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THE IMPACT OF GREEN BUILDING MAINTENANCE PRACTICES IN MITIGATING PROMINENT DEFECTS AT UNIVERSITI TEKNOLOGI MARA (UiTM): A SYSTEMATIC LITERATURE REVIEW (SLR)

Zaimah Zainal Abidin¹, Nur Azfahani Ahmad², Nor Rima Mohamad Ariff³, Wan Norizan Wan Ismail⁴

*^{1,2,3,4} Department of Built Environment Studies & Technology,
College of Built Environment,
UNIVERSITI TEKNOLOGI MARA MALAYSIA*

Abstract

The presence of building defects poses significant challenges to the sustainability and functionality of university facilities over time. At Universiti Teknologi MARA (UiTM), these defects negatively impact building performance, visual appeal, and operational efficiency, underscoring the need for an effective solution. Implementing green building maintenance practices provides a feasible way to address these challenges by merging eco-friendly strategies with modern maintenance techniques. This study conducts a Systematic Literature Review (SLR) to examine the impact of green building maintenance practices on addressing critical defects at UiTM. To identify crucial maintenance techniques, their benefits, and their real-world applications, the review compiles the body of available research. The results highlight effective approaches that align with the Sustainable Development Goals (SDGs) and identify significant gaps in existing frameworks. To enhance building performance, reduce defects, and encourage sustainable maintenance practices at higher education institutions, this study aims to develop an institutional framework tailored for UiTM.

Keywords: Green Building Maintenance, Prominent Defects, Universiti Teknologi MARA (UiTM), Sustainable Development Goals (SDGs), Systematic Literature Review (SLR), Sustainable Practices, Higher Education Institutions

¹ Corresponding author. Email: eymahzainal@gmail.com

INTRODUCTION

Public universities in Malaysia play a crucial role in national development by producing skilled graduates and supporting various sectors of the economy (Othman, 2018). To ensure a conducive learning environment for students and staff, university facilities must be properly maintained to guarantee safety, functionality, and operational efficiency. Building maintenance therefore represents an essential component in sustaining the long-term performance and serviceability of institutional buildings.

However, many public institutions tend to adopt a reactive approach to building maintenance, where repairs and improvements are carried out only after defects are detected. According to Jones and Brown (2018), such reactive maintenance strategies often lead to higher maintenance costs, increased building deterioration, and disruptions to institutional activities. In large and complex facilities such as university campuses, delayed maintenance interventions may further accelerate the occurrence of building defects.

In the Malaysian context, building defects remain a common issue in many public university buildings. These defects may result from various factors, including poor design decisions, construction errors, material deterioration, and inadequate maintenance practices (Fateh & Nikmat, 2023). In addition, many university buildings in Malaysia have been in operation for several decades, which increases their exposure to age-related deterioration such as water leakage, dampness, and structural wear (Hong et al., 2016; Yacob et al., 2019; Othman et al., 2015; Hassan et al., 2015; Suffian, 2013; Mydin et al., 2014). If not properly managed, these defects can significantly affect building performance, user comfort, and operational sustainability.

To address these challenges, the concept of green building maintenance has gained increasing attention in recent years. Green building maintenance focuses on integrating environmentally responsible maintenance strategies with sustainable building management practices. These practices aim to reduce environmental impacts, improve energy efficiency, and enhance building durability while maintaining optimal building performance.

In Malaysia, sustainability initiatives in the built environment are supported through several national policies and regulatory frameworks. These include the National Green Technology Policy, the Green Building Index (GBI) certification system, and sustainability initiatives promoted by government agencies such as the Construction Industry Development Board (CIDB) and the Public Works Department (JKR) (CIDB, 2021; Green Building Index, 2020; Ministry of Energy, Green Technology and Water, 2009). These policies encourage institutions, including universities, to adopt more sustainable building management and maintenance strategies in line with national sustainability goals.

Despite the increasing emphasis on sustainable building practices, limited studies have systematically reviewed the role of green building maintenance practices in mitigating building defects within Malaysian higher education institutions. Previous research has primarily focused on individual aspects of maintenance management, technological solutions, or sustainability practices, without providing a comprehensive synthesis of how these elements collectively contribute to defect mitigation in university buildings.

Therefore, this study aims to conduct a systematic literature review (SLR) to examine the impact of green building maintenance practices in mitigating prominent defects at Universiti Teknologi MARA (UiTM). By synthesizing existing literature, this study seeks to identify key maintenance practices, technological approaches, and regulatory considerations that contribute to sustainable building performance. The findings of this study are expected to provide valuable insights for improving maintenance strategies in Malaysian universities while supporting broader sustainability objectives.

METHODOLOGY

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

To conduct a systematic review of the literature on green building maintenance methods for reducing significant weaknesses at Universiti Teknologi MARA (UiTM), this study adopts the PRISMA framework (Figure 1), which was specifically adapted for this research. Although initially developed for scientific study, PRISMA's structured methodology has been widely applied in the social sciences and built environment, ensuring an organised and open review process (Shaffril et al., 2021).

Within a defined timeframe, PRISMA assists with the establishment of inclusion and exclusion criteria, the refinement of research questions, and the systematic analysis of literature databases (Abu Samah et al., 2021). There are several frameworks for systematic reviews, especially in environmental management, like the Reporting Standards for Systematic Evidence Syntheses (ROSES) (Shaffril et al., 2021). However, PRISMA was used for this study, as it can generate concise and accessible results, making it appropriate for assessing green building maintenance practices (Belle & Zhao, 2023).

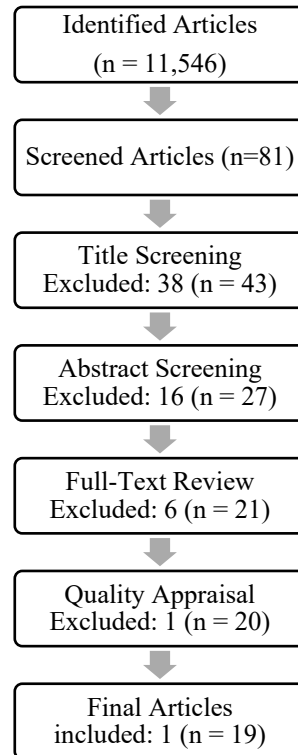


Figure 1: PRISMA Flow Diagram
 Source: Author

Formulation of Research Question

The first step in conducting a Systematic Literature Review (SLR) is to develop a clear research topic to guide the review process. In line with the study's objective, the following research question was formulated: "What are the current green building maintenance practices in mitigating prominent defects at Universiti Teknologi MARA (UiTM)?"

Systematic Searching Strategies

As suggested by Abu Samah et al. (2021), three systematic processes, identification, screening, and eligibility, were applied to obtain relevant research on green building maintenance approaches for reducing critical defects at Universiti Teknologi MARA (UiTM). By implementing these procedures into practice, it ensures that the Systematic Literature Review (SLR) remains comprehensive, clear, and well-organised. Each procedure is explained in detail in the following sections:

Identification

To make sure the review is relevant, the identification procedure aims to refine the primary keywords (Abu Samah et al., 2021). Based on the research topic, five key keywords were selected for this study, including Universiti Teknologi MARA (UiTM), building defects, sustainable maintenance practices, mitigation approaches, and green building maintenance. These keywords were further expanded with synonyms, related terms, and variations to improve the search process. To maximise the retrieval of relevant material, various search strategies were employed, such as field numbers, keyword searching, wildcards, and reduction.

Four scholarly databases were explored, including Google Scholar, Web of Science, ScienceDirect, and Scopus. Depending on their relevance, these methods were used separately or in combination. As a result of these search efforts, potential articles were found from the chosen databases.

Table 1: Search String Used in the Selected Databases

Databases	Keyword Used
Scopus	("green building maintenance" OR "sustainable maintenance") AND ("building defects" OR "mitigation strategies") AND ("Universiti Teknologi MARA" OR "UiTM")
Web of Science	("green maintenance" OR "sustainable maintenance") AND ("building defects") AND "Malaysia"
ScienceDirect	("green building" AND "maintenance practices") OR ("sustainable building management")
Google Scholar	("green building maintenance" AND "Malaysia") OR ("building defects mitigation")
Total Articles Identified	11,546

Source: Author

In total, 11,546 potential articles were identified across the chosen databases after a thorough search process.

Screening

The screening stage involved examining the retrieved articles, either through manual evaluation or database filtering, to decide whether to include them in the study. Table 2 outlines the predetermined requirements, such as type of literature, language, and publication year, that served as a guide for the selection process. As journal articles include original data, which is necessary for carrying out a systematic literature review, they were given priority as primary sources.

Table 2: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Type of Literature	Peer-reviewed journal articles, conference papers	Books, non-peer-reviewed articles, reports
Language	English	Non-English
Publication Year	2012–2023	Articles published before 2012
Research Scope	Green building maintenance, building defects, and sustainability practices	Studies unrelated to construction
Type of Literature	Peer-reviewed journal articles, conference papers	Books, non-peer-reviewed articles, reports

Source: Author

Based on Table 2, this review limited the screening procedure to articles published between 2012 and 2023, consistent with the research scope suggested by Abu Samah et al. (2021). This timeframe was chosen to guarantee that there were enough papers included for a representative analysis. Only articles written in English were taken into consideration to ensure uniformity. Furthermore, choosing research related to construction was essential in obtaining relevant publications, given the study's focus on green building maintenance practices.

Following screening, 81 articles remained for further evaluation, with 11,465 having been eliminated for not meeting the inclusion criteria. Two duplicate articles were also removed, leaving 79 papers for eligibility assessment.

Eligibility

The eligibility stage was the last step in making sure that every article that remained after the screening process met the specified inclusion criteria requirements. To ensure their applicability, articles were reviewed using their titles and abstracts. A full-text review was carried out to confirm that they were suitable for inclusion in the study if there was still concern.

At this stage, a total of 38 items were removed following title screening. A further 16 articles were excluded after abstract review, and six additional papers were eliminated after evaluating the full content. Ultimately, 19 articles proceeded to the final quality appraisal stage, after a total of 60 articles had been eliminated. 18 final papers were chosen for the systematic literature review after one article had been removed during the quality appraisal for being unable to meet the required criteria

Quality Appraisal

This stage was taken to make sure the methodology and analysis of the chosen articles were conducted to the highest possible level. To assess systematic mixed-studies reviews, Hong et al. (2018) used the Mixed-Method Appraisal Tool (MMAT), which evaluates five different research types, including mixed-methods research, qualitative research, non-randomised research, quantitative and qualitative studies, and controlled trials. Five main criteria outlined in the research design were used to assess the quality of the chosen articles.

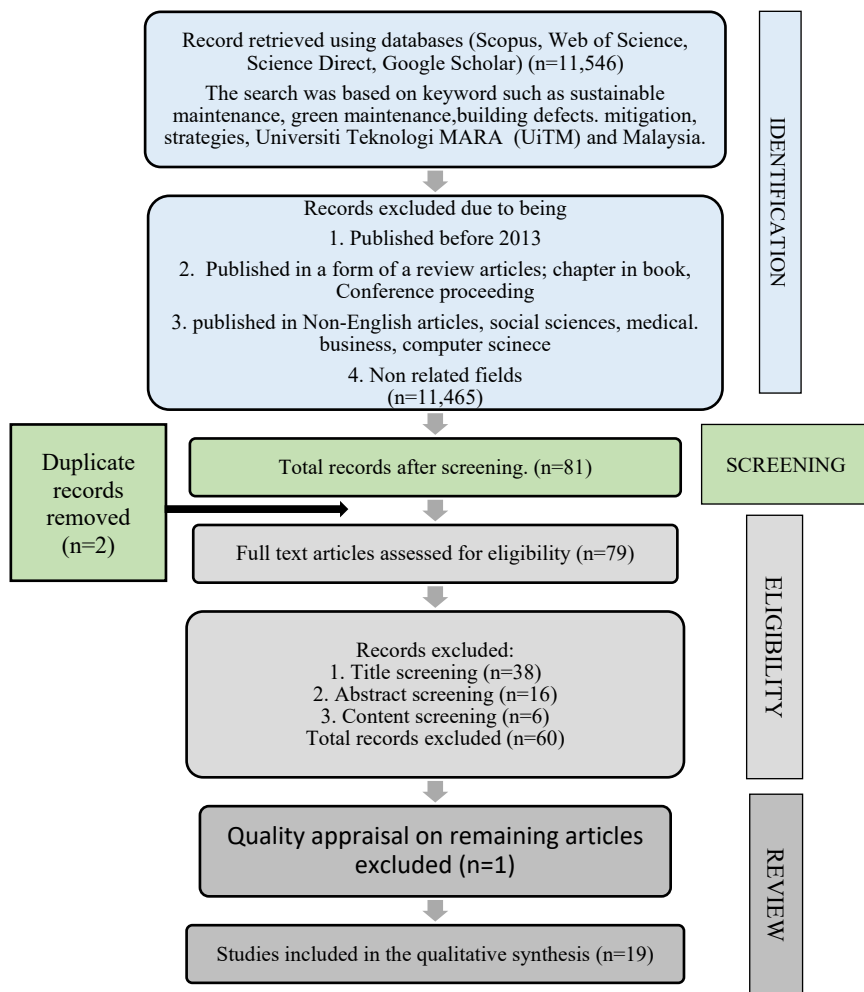


Figure 2: Flow diagram of the search process
Source: Author

Using this systematic framework, the researchers evaluated the quality of the 19 chosen publications, with particular focus on the suitability of statistical analysis, sampling techniques, data collection, research question clarity, and confidence in the findings. Based on the five predetermined criteria, each item was rated as "yes", "no", or "cannot tell". The review includes articles that met at least three of the five requirements. Consensus among the reviewers ensured that all chosen research satisfied the minimal requirements for data analysis and rigorous methods.

Table 3: Assessment Criteria

Research Design		Assessment criteria
Qualitative (Q1)	i.	Is the qualitative approach appropriate to answer the research question?
	ii.	Are the qualitative data collection methods adequately derived from the data?
	iii.	Is the interpretation of results sufficiently substantiated by data?
	iv.	Is there coherence between qualitative data sources, collection, analysis and interpretation?
Quantitative randomised controlled trials (Qn (rc))	i.	Is the randomisation process clearly described and appropriately implemented?
	ii.	Is the sample size justified and sufficient to ensure statistical power?
	iii.	Are the outcome measures valid, reliable, and consistently applied?
	iv.	Is the handling of attrition, missing data, and follow-up appropriately managed?
	v.	Are the statistical analyses appropriate and clearly reported?
	vi.	Is there evidence of selective outcome reporting being avoided?
Quantitative non-randomised (Qn (nr))	i.	Are the study participants selected using clear and appropriate inclusion/exclusion criteria?
	ii.	Are the outcome measures valid, reliable, and objectively assessed?
	iii.	Is the comparison group adequately described and matched where possible?
	iv.	Is the sample size sufficient to support the findings with statistical power?
	v.	Is the follow-up period appropriate and clearly reported (if applicable)?
	vi.	Are the statistical analyses appropriate to the study design and data type?
	vii.	Are the results presented clearly, with confidence intervals or effect sizes where relevant?
	viii.	Is there transparency in reporting, with no evidence of selective reporting or bias?
Quantitative descriptive (Qn (d))	i.	Are the research objectives or questions clearly stated and appropriate for a descriptive design?
	ii.	Is the sampling method clearly described and appropriate to the study population?
	iii.	Are the measurement instruments valid and reliable for capturing the required data?
	iv.	Are the data collection procedures clearly outlined and systematically applied?
	v.	Are the results presented clearly using appropriate descriptive statistics (e.g., frequencies, percentages, means)?
Mixed methods (MM)	i.	Is there a clear rationale for using a mixed methods approach to address the research objectives?
	ii.	Are both qualitative and quantitative components clearly described and appropriately integrated?
	iii.	Are the data collection and analysis procedures for both components rigorous and appropriate?
	iv.	Is there evidence of integration at the interpretation and discussion stage to generate comprehensive insights?

Source: Hong et al., 2018

Table 4: Result of Quality Assessment

Study	Research Design	QA1	QA2	QA3	QA4	QA5	Number Criteria Fulfilled	Inclusion in the Review
Abu Bakar and Kamaruzzaman (2023)	Qn(d)	/	/	C	/	/	4/5	/
Norazman et al. (2023)	Ql	/	/	/	/	/	5/5	/
Dzulkifli et al. (2021)	Ql	/	/	/	/	/	5/5	/
Razali et al. (2021)	Qn(d)	/	x	/	C	/	3/5	/
Hauashdh et al. (2020)	Ql	/	/	C	/	/	4/5	/
Kayan (2019)	Qn(d)	/	/	/	C	/	4/5	/
Au-Yong et al. (2019)	Qn(d)	/	/	/	/	/	5/5	/
Khalid et al. (2019)	Qn(d)	/	/	/	/	/	5/5	/
Mong et al. (2019)	Qn(d)	/	x	/	C	/	3/5	/
Kamaruzzaman et al. (2018)	Qn(d)	/	x	/	x	/	3/5	/
Au-Yong et al. (2017)	MM	/	/	/	/	/	5/5	/
Rahmat & Nawawi (2017)	Ql	x	x	x	x	x	0/5	x
Ali et al. (2016)	MM	/	/	/	/	/	5/5	/
Douglas (2016)	Qn(d)	x	/	/	C	/	3/5	/
Zawawi et al. (2016)	MM	/	/	/	/	/	4/5	/
Raja Mazlan & Mohammed (2015)	Qn(d)	/	/	/	/	/	5/5	/
Rani et al. (2015)	Qn(nr)	/	/	/	C	C	3/5	/
Myeda & Pitt (2014)	Ql	/	/	/	C	/	4/5	/
Adnan et al. (2012)	Ql	/	/	/	/	/	5/5	/

QA= Quality Assessment; QN (d)= Quantitative descriptive; QN (nr)= Quantitative non-randomised; QL= Qualitative; MM= Mixed Methods; C= Cannot tell

Source: Author

Of the 19 articles assessed, seven fulfilled all five requirements, seven fulfilled four of the five, and five satisfied only three. One article was excluded from further analysis as it did not satisfy the minimal quality criteria.

Data Extraction and Analysis

The remaining articles were then reviewed and analysed. Each article's important information was extracted, with particular emphasis on the research question. The review specifically focused on abstracts, results, and discussions of both primary and secondary empirical data. To facilitate synthesis, the data were systematically organised in tables.

A thematic analysis was conducted to identify important topics in green building maintenance practices for defect mitigation at UiTM. Thematic analysis, as described by Abu Samah et al. (2019) and Braun and Clarke (2019), involves identifying, categorising, and summarising common themes. Following the steps outlined by Kiger and Varpio (2020), the researchers repeatedly examined the dataset to gain familiarity and acquire important knowledge for later stages.

In the following stage, researchers created preliminary codes by systematically classifying the data according to recurrent patterns. Data relevant to the research questions were extracted following a careful analysis of the chosen papers. An inductive coding framework was used to identify patterns and connections in the coded material during the theme generating stage. These themes represented the entire dataset and were connected to the original data (Braun & Clarke, 2019).

The analysis produced four major themes and several subthemes. Two green building maintenance experts were consulted to validate the identified themes and subthemes in order to verify their reliability and relevance. Following their validation, four themes and ten subthemes were finalised for further study discussion.

RESULTS

General Background of the Selected Studies

Of the total 18 articles that were chosen, 11 of them, including Abu Bakar and Kamaruzzaman (2023), Razali et al. (2021), Au-Yong et al. (2019), Kayan (2019), Khalid et al. (2019), Mong et al. (2019), Kamaruzzaman et al. (2018), Douglas (2016), Mazlan and Mohammed (2015), Rani et al. (2015), and Myeda and Pitt (2014), focused on quantitative analyses of green building maintenance practices for defect mitigation at UiTM. Four articles, including Adnan et al. (2012), Mong et al. (2021), and Norazman et al. (2023), adopted qualitative analysis, while three applied mixed-method techniques.

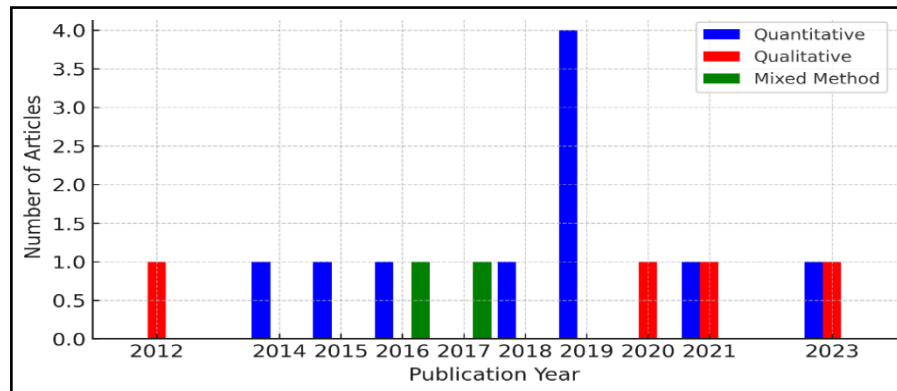


Figure 3: Publication Year and Number of Articles
Sources: Au-Yong et al. (2017); Chu et al. (2016); Zawawi et al. (2016)

The distribution of research designs across the 18 chosen papers on green building maintenance practices for defect mitigation at UiTM is shown in Figure 3. The studies are divided into three research approaches:

1. **Quantitative research (Blue bars):** This category evaluated many aspects of green building maintenance using statistical and numerical techniques. This category has 11 articles in total, with 2019 showing the highest focus, suggesting an important focus on quantitative analysis in that year's research.
2. **Qualitative Research (Red bars):** Four studies used qualitative approaches to fully investigate green building maintenance issues, mostly through the use of case studies, interviews, and thematic analyses. These studies were published across different years, with a minor increase in more recent publications.
3. **Mixed-Method Research (Green bars):** To get an improved understanding of green building maintenance practices, three studies combined qualitative and quantitative methodologies, including both descriptive and statistical analysis. Most of this research was released between 2016 and 2017.

Figure 3 shows that research on green building maintenance has increased noticeably over the past five years, with quantitative studies leading this trend. A comprehensive understanding of UiTM's defect mitigation measures is ensured by the inclusion of qualitative and mixed-method studies, which show how to investigate the problem from various perspectives.

Table 5: Selected Journals and Their Rankings

Journal Name	Article No.	Indexed by WoS	WoS Quartile	Indexed by Scopus	Scopus Quartile
Journal of Facilities Management	3	Yes	Q1	Yes	Q1
Sustainable Cities and Society	2	Yes	Q1	Yes	Q1
Building and Environment	2	Yes	Q1	Yes	Q1
Facilities	1	No	-	Yes	Q2
Journal of Building Engineering	3	Yes	Q1	Yes	Q1
International Journal of Building Pathology and Adaptation	2	No	-	Yes	Q2

*Last ranking before the journal was discontinued

Source: Author

The journals chosen for this study were evaluated according to their quartile rankings and Web of Science (WoS) and Scopus indexing, as shown in Table 5. Seven important journals were identified, with a particular focus on defect reduction and green building maintenance methods. With a quartile score of Q1, the Journal of Facilities Management, Sustainable Cities and Society, Building and Environment, and the Journal of Building Engineering were indexed in both WoS and Scopus, showing their excellent quality and impact in the field.

Meanwhile, the journal Facilities was not indexed in WoS, even though it was indexed as a Q2 journal in Scopus. Similarly, the International Journal of Building Pathology and Adaptation was excluded from WoS but had a Q2 ranking in Scopus. The choice of these publications ensures that the research is based on accurate data and provides robust and reliable insights into maintenance practices for green buildings. The chosen papers' scientific importance is further supported by their quartile rankings, which show their relevance in discussing defect mitigation practices in the context of UiTM.

The Developed Themes

A structured overview of the studies selected, according to their focus areas, Specifically, green building maintenance practices, defect mitigation approaches, and policy and regulatory compliance, are presented by the themes and subthemes listed in Table 6. The table shows the distribution of research efforts in addressing sustainable maintenance solutions and defect reduction in UiTM's built environment, highlighting each author's contributions to these key areas. All three themes are thoroughly addressed in studies such as those by Abu Bakar and

Kamaruzzaman (2023), Dzulkifli et al. (2021), and Khalid et al. (2019), indicating a thorough approach to green building maintenance and regulatory compliance. Other research, on the other hand, highlights different emphasis in the literature by focusing on either defect mitigation or maintenance procedures independently. In creating a systematic framework for green building maintenance at UiTM, this thematic classification makes it easier to understand research trends, gaps, and future directions.

Table 6: Themes and Subthemes Listed

Authors/ Theme	Green Building Maintenance Practices	Defect Mitigation Strategies	Technology	Policy and Regulatory Compliance	Overall Rank
Abu Bakar & Kamaruzzaman (2023)	√	√	√		2
Norazman et al. (2023)	√	√		√	3
Dzulkifli et al. (2021)	√	√	√	√	1
Razali et al. (2021)	√		√	√	4
Hauashdh et al. (2020)		√			5
Kayan (2019)	√	√			2
Au-Yong et al. (2019)	√	√			2
Khalid et al. (2019)	√	√	√	√	1

Sources: Author

Table 6 illustrates the thematic classification of the selected studies based on four key dimensions: green building maintenance practices, defect mitigation strategies, technological applications, and policy and regulatory compliance. The table highlights how each selected study contributes to one or more thematic areas, demonstrating the multidimensional nature of green building maintenance research.

This thematic mapping also helps identify research trends and gaps within the literature. While most studies emphasize maintenance practices and defect mitigation strategies, fewer studies focus on regulatory compliance and the integration of policies. This finding indicates the need for stronger alignment between institutional maintenance practices and national sustainability policies in the context of Malaysian higher education institutions.

Green Building Maintenance Practices

With 15 out of 18 articles addressing this theme, it was the most frequently discussed. Three subthemes were identified. 12 papers examined the first subtheme, which organised maintenance techniques designed for green buildings. The second subtheme, which is covered in nine articles, addresses ways to improve sustainability through preventive maintenance. 11 articles addressed the third subtheme, which highlights systematic green maintenance techniques aiming to mitigate environmental effects.

Defect Mitigation Strategies

13 of the 18 articles had this theme, which included three subthemes. Ten articles address the first subtheme, which focuses on predictive maintenance methods for identifying and correcting defects early. Seven articles cover the second subtheme, which is sensor-based monitoring for fault detection. Furthermore, eight papers address the third subtheme, which highlights the importance of quick reactions and routine inspections in avoiding serious defects.

Technology in Green Building Maintenance

11 of the 18 articles had this theme, which included three subthemes. The first subtheme, which has been examined in nine articles, focuses on how smart technologies, such as BIM and IoT, are utilised in building maintenance. Six articles address the second subtheme, which studies the use of digital platforms for reporting and scheduling maintenance. The use of machine learning and artificial intelligence for predictive maintenance in green buildings is the third subtheme, which is the subject of seven papers.

Policy and Regulatory Compliance

Ten of the 18 articles investigated this theme, which included three subthemes. Eight articles examined the first subtheme, which examines the compliance with national and international certified green building requirements. The second subtheme addresses how government rules influence maintenance policies and is covered in six articles. The enforcement approaches that guarantee compliance with sustainable maintenance practices are the focus of the third subtheme, which is discussed in seven articles. The long-term sustainability and regulatory compliance of green buildings in Malaysia are guaranteed by these themes, which offer a thorough review of green building maintenance practices and defect mitigation techniques.

DISCUSSION

The outcomes of the systematic literature study provided significant understanding on how Malaysian UiTM buildings, in particular, employ green building maintenance processes and defect mitigation techniques. According to the quality appraisal, seven studies fulfilled all five quality evaluation criteria, while only one study was removed for not meeting the minimum threshold. This indicates that the majority of the articles fulfilled methodological consistency, thereby reinforcing their reliability in providing a strong framework for maintaining green buildings.

Four primary themes emerged from the thematic analysis, including policy and regulatory compliance, technology in green building maintenance, defect mitigation measures, and green building maintenance practices. With 15 out of 18 research addressing the topic, green building maintenance practices were identified as the most common theme, highlighting the significance of structured maintenance frameworks for sustainability. There was extensive discussion on defect mitigation strategies, with research highlighting real-time monitoring systems and predictive maintenance methods as essential steps in defect prevention.

Additionally, 11 studies identified the use of technology in maintenance, specifically through digital tools such as BIM and IoT, indicating an increasing reliance on intelligent alternatives for effective building maintenance. Finally, ten studies highlighted the importance of strict adherence to government regulations and green building certification standards, highlighting policy and regulatory compliance as a key subject.

Overall, the reviewed studies support the claim that increasing green building sustainability and reducing building defects requires the implementation of structured maintenance procedures, the adoption of technology, and the enforcement of regulatory frameworks. The systematic selection and review of papers ensured that only high-quality research was included in the discussion, which enhanced the reliability of the findings.

Policy and Regulatory Implications for UiTM

Green building maintenance practices in Malaysian public universities are also influenced by several national policies and regulatory frameworks. In Malaysia, sustainability initiatives in the built environment are supported through policies such as the National Green Technology Policy, the Green Building Index (GBI) certification framework, and sustainability guidelines promoted by agencies such as the Construction Industry Development Board (CIDB) and the Public Works Department (JKR) (Ministry of Energy, Green Technology and Water, 2009; Green Building Index, 2020; CIDB, 2021). These policies encourage institutions to adopt environmentally responsible practices in building operation and

maintenance while improving long-term building performance and sustainability (Kamaruzzaman et al., 2018; Au-Yong et al., 2019).

For Universiti Teknologi MARA (UiTM), aligning maintenance strategies with these national sustainability policies can significantly improve building performance and reduce recurring building defects. For example, preventive maintenance planning, energy-efficient building operation, and the use of sustainable materials can help extend building life cycles while minimizing environmental impacts (Ali et al., 2016; Dzulkifli et al., 2021). Integrating these regulatory frameworks into institutional maintenance strategies also supports Malaysia's commitment to the Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production) (United Nations, 2015).

However, implementing green building maintenance practices at the university level may also present several challenges. One major challenge is financial limitation, as the adoption of advanced technologies such as IoT monitoring systems, BIM-based maintenance management, and predictive maintenance tools may require significant investment (Au-Yong et al., 2017; Khalid et al., 2019). In addition, institutional resistance to change and limited awareness among maintenance personnel may slow down the adoption of sustainable practices (Myeda & Pitt, 2014; Hauashdh et al., 2020).

Furthermore, large university campuses such as UiTM consist of numerous buildings with different ages, functions, and maintenance conditions. This complexity may complicate the standardization of green maintenance strategies across all facilities. Therefore, strong institutional commitment, proper training for facility management personnel, and strategic long-term planning are essential to ensure the successful implementation of green building maintenance practices (Kayan, 2019; Zawawi et al., 2016).

CONCLUSION

This systematic literature review highlights the significant role of green building maintenance practices in mitigating prominent building defects in Universiti Teknologi MARA (UiTM). The findings demonstrate that effective maintenance strategies, supported by technological integration and regulatory compliance, are essential in improving the sustainability and performance of university buildings.

Four major themes were identified through the thematic analysis, namely green building maintenance practices, defect mitigation strategies, technological integration, and policy and regulatory compliance. Among these themes, structured maintenance practices and proactive defect mitigation strategies were the most frequently discussed in the selected studies, indicating their importance in maintaining sustainable building performance.

The increasing use of digital technologies such as Building Information Modelling (BIM), Internet of Things (IoT), and predictive maintenance tools also highlights the potential of technology-driven solutions in improving maintenance efficiency and reducing operational risks in university facilities. These technologies can enhance early defect detection, improve maintenance planning, and support data-driven decision-making.

In the context of UiTM, implementing green building maintenance practices requires a comprehensive institutional approach. Preventive maintenance planning, technology adoption, and alignment with national sustainability policies are essential strategies to ensure effective building management. In addition, strengthening collaboration between facility management teams, sustainability experts, and institutional leadership can further support the successful implementation of green maintenance initiatives.

Despite these potential benefits, several challenges remain, including financial constraints, technological readiness, and the complexity of managing large campus facilities. Addressing these challenges requires long-term strategic planning, adequate resource allocation, and continuous capacity-building among maintenance personnel.

Overall, this study contributes to the growing body of knowledge on sustainable building maintenance by providing a structured overview of green building maintenance practices and their role in mitigating building defects in higher education institutions. The findings can serve as a reference for UiTM and other Malaysian universities in developing more sustainable and effective maintenance management strategies.

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DISCLOSURE STATEMENT

The authors declare no conflict of interest related to this research.

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