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SUSTAINABLE BUILDING MAINTENANCE PRACTICES FOR ASSESSING DEFECTS IN UITM: THE SWOT AND SURVEY RESEARCH APPROACHES

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ABSTRACT

In Malaysia, the maintenance of public university buildings is crucial in ensuring functionality, safety and security towards the establishment of a conducive learning environment for students and staff. Building maintenance involves a comprehensive process that includes defect identification, severity assessment, and the subsequent recommendation of appropriate solutions. Defects pose a prevalent challenge in Malaysian public university buildings, potentially causing significant damage if not promptly identified and rectified. These issues may arise from various factors, such as poor design, construction errors, and a lack of maintenance. The current approach to developing building maintenance practices for defect assessment in

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Malaysian public university buildings relies on manual inspections, which are often time-consuming, expensive, and less accurate. This paper aims to discuss the differences between the existing building maintenance practices and the potential of sustainable building maintenance practices for defect assessment in Malaysian public universities through SWOT analysis and questionnaires. This paper will compare current conventional maintenance practices with sustainable maintenance practices to identify prominent defects in Malaysian public universities and investigate common building maintenance practices to address these issues. It will then suggest significant sustainable building maintenance practices to address these defects. A case study and questionnaire were conducted at a public university in Shah Alam, Selangor, focusing on a sustainable maintenance practice for assessing defects at the university. SWOT analysis was applied in order to highlight the strength, weakness, opportunitie, and threat of each maintenance practices for the best application in mitigating the issues of building defects in the university. The results also suggest that by implementing sustainable maintenance practices in the buildings will not only address current defects but also contribute to mitigating potential issues in the future.

Keywords: *Defects assessment, Public university, Sustainable building, Maintenance practices, SWOT analysis, Questionnaires*

INTRODUCTION

Buildings constitute an integral facet of modern society, playing a significant role in facilitating human activities (Smith, 2020). To ensure the university's continued functionality, safety, and durability, regular maintenance is indispensable. Building maintenance comprises a multifaceted process encompassing the identification of defects, assessment of their severity, and the subsequent recommendation of appropriate solutions (Lateef, 2009). Neglecting proper building maintenance can result in significant issues, such as defects that can compromise the structural integrity of the building and jeopardize the well-being of its occupants (Mohd, 2023).

In the pursuit of sustainable development, the built environment plays a crucial role, with buildings standing as significant contributors to energy consumption, resource utilization, and environmental impact (Sev,

2009). Within this context, the maintenance and management of buildings emerge as significant factors in achieving sustainability objectives. In Malaysia, where public universities serve as hubs of education, research, and innovation, ensuring the sustainability of their building stock becomes imperative.

This study focuses on sustainable building maintenance practices within Malaysian public universities, specifically addressing the assessment of defects. Defect assessment serves as a foundational aspect of building maintenance, enabling proactive identification, prioritization, and remediation of issues to prolong the lifespan of structures, optimize resource utilization, and enhance occupant comfort and safety (Mohd et al., 2023).

By centering the investigation on Malaysian public universities, the study aims to contribute to the enhancement of maintenance strategies within educational institutions—a sector uniquely positioned to influence societal perceptions and practices related to sustainability. Moreover, the context of Malaysian public universities offers a rich terrain for exploration, given the diverse architectural typologies, climatic considerations, and institutional priorities prevalent across the country (Yigitcanlar and Sarimin, 2011).

Through a comprehensive review of literature, coupled with questionnaires, this study seeks to delineate sustainable building maintenance practices tailored to the Malaysian context. Emphasis will be placed on leveraging technological innovations, integrating principles of green building design, and fostering interdisciplinary collaboration among stakeholders to develop holistic defect assessment frameworks.

The outcomes of this research endeavour hold significant implications for both academia and practice, offering actionable insights to facility managers, policymakers, and industry professionals involved in the maintenance and management of built assets.

In the subsequent sections of this paper, it will explore the theory of sustainable building maintenance, contextualize the significance of defect assessment within the Malaysian university landscape, outline the research methodology, and present findings and recommendations aimed at advancing sustainable practices in building maintenance within this critical sector.

LITERATURE REVIEW

The university building life cycle starts from the design stage to construction, operation, and demolitions (Feng et al., 2022). The operation phase entails using the building for academic activities in which the building may be used as a classroom, laboratory, workshop, or any other academic activity specific to an institution. The operation phase is when a building requires a lot of maintenance activities as it develops various defects or gets damaged by the user (Lateef et al., 2010; Olanrewaju et al., 2015). Hence, university management must consider proper building maintenance as a crucial factor.

Sustainable building maintenance practices are gaining increasing attention worldwide due to their potential to mitigate environmental impacts, improve energy efficiency, and enhance the longevity of infrastructure. In the context of Malaysian public universities, where ageing buildings are prevalent, the need for sustainable maintenance practices is particularly pressing. This literature review aims to explore existing research on sustainable building maintenance practices, focusing on defect assessment methodologies within Malaysian public universities.

Sustainable building maintenance practices encompass a range of strategies aimed at reducing resource and waste consumption, minimizing environmental impact, and ensuring the long-term functionality of buildings (Ayarkwa et al., 2022). These practices often involve the use of (i) environmentally friendly materials, (ii) energy-efficient technologies, and (iii) proactive maintenance strategies with minimum resource wastage (Bakar et al., 2022). Research by Fauzi et al. (2021) highlights the importance of incorporating sustainability principles into building maintenance to achieve cost savings and environmental benefits (Refer Figure 1).

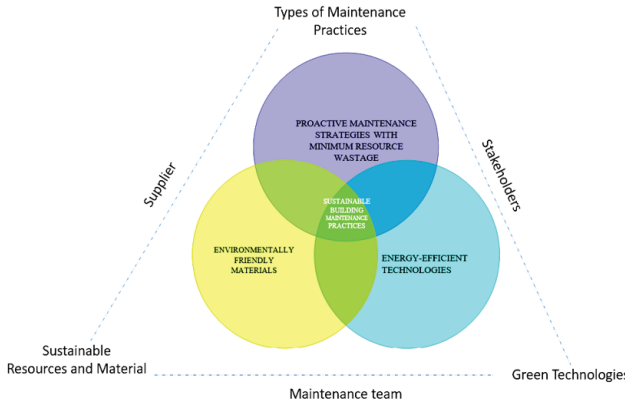

Figure 1. Incorporating Components of Sustainable Maintenance Practices
Source: Author, 2025

As illustrated in Figure 1, various types of maintenance practices include (i) planned maintenance, (ii) unplanned maintenance, (iii) preventive maintenance, (iv) corrective maintenance, (v) scheduled maintenance, (vi) condition-based maintenance, (vii) running maintenance, (viii) predictive maintenance, (ix) reactive maintenance, (x) predetermined maintenance, and (xi) emergency maintenance (Gackowiec, 2019). In the maintenance practices, defect assessment is a crucial aspect of these building maintenance practices, involving the identification, evaluation, and rectification of structural, mechanical, and aesthetic flaws (Faqih, 2021), as illustrated in Figure 2. Conventional defect assessment methods focus primarily on visual inspections and manual measurements, which may lack accuracy and efficiency. In contrast, sustainable maintenance approaches integrate energy-efficient technologies and advanced technologies such as infrared thermography, acoustic monitoring, and digital imaging to enhance defect detection and diagnosis (Kim et al., 2023). It involves three strategic points involving the maintenance team, supplier, and stakeholders. Despite the importance of sustainable building maintenance, Malaysian public universities face various challenges in implementing effective practices. Limited financial resources, inadequate expertise, and bureaucratic hurdles often hinder the adoption of sustainable maintenance strategies. Additionally, the lack of standardized guidelines and performance metrics complicates decision-making and evaluation processes (Myeda et al., 2011).

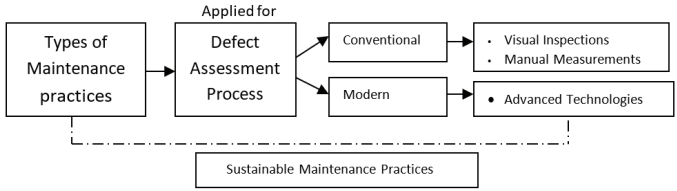

Figure 2. Relationship between the Maintenance Practices and Defect Assessment Process

Source: Author, 2025

The table below shows comparisons between conventional maintenance practices and sustainable Maintenance Practices with a more comprehensive approach to sustainable maintenance, highlighting the importance of long-term vision, stakeholder engagement, innovation, and holistic performance measurement.

Table 1. Comparison Between Conventional Maintenance Practices vs Sustainable Maintenance Practices

Aspect	Conventional Maintenance Practices	Sustainable Maintenance Practices
Definition (Zuluaga, 2021; Mensah, 2019)	Refers to the present methods and approaches being used to maintain systems, equipment, or infrastructure in a sustainable manner (Zuluaga, 2021)	Encompasses established strategies, techniques, and principles aimed at maintaining systems, equipment, or infrastructure sustainably over time (Mensah, 2019).
Scope (Ghaleb, 2022; Strommer, 2022)	Focuses on the current state of maintenance practices without necessarily considering long-term sustainability goals (Ghaleb, 2022).	Incorporates a forward-looking perspective, considering the long-term environmental, social, and economic impacts of maintenance activities (Strommer, 2022).
Environmental Impact (Ayarkwa et al., 2022; Bakar et al. 2022)	May involve sustainable practices but often lacks a comprehensive strategy for minimizing environmental footprint (Ayarkwa et al., 2022).	Prioritizes eco-friendly practices such as energy efficiency, waste reduction, and pollution prevention throughout the maintenance lifecycle (Bakar et al. 2022).
Resource Management (Kedir, 2021; Li et al., 2023)	Resource management may not be optimized, leading to inefficient use of materials, energy, and other resources (Kedir, 2021).	Emphasizes efficient resource utilization, including the use of renewable materials, energy-efficient technologies, and recycling/reuse programs (Li et al., 2023).
Lifecycle Approach (Pajula et al., 2017; Cimen, 2023)	Often lacks consideration of the entire lifecycle of assets, leading to higher long-term costs and environmental impact (Pajula et al., 2017).	Adopts a lifecycle approach, considering factors from design and construction to operation, maintenance, and eventual decommissioning or recycling (Cimen, 2023).

Stakeholder Engagement (Murphy et al., 2021; Gutterman, 2023)	Engagement with stakeholders may be limited, resulting in missed opportunities for collaboration and feedback (Murphy et al., 2021).	Values stakeholder input and actively engages with communities, employees, suppliers, and other relevant parties to foster transparency, accountability, and mutual understanding (Gutterman, 2023).
Innovation and Technology Adoption (Chambers, 2024; Longgan, 2024)	Innovation and technology adoption may vary, with some practices lagging behind the latest advancements (Chambers, 2024).	Embraces innovation and continually seeks out new technologies, methodologies, and best practices to enhance efficiency, effectiveness, and sustainability (Longgan, 2024).
Performance Metrics (Hristov, 2019; Ghaleb, 2022)	Performance metrics may focus primarily on short-term goals such as cost savings and uptime, overlooking broader sustainability indicators (Hristov, 2019).	Utilizes a balanced set of performance metrics that include not only financial measures but also environmental and social indicators to gauge the overall sustainability of maintenance practices (Ghaleb, 2022).
Regulatory Compliance (Wu and Tham, 2023; Ajibike et al., 2021).	Compliance with environmental regulations may be the primary driver for sustainability initiatives (Wu and Tham, 2023).	Goes beyond regulatory requirements to proactively address environmental and social concerns, striving for excellence in sustainability performance (Ajibike et al., 2021).
Continuous Improvement (Mackie, 2020; David, 2021)	Improvement efforts may be ad-hoc or reactive, lacking a systematic approach to learning and adaptation (Mackie, 2020).	Cultivates a culture of continuous improvement, where feedback loops, lessons learned, and innovation drive ongoing enhancements to maintenance practices and sustainability outcomes (David, 2021).
Technologies (Abdullah et al., 2020; Bagavathiappan, 2013)	•Visual Inspections •Manual Measurements (Abdullah et al., 2020)	Advanced Technologies: •Infrared Thermography •Acoustic Monitoring Digital Imaging to Enhance Defect Detection and Diagnosis (Bagavathiappan, 2013)

Besides that, based on several past studies, there are several issues that arise in the current practice of university management with regard to building maintenance, as highlighted in the summary presented in Table 2:

Table 2. Building Maintenance Issues in Malaysia Public Universities

Categories	**Issues**
Management system	Inadequate management system approaches (Lateef et. al, 2010), System in addressing complaints and work is outdated (Olanrewaju and Abdul Aziz, 2015), The reporting system is fragmented and complicated (Lateef et. al, 2010), There is no feedback mechanism on users' satisfactions (Lateef et. al, 2011)
Financial constraint	Small budget allocations (Olanrewaju and Abdul Aziz, 2015).

Operation and management	Department are understaffed (Lateef et al., 2011; Olanrewaju and Abdul Aziz, 2015), Staff inadequate qualified (Olanrewaju and Abdul Aziz, 2015). The outsourcing approach is very rudimentary and hazard (Lateef et. al, 2010). The technicians were merely performing clerical functions, leading to under utilizations of staff (Lateef et. al, 2010).

Moreover, according to Suwaibatul et. al. (2012) and Olanrewaju and Abdul Aziz (2015), buildings in public universities in Malaysia are poorly maintained and maintenance is seen as an unimportant activity, hence increased demand among the users of university buildings for better building maintenance. In conclusion, sustainable building maintenance practices play a crucial role in ensuring the functionality, safety, and environmental performance of infrastructure in Malaysian public universities. By adopting proactive maintenance strategies and integrating advanced defect assessment methodologies, universities can minimize operational costs, reduce carbon emissions, and enhance the quality of the built environment. However, significant challenges remain, necessitating further research and collaboration between academia, industry, and government stakeholders to advance sustainable maintenance practices in Malaysian public universities.

METHODOLOGY

A mixed-method approach was chosen to gain a comprehensive understanding of the research problem, integrating quantitative and qualitative data to triangulate the findings and increase the validity of the results (Phadermrod, 2019). The research integrates a literature review via SWOT analysis and a questionnaire. While the literature review provides an overview of building maintenance practices, the SWOT analysis provides qualitative and contextual data on the building maintenance procedures of a typical university organization in Malaysia. The method to use for the research depends on the nature of the information required and other prevailing circumstances pertaining to the topic and the study area (Phadermrod, 2019).

SWOT Analysis

This study employs a SWOT analysis to evaluate the building

maintenance in a university. The SWOT analysis is chosen for its effectiveness in identifying and categorizing internal and external factors that impact maintenance practices (Phadermrod, 2019).

Questionnaires

A total of 113 respondents were selected to complete this study. The method of selecting respondents according to the scope of work done at the university, especially the implementation of sustainable building maintenance practices for assessing defects. Data were collected using a Quantitative Survey. The survey consisted of 4 sections that measured the level of use of sustainable building maintenance practices and was confirmed in a pilot study by the panel of expert. Quantitative data were analysed using SPSS. Descriptive statistics were calculated to summarize the data, and inferential statistics were used to test the information. This study included 113 individual staff members who were selected from Universiti Teknologi MARA (UiTM) Shah Alam through a purposive sampling method. The selected participants possess experience in university maintenance management, particularly in defect assessmentThe table below lists the staff and their roles.

Table 3. The Respondents at UiTM Shah Alam

No.	Department	Number
A.	Unit Senibina	12
B.	Unit Kejuruteraan	16
C.	Unit Pengurusan Kontrak Pembangunan	6
D.	Unit Pengurusan Kontrak Fasiliti	8
E.	Bahagian Dasar	6
F.	Bahagian Dasar Dan Operasi PFI	11
G.	Bahagian Pengurusan Fasiliti	1
H.	Unit Operasi Awam	1
I..	Bangunan 1 And Infra Awam	1
J.	Operasi Bangunan Kolej Kediaman Dan Rekreasi	16
K.	Operasi Bangunan Premier	10
L.	Operasi Bangunan Fakulti Dan Pejabat	14
M.	Operasi Bangunan Fakulti Dan Pejabat 2	10
N.	Operasi Kualiti	1

	TOTAL	113

Source: Pejabat Pembangunan Infrastruktur and Infostruktur UiTM Shah Alam, Selangor, (2024)

RESULTS AND FINDINGS

SWOT Analysis

The results section presents a detailed SWOT analysis of building maintenance issues in Malaysia's public universities. This analysis identifies the strengths, weaknesses, opportunities, and threats related to current maintenance practices. By understanding these factors, the research can highlight key areas for improvement and potential strategies for enhancing the effectiveness and sustainability of maintenance operations. The following SWOT analysis provides a clear overview of the current situation and offers insights for future actions that were collected from many researchers as described in the Literature Review section (see Table 1 and Table 2). Table 4 shows the SWOT analysis to evaluate the sustainable maintenance practices in universities. This SWOT analysis result can serve as a guide for developing strategic actions to address the identified issues and leverage opportunities for improvement.

Table 4. The SWOT Analysis to Evaluate the Sustainable Maintenance Practices for University

Strengths:	**Weaknesses:**
1)Prioritizes eco-friendly practices, such as energy efficiency, waste reduction, and pollution prevention. 2)Emphasizes efficient resource utilization, including the use of renewable materials and energy-efficient technologies. 3)Adopts a lifecycle approach that considers all stages from design to decommissioning, leading to reduced long-term costs and environmental impact. 4)Actively engages with various stakeholders, fostering transparency, accountability, and mutual understanding. 5)Continuously seeks out new technologies and methodologies to enhance sustainability, efficiency, and effectiveness. 6)Uses a balanced set of metrics that includes financial, environmental, and social indicators. 7)Proactively addresses environmental and social concerns, aiming for excellence beyond mere regulatory compliance. 8)Cultivates a culture of continuous improvement driven by feedback loops, lessons learned, and innovation. 9)Clear identification of management, financial, and operational issues provide a basis for targeted improvements. 10)Recognition of specific problems like inadequate management systems, fragmented reporting, and lack of qualified staff highlights areas needing immediate attention.	1)May require significant upfront investment in new technologies, training, and processes. 2)Integrating sustainable practices can add complexity to maintenance operations, requiring specialized knowledge and skills. 3)Potential resistance from stakeholders accustomed to conventional practices. 4)Difficulty in accurately measuring and reporting on broader sustainability indicators compared to traditional financial metrics. 5)Inadequate management system approaches and outdated complaint and work addressing systems. 6)Fragmented and complicated reporting systems. 7)Lack of feedback mechanisms on users' satisfaction. 8)Small budget allocations hinder effective maintenance and upgrades. 9)Understaffed departments leading to workload issues and inefficiencies. 10)Inadequately qualified staff affecting maintenance quality. 11)Rudimentary and hazardous outsourcing approaches. 12)Technicians performing clerical functions instead of technical tasks, leading to underutilization of skills.

Opportunities:	Threats:
1)Potential to benefit from government incentives and support for sustainable practices. 2)Can serve as a differentiator in the market, attracting environmentally conscious customers and investors. 3)Rapid advancements in green technologies can further enhance the efficiency and effectiveness of sustainable maintenance. 4)Opportunities to form partnerships and collaborations focused on sustainability initiatives. 5)Potential for significant long-term cost savings through efficient resource management and reduced environmental impact. 6)Implementing modern management systems to streamline reporting and feedback mechanisms. 7)Adopting new technologies to update and simplify the complaint and work addressing systems. 8)Investing in staff training and development to improve qualifications and technical skills. 9)Optimizing the use of current staff by aligning roles with their technical capabilities. 10)Exploring alternative funding sources and budget optimization strategies. 11)Seeking government or private sector partnerships to enhance financial resources. 12)Developing a more structured and safe outsourcing approach to improve efficiency and safety.	1)Economic downturns or budget cuts may deprioritize sustainability initiatives. 2)Changes in environmental regulations could impose new challenges or increase compliance costs. 3)Dependence on emerging technologies may introduce risks associated with their reliability and performance. 4)Fluctuations in market conditions could impact the availability and cost of sustainable resources and technologies. 5)Competitors may adopt sustainable practices more quickly or effectively, leading to potential market disadvantages. 6)Continued small budget allocations could further exacerbate maintenance issues. 7)Economic downturns affecting the availability of funds for maintenance and upgrades. 8)Potential resistance from staff and stakeholders to new management systems and processes. 9)Challenges in implementing new technologies and training programs due to resistance or lack of buy-in. 10)Continued understaffing and lack of qualified personnel could lead to further deterioration of maintenance standards. 11)Inefficiencies and safety risks associated with the current outsourcing practices.

Sources: Lateef et. al, 2010; Olanrewaju and Abdul Aziz, 2015; Lateef et. al, 2011; Zuluaga, 2021; Mensah, 2019; Ghaleb, 2022; Strommer, 2022; Ayarkwa et al., 2022; Bakar et al. 2022; kedir, 2021; Li et al., 2023; Pajula et al., 2017; Cimen, 2023; Murphy et al., 2021; Gutterman, 2023; Chambers, 2024; Longgan, 2024; Hristov, 2019; Ghaleb, 2022; Wu and Tham, 2023; Ajibike et al., 2021; Mackie, 2020; David, 2021; Bagavathiappan, 2013; Abdullah et al., 2020

Questionnaires

The questionnaire survey consisted of four (4) parts: Part A, Part B, Part C and Part D, totalling 103 structured closed questions. These questions were designed to guarantee the validity and impartiality of the data collected. In the questionnaire, four (4) sections were designed to gather specific information that related to the research objectives. Results in Tables 5 and 6 have listed the buildings in the university that have the highest number of defects occurrence.

Table 5. Category of Buildings in the University which have the Highest Number of Defects Occurrence

Location	Frequency	Percent
Student Accommodation (College/hostel)	60	53.1

Library	15	13.3
Administration Building	24	21.2
Academic building (Classroom/Workshop/ Studio/Lab)	60	53.1
Multipurpose Hall/Lecture Hall	38	33.6
Cafeteria/ Canteen/ Food court	45	39.8
Mosque/ Religious Centre	15	13.3
Sport Centre/ Gymnasium	49	43.4
Infrastructure (Road, Curb, Signboard, drainage, water reticulation, and landscaping)	53	46.9
External compound university (Parking)	28	24.8

Source: Author (2025)

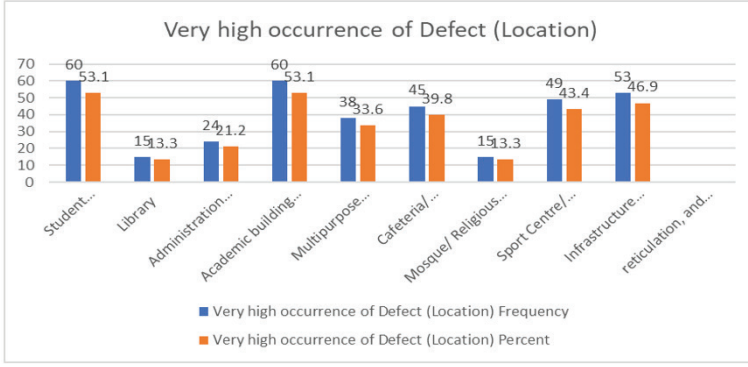

Figure 3. Frequencies and Percentage (%) for very High Occurrence of Defect (Location)

Table 5 and Figure 3 data reveal that student accommodation (53.1%) and academic buildings (classroom/workshop/studio/lab) have the highest defect occurrence (53.1%), while mosques and libraries have the lowest defect occurrence (13.3%).

Table 6. Types of Conventional Maintenance Practices to Solve Defects Issues

Maintenance Management Practices	Frequency	Percent
Planned maintenance (PLM)	59	52.2
Unplanned maintenance (UM)	44	38.9
Preventive maintenance (PVM)	35	31
Corrective maintenance (CRM)	29	25.7

Scheduled Maintenance (SM)	15	13.3
Condition based maintenance (CDM)	22	19.5
Running maintenance (RM)	37	32.7
Predictive Maintenance (PRM)	24	21.2
Re-active maintenance (RAM)	13	11.5
Predetermined Maintenance (PDM)	35	31
Emergency maintenance (EM)	13	11.5

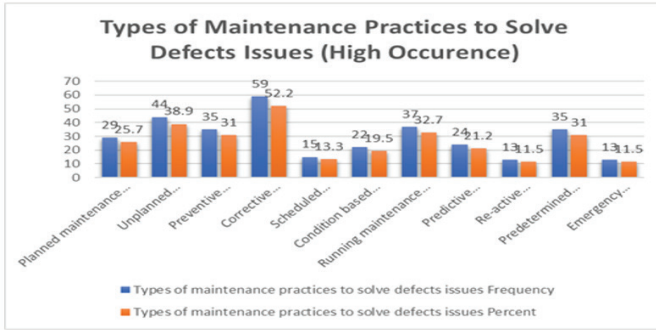

Figure 4. Frequencies and Percentage (%) of conventional maintenance practices to solve defects issues (High Occurrence)

Table 6 and data from Figure 4 demonstrate that planned maintenance (PLM) has the highest occurrence of maintenance practices to resolve defect issues (52.5%), while reactive maintenance (RAM) and emergency maintenance (EM) have the lowest occurrence of these practices (11.5%).

The following is a list of the sustainable maintenance management practices that UiTM currently uses in Figure 5:

(i) Energy-Efficiency
(ii) Water Conservation
(iii) Waste Management
(iv)Green Building Materials
(v)Regular Inspections and Maintenance
(vi) Renewable Energy Integration
(vii) Natural Landscaping
(vii) Sustainable Pest Management
(ix) Indoor Air Quality
(x) Behavioral Awareness

(xi) Life Cycle Assessments
(xii) Green Roofing
(xiii) Predictive Maintenance
(xiv) Recycled Building Materials
(xv) Bicycle Infrastructure
(xvi) Waste Reduction
(xvii) Regular Building Audits

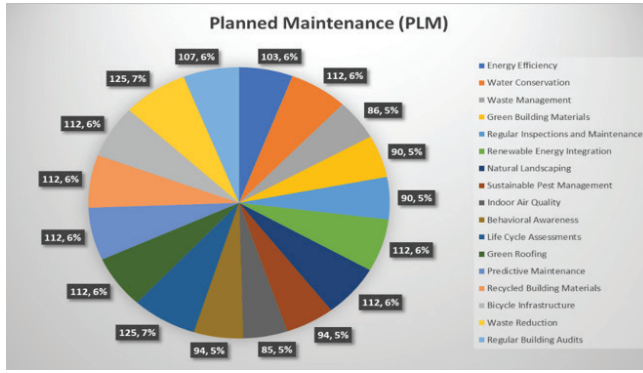

Figure 5. Sustainable Maintenance Management Practices That Are Currently Applied in Solving Defect Issues in University

According to the result shown in Figure 5, university primarily applies (i) life cycle assessment (7%) and (ii) waste reduction (7%) as sustainable maintenance management practices to address defect issues. In contrast, the least commonly applied practice is indoor air quality management (5%). However, we find that the ratio (%) between all sustainability elements is relatively narrow, ranging only between 5% and 7%.

DISCUSSION

Category of Buildings in The University and Conventional Maintenance Practices

This study identifies which university's building have the highest reported defect occurrences based on respondent feedback. The academic buildings and the student accommodation (college/hostel) categories both

received the highest number of defect reports, with 60 respondents each (53.1%), highlighting the importance of maintaining living conditions for student well-being. The library (15 respondents, 13.3%) and mosque/ religious centre (15 respondents, 13.3%) received fewer reports, potentially suggesting better maintenance or less intensive use in these areas.

Next, the most commonly reported maintenance management practices at the university, highlighting areas that require improvement and optimization. The results indicate that Planned Maintenance (PLM) is the most frequently reported practice, with 59 respondents (52.2%) indicating its use. This high frequency suggests that many maintenance activities are reactive, addressing defects after they occur rather than preventing them. Thirteen respondents (11.5%) identified Re-active Maintenance (RAM) and Emergency Maintenance (EM). The lower frequencies of these practices suggest room for improvement in terms of systematic and proactive maintenance strategies.

Sustainable Maintenance Management Practices

The application of sustainable maintenance management practices in addressing defects at the university, focusing on the most and least frequently utilized methods. The analysis reveals that waste reduction (7%) and life cycle sssessments (7%) are the most frequently applied sustainable practices, under a Planned Maintenance (PLM) application, with the frequency of 125. This high frequency underscores the university's strong commitment to sustainability and resource efficiency. By focusing on waste reduction, the university likely aims to minimize environmental impact and improve operational efficiency. Life Cycle Assessment follows closely, with a frequency also 125 under PLM. Conducting life cycle assessments of building components and systems to evaluate their environmental impacts and make informed decisions about maintenance, repair, and replacement will enable sustainable maintenance practices accordingly. In contrast, indoor air quality management is the least frequently applied practice, with a frequency of 85 (5%) under PLM. While these practices are essential for sustainable building management, their lower application rates suggest that they may not be prioritized to the same extent. However, it is found that the ratio (%) between all elements of sustainabililty are not too wide, between 5% to 7% only indicating that all sustainable elements are significant and

relevant to each category. The result from the SWOT analysis (Table 4) also supports this, demonstrating that incorporating sustainability principles into building maintenance is crucial for improving the effectiveness of sustainability maintenance operations and achieving cost savings and environmental benefits for UiTM.

CONCLUSION

The findings of this study reveal that the maintenance team of UiTM in the Shah Alam campus employs a comprehensive range of maintenance practices to manage building defects. The frequent use of Planned Maintenance (PLM) is relatively significant in order to achieve sustainable maintenance practices for UiTM. Overall, the study underscores the importance of a multifaceted maintenance approach in ensuring the sustainability and functionality of university buildings. By improving the balance and integration of various maintenance practices, UiTM can further enhance its ability to manage defects effectively and sustainably. This case study provides valuable insights for other public universities in Malaysia seeking to optimize their maintenance management systems from the perspective of sustainable approaches.

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AUTHOR CONTRIBUTIONS

All authors contributed to the design of the research, the questionnaire, and the write-up. -All authors have read and approved the final manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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