cover in Majene Urban Areas 2011 and 2022

The LST changes from 2011 to 2022 reveal new temperature patterns. In 2011, there were only three classes (<20°C, 21-24°C, 25-28°C) identified, but by 2022, a >28°C category emerged in the southern urban area, as shown in Figure 4. Table 2 shows that in 2011, there were 4,932.63 hectares in the temperature range of 21-24°C, accounting for approximately 95% of the total area of the Urban Areas of Majene. The lowest temperature class <20°C had an area of 7.83 hectares, constituting only about 0.15% of the total area of the Urban Areas of Majene. Moving on to the subsequent period in 2022, the temperature class of 25-28°C is the most dominant, covering an area of 4,048.97 hectares or approximately 78.23% of the total area of the Urban Areas. Furthermore, the highest temperature range (>28°C) covers an area of 315.13 hectares, representing about 6.09% of the total area of the Urban Areas of Majene in 2022. These changes indicate a significant rise in higher-temperature areas and are bound to decrease in lower-temperature areas, indicating a tendency toward warming. The UHI effect seems to have increased during one decade, which is possibly caused by the increase in urbanization and reduced vegetation cover.

**Table 2:** Land Surface Temperature in Majene Urban Areas 2011-2022

Class	LST	Area in 2011		Area in 2022	
		(Ha)	(%)	(Ha)	(%)
1	<20°C	7.83	0.15	121.50	2.35
2	21-24°C	4,932.63	95.31	689.85	13.33
3	25-28°C	234.99	4.54	4,048.97	78.23
4	>28°C	0	0	315.13	6.09
<b>Total Area</b>		5,175.45	100	5,175.45	100

In 2011, it could be observed that the highest temperature range of 25-28°C was concentrated in the city center in the urban areas of Majene itself, i.e., in the southern area, where the dominant feature of land cover is comprised of built-up areas, commercial zones, and office spaces (Figure 4). The most significant increase was within the 25-28°C LST interval, which increased from approximately 235 hectares or 4.54% of the urban area in 2011 to 4,049 hectares or 78.23% of the urban area. This high-temperature zone expanded to the western and southern parts of the city, mainly in Banggai district, due to the increase in built-up areas along the coastline.



**Figure 4:** Land Surface Temperature in Majene Urban Areas 2011 and 2022

In 2022, the lowest temperatures (<20°C) were found in coastal areas of southeast Majene, in Banggai Timur, which were dominated by rice fields, fishponds, and mangrove forests. Rising land surface temperatures typically progress from these coastal regions to the built-up areas, which include residential, office, and commercial spaces. Table 3 shows that from 2011 to 2022, all land cover types have experienced an increase in average LST, with built-up areas, agricultural land, non-agricultural land, and water bodies seeing temperature rises exceeding 2°C, although the overall LST development did not show significant changes.

**Table 3:** Average Land Surface Temperature (LST) by Land Cover, Majene Urban Area

Land Cover	LST 2011 (°C)	LST 2022 (°C)
Built-up Areas	23.65	25.70
Bare land	23.03	25.00
Agriculture vegetation	22.51	24.61
Non-agriculture vegetation	21.77	23.88
Water Bodies	21.34	23.80

Factors that could explain such temperature dynamics for Majene include its coastal urban setting and a mix of built-up areas, agriculture, and non-agriculture. Increases in built-up and high-temperature areas signal urban growth and changes in land use that support positive heat retention and limit any cooling effect that is created by vegetation and previous spaces.

### **The Dynamics of Urban Heat Island in Majene**

The UHI assessment was conducted in 2011 and 2022, categorizing temperature variations to map their spatial distribution in urban areas. This classification links land cover changes to heat levels, identifying the most affected regions and informing interventions, such as increasing green spaces. Previous studies highlight the significance of these classifications in prioritizing mitigation strategies during urban renewal (Liu et al., 2023) and improving our understanding of daily urban heating dynamics.

Regions with temperatures exceeding the threshold by 0-2°C will be classified as UHI class I. Subsequently, areas with temperatures exceeding the threshold by 2-4°C will be categorized as UHI class II. Finally, regions with temperatures surpassing the threshold by more than 4°C will be classified as UHI class III. Most of the areas are categorized as non-UHI, which means they do not exceed the yearly threshold temperature. However, UHI Class I dominates with a temperature difference of around 0-2°C from the threshold. In 2011, it covered 1,062.18 hectares or 20.52 of the total area, increasing to 1,656.36 hectares (32%) in 2022. This indicates an increase in the UHI-affected areas over the decade, as shown in Table 4.

Class UHI I represents areas experiencing a temperature increase of 0-2°C compared to their surroundings. In 2011, Class UHI I was evenly distributed across the study area, in Banggai to the south and Banggai Timur to the north. The predominant land cover in these areas consisted mainly of open land, with some sections covered by vegetation, including both agricultural and non-agricultural types. The dynamic in Class UHI II shows slight differences. In both 2011 and 2022, UHI II is predominantly located in the central urban areas, where the land cover consists of built-up areas, including residential and office areas. The difference occurs in 2022 when the UHI II areas expand following the

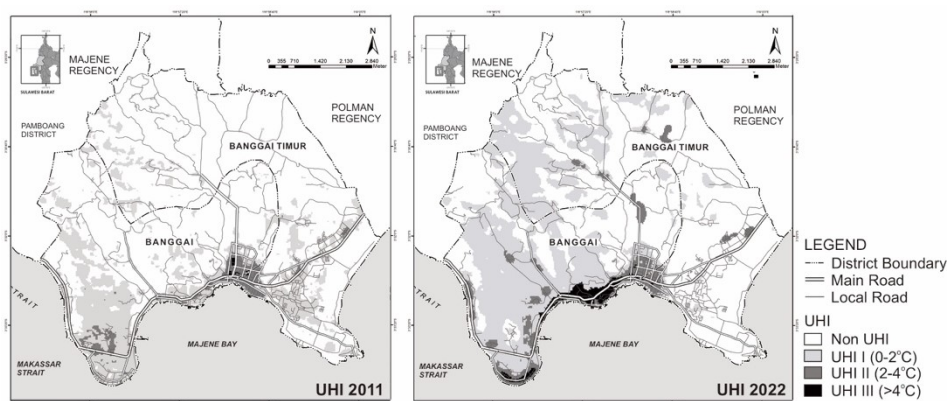
existing pattern of built-up land cover. Figure 3 provides the details of the built-up area location.

The UHI III ( $>4^{\circ}\text{C}$ ) classified areas are predominantly the built-up areas that are located in the city center, specifically in the Banggae District. Both in 2011 and 2022, these UHI III areas are situated in this district, characterized by built-up land cover consisting of residential, office, commercial, and service areas.

Considering the spatial development of built-up areas as represented in Figures 3 and Figure 5, it can be said that, similar to large cities, the UHI effect in Majene results in higher temperatures within the urban zone compared to vegetated or non-urban surroundings. This effect is driven by urban expansion following road networks, where natural landscapes such as agricultural fields, grasslands, and wetlands are replaced by buildings, roads, and infrastructure. Again, vegetation removal contributes to increasing surface temperatures by cooingly shading the environment and through evapotranspiration processes.

**Table 4:** UHI Area in Majene Urban Area 2011 and 2022

No	Class	Area in 2011		Area in 2022	
		(Ha)	(%)	(Ha)	(%)
1	Non UHI	3,981.69	76.93	3,207.96	61.98
2	UHI I ( $0-2^{\circ}\text{C}$ )	1,062.18	20.52	1,656.36	32.00
3	UHI II ( $2-4^{\circ}\text{C}$ )	125.37	2.42	225.63	4.36
4	UHI III ( $>4^{\circ}\text{C}$ )	6.21	0.12	85.5	1.65
Total Area		5,175.45	100	5,175.45	100



**Figure 5:** UHI in Majene Urban Area in 2011 and 2022

Generally, an increase in water-resistant surfaces such as asphalt, concrete, and rooftops contributes to high thermal conductivity and low albedo, leading these surfaces to absorb more heat during the day and release it slowly

at night, thereby intensifying the UHI effect. Majene's local government should incorporate UHI mitigation strategies into urban planning as a medium-sized coastal city. These could include expanding green spaces, establishing green buffer zones along the waterfront, protecting natural wetlands and mangrove areas, using permeable materials for walkways and plazas, incorporating ponds, and designing open corridors that allow coastal breezes to cool the city. Planting trees along streets to provide shade for pedestrians, encouraging community-based initiatives such as tree planting and water conservation, and implementing sustainable building practices with large coverage ratios can support effective UHI management, reduce energy demand for cooling, and improve urban comfort and resilience against climate impacts.

## **CONCLUSION**

Based on the results and discussion of the study, it can be concluded that Majene, a medium-sized city, also experiences the Urban Heat Island (UHI) effect. Although the changes in land cover within Majene's urban areas from 2011 to 2022 are not highly significant, there has been an increase of 62.27 hectares in built-up land. This development predominantly extends northward, following the existing infrastructure development pattern.

The study shows that land cover changes and urbanization contribute to elevated temperatures in cities compared to their natural landscapes or rural counterparts. This is evident from the average land surface temperature rise in the Urban Areas of Majene by 3.55°C over the decade. According to UHI calculations, the area affected by UHI has expanded considerably, with UHI I increasing by 594.18 hectares, UHI II by 100.26 hectares, and UHI III by 79.29 hectares between 2011 and 2022.

The relationship between the growth of built-up land and the increasing area of Urban Heat Islands (UHIs) demonstrates that changes in land use patterns and urbanization significantly intensify the UHI effect. The study confirms that larger areas of built-up land are associated with higher UHI values, while greater vegetation cover leads to lower land surface temperatures and reduced UHI effects. This highlights the need to incorporate strategies to mitigate the UHI effect into urban planning, ensuring that future urban development considers sustainable land use and integrating green spaces. The local government of Majene should apply the inclusion of strategies in urban planning for UHI.

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Engineering, Hasanuddin University. The invaluable support and resources from the laboratory have been crucial in advancing this research.

## DISCLOSURE STATEMENT

The authors confirm that there are no conflicts of interest related to this paper. Our research was carried out independently, without any financial support or benefits from commercial entities or organizations that could affect the results.

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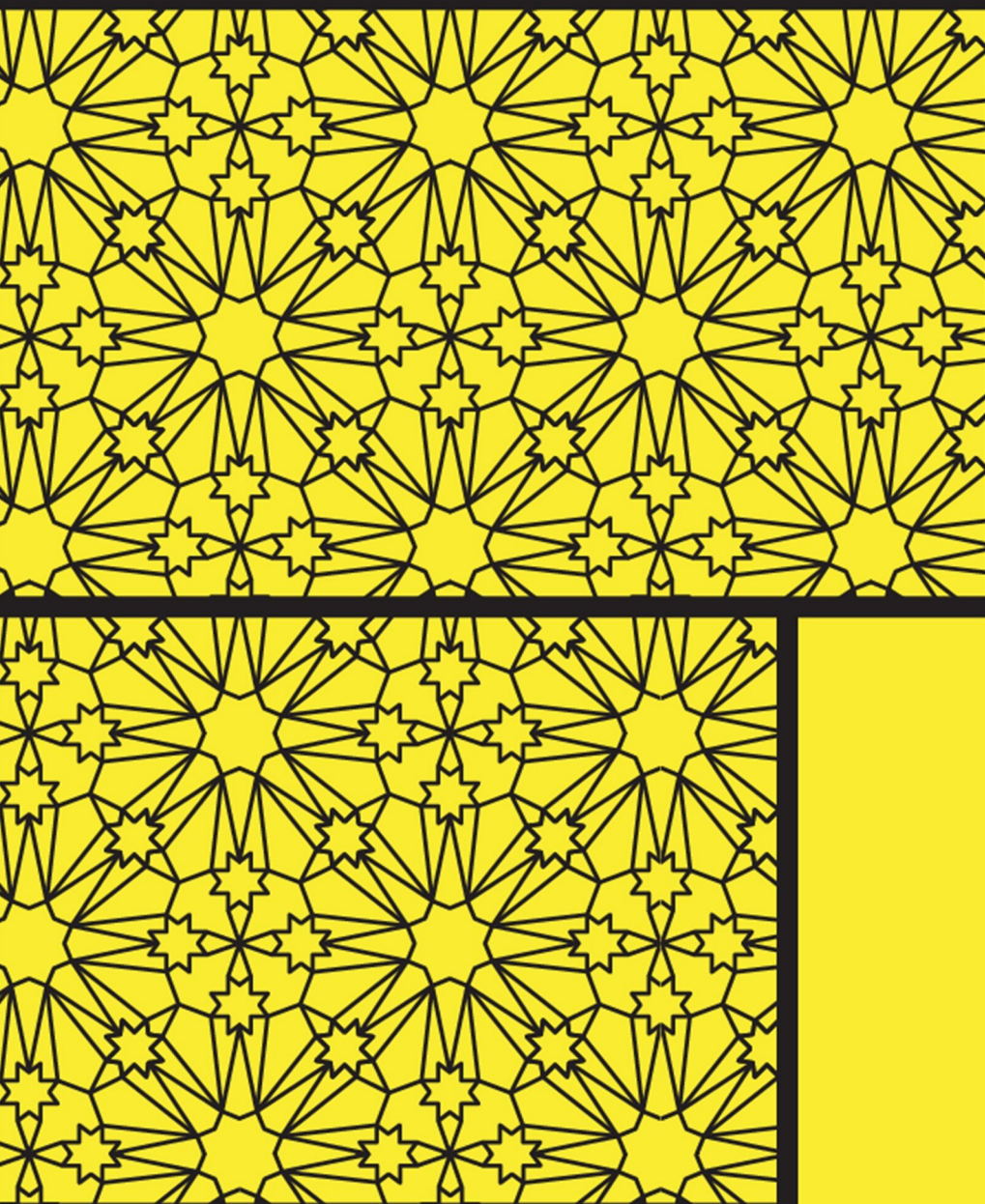
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