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Potential of Technology Application on Building Facilities Management: Schedule of Maintenance

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Abstract

Building Facility Management refers to the routine and extraordinary operations required to ensure that a physical environment meets the needs and functions for which it was designed and built throughout its life cycle. As mentioned from Facility Management Green Key FM, poor facility management results in excessive demands for unplanned periodic maintenance expenses. The objective of this research is to identify the challenges of proper schedule maintenance in buildings, to identify the risks that would occur of improper schedule maintenance in building and to propose the potential of technology application on prepare schedule maintenance in building. The method that has been used in this study is quantitative method that is by collecting information through questionnaires survey form through the form of email and other applications to gather data in order to archive the research objectives. A total of 132 questionnaires were distributed and only 103 respondents received the questionnaire. The study identified "Unclear job descriptions" and "Reduced comfort and safety" for the challenges of proper schedule maintenance in buildings and the risks that would occur of improper schedule maintenance in building as the key obstacles, but it also highlighted the potential of technology application on prepare schedule maintenance in building on how mobile applications may improve building upkeep. Overall, by identifying maintenance difficulties, related hazards, and technology's role in enhancing building facilities management, the study successfully met its objectives. In conclusion, good schedule maintenance practices in building facility management can reduce risks, unscheduled maintenance costs, and building performance.

1. Introduction

Facility Management (FM) is a crucial organizational function that enhances business productivity through the effective integration of place, people, technology, and processes. According to the International Standard Organization (ISO) and the International Facility Management Association (IFMA), FM optimizes the built environment to improve the quality of life and core business productivity. Technological advancements in building facilities management have opened new avenues for efficient maintenance scheduling, asset longevity, and enhanced operational efficiency, as noted by Mydin (2015). In the Malaysian context, the separation of building and maintenance stages results in fragmented processes. Traditional manual methods for building maintenance scheduling are not only inefficient but also error prone. However, technological breakthroughs

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offer automated systems and digital solutions, providing benefits such as precision, improved decision-making, real-time monitoring, and predictive analytics (Sepasgozar *et al.*, 2023).

The problem statement highlights challenges in maintenance management within the Malaysian construction industry, including disparate strategies, financial constraints, and overspending. Inadequate maintenance of government assets contributes to suboptimal building performance. Efficient maintenance strategies are crucial for preventing unfavorable circumstances and optimizing building functionality (Lateef, 2009). The issues encompass ineffective maintenance procedures, a lack of preventive maintenance, and insufficient personnel for daily inspections (Ali *et al.*, 2016). To address these issues, the study's research questions focus on the challenges and risks associated with proper scheduled maintenance in buildings, as well as the potential role of technology in improving scheduled maintenance. The objectives of the research are to identify the challenges of proper schedule maintenance in building, to identify the risk that would occur of improper schedule maintenance in building and to propose the potential of technology on prepare schedule maintenance in building.

The research scope encompasses the impact of scheduled maintenance on development, addressing challenges and risks across various building types. Respondents include building maintenance management and contractors. The significance of the research lies in the effective management of facilities to ensure safe, welcoming, and efficient environments. The study aims to optimize space, guide capital projects, manage energy, and maintain equipment for long-term value and improved work, play, learning, and living environments. In terms of methodology, quantitative methods, including data collection through Telegram, Facebook, and other websites, will be employed. The research design focuses on a systematic empirical investigation using statistical, mathematical, and computational techniques, aiming to understand past risks and inform future FM practices (Apuke, 2017).

2. Literature Review

The literature review section describes all relevant literature related to the research and critically discussed. This section can be structured based on the stated objectives and focus of the study or any logical order as deemed appropriate.

2.1 Challenges of Proper Schedule Maintenance in buildings.

The literature review section describes all relevant literature related to the research and critically discussed. This section can be structured based on the stated objectives and focus of the study or any logical order as deemed appropriate.

2.1.1 Top Management Problems

(i) Lack of knowledge in maintenance scope
To uphold quality in maintenance operations, efficient maintenance management, especially at the top level, is crucial. Rahman *et al.* (2012) emphasizes the significance of proper management and leadership in ensuring the effectiveness of maintenance processes, making it vital for maintenance works.

(ii) Unqualified maintenance contractor
According to Ali and Chua (2011), highlight a common issue that many maintenance workers lack comprehension of the management and operational framework, overly relying on technology. This stems from employing foreign laborers, often unskilled, with varying degrees of maintenance experience. Consequently, contractors often fail to dispatch competent workers, leading to inefficiencies in tasks, wasting time and energy.

(iii) Government regulations and rules.
One disadvantage of selecting the contractor with the lowest price, according to Alshehri *et al.* (2015), is that the quality of the work is not guaranteed. Consider both the age of the structure and the ups and downs of the economy. Older structures typically require more complicated upkeep, and as living standards grow, so do the costs of replacement parts and specialized labor for these tasks.

(iv) Financial issues
Using the previous year's budget as a foundation for planning and allocating maintenance funds is common. However, building managers often face challenges in accurately assessing the required maintenance amount and associated costs, leading to potential budget overruns or underruns (Rahman *et al.*, 2012).

2.1.2 Human Resources Problems

(i) Lack of supervision from maintenance team
Sub-section headings should also be in the same style as the headings, numbered 1.1, 1.2, etc, and left justified, with second and subsequent lines indented.

(ii) Lack of engineers and specialist
Diverse maintenance tasks, like various building works, demand specific skills and individuals. Some services require skilled and trained workers, and delays may occur if such expertise is not locally available. Hence, it is essential to assign tasks that can be completed by the citizens of our nation when needed (Alshehri *et al.*, 2015).

(iii) Unclear job description and department structure
Zakaria and Hamzah (2007) found that most maintenance departments lack an effective strategy for improving operations. The organization responsible for building maintenance is often unclear, with various titles such as support services, service management, and service center being used interchangeably.

(iv) Lack of awareness
To maintain a building's acceptable condition for occupants, building managers must be cognizant of necessary maintenance tasks. They bear the responsibility of budget planning and financing these tasks. Additionally, building managers need awareness of ongoing maintenance to preempt potential system failures and breakdowns (Alshehri *et al.*, 2015).

2.1.3 Technical Problem

(i) Lack of maintenance software tool
The maintenance software would assist the building managers in planning the maintenance by distributing the budget in an appropriate manner and determining the effective total life span of a system. This would help the building managers save time and money (Alshehri *et al.*, 2015).

(ii) Shortage of spare parts
Dealing with an older machine or system, finding suitable replacement parts locally can be challenging. This complicates the facility's maintenance, requiring the purchase of parts from the open market, leading to prolonged processes and increased costs. In the worst-case scenario, a shortage of spare parts could halt the building's operation and maintenance entirely (Alshehri *et al.*, 2015).

(iii) Failure of preventive maintenance/maintenance strategies
The building owner contends that the maintenance strategies employed were ineffective, failing to optimize the building's function or the implemented system. Some maintenance methods involve prior planning, completing unnecessary replacements based on the job description. However, due to the staff's focus on immediate breakdown responses, preventive maintenance lacks a predetermined schedule, even though it necessitates inspections on a daily, weekly, monthly, and yearly basis (Lee & Scout, 2009).

2.2 Risk That Occurs Of Improper Schedule Maintenance in Building

2.2.1 Non-operational use of building

Challenges in undertaking extensive rehabilitation, resulting in the abandonment of many Public Buildings (PB). The high cost of financing repairs or major rehabilitation poses a serious threat to the future financial sustainability of these institutions. Additionally, most government agencies provide essential services at no cost, causing the PB renovations budget to compete with other highly valued government services, potentially leading to facility neglect (Kamarazaly, 2014).

2.2.2 Reduce the economy of the country

Poor facility management is having a negative financial impact on most public organizations (Kamarazaly *et al.*, 2013). Due to the high costs of rectifying the mistakes made by poorly managed building facilities, this puts strain on future government budgets (Hamid *et al.* 2010).

2.2.3 Low production due to hindered productivity

Simultaneously, industries contend with the repercussions of inadequate maintenance, experiencing malfunctions in machines and industrial equipment that hinder production. The poor maintenance of production resources results in adverse effects on production, including reduced capacity, lower-than-expected service levels, increased production costs, and public dissatisfaction (Tijani *et al.*, 2016).

2.2.4 Public building loses its physical appearance

The decisions and actions taken in the history of a building, especially regarding maintenance, significantly influence the outward appearance of Public Buildings (PB). Often, the condition and quality of buildings serve as indicators of community pride, reflecting societal values and behaviors. The appearance of PBs contributes to assessing the affluence and aesthetics of an area. In neighborhoods and streets where PB maintenance is lacking, the beauty of the surrounding landscapes diminishes (Ackah, 2016).

2.2.5 Increases cost for emergency repairs

Compared to the expenses associated with emergency maintenance, planned repairs incur significantly lower costs. Emergency maintenance, often conducted during peak production hours to swiftly resume operations, tends to be outsourced to third-party contractors instead of being performed by internal staff, leading to elevated expenses (Richards, 2018).

2.2.6 Reduce the value of buildings

Postponing building maintenance causes the structure's physical condition to deteriorate, which in turn causes the building to lose some of the value it had when it was first constructed. In most cases, reversing the effects of physical deterioration can be accomplished by performing the necessary upkeep and enhancements. The term "curable obsolescence" refers to this type of building depreciation, as does 'curable physical depreciation' (Fakhrudin *et al.*, 2011).

2.3 Technology That Can Be Utilized To Prepare Schedule Maintenance

2.3.1 Building Information Modelling (BIM)

BIM is a digital picture of what a building looks like and how it works. It makes it possible to combine info from different sources and helps people work together on planning, design, and maintenance. BIM makes it easy to schedule repair tasks because it gives a complete and visual picture of a building's parts and systems (Eastmen, 2011).

2.3.2 Computerized Maintenance Management System (CMMS)

Maintenance management chores like scheduling, making work orders, keeping track of assets, and allocating resources are all done automatically by CMMS software. CMMS systems help you plan and complete maintenance tasks more effectively by centralizing all of your data and enabling real-time viewing. (Hwang, 2018).

2.3.3 Internet of Things (IoT)

IoT technology connects physical gadgets and sensors so that data can be collected and sent. IoT sensors can watch equipment and systems and give real-time data on performance, usage trends, and condition, which can be used to plan maintenance. This information can be used to schedule repair ahead of time and improve how maintenance is done (Ziegler,2018).

2.3.4 Mobile Application

Mobile apps give you access to repair information, work orders, and schedules while you're on the go. Maintenance technicians can get alerts, update the status of their work, and look at relevant papers or manuals. This makes communication easier and boosts productivity (Cheng, 2018).

3. Research Methodology

According to Jones *et al.* (2019), research methodology is comprised of the phases of a study that include planning, design, data collecting, analysis, and interpretation. The overarching goal of these phases is to provide findings that are reliable and useful. The choice of an appropriate research methodology is extremely important since it has a direct influence on the quality and validity of the results that are acquired (Brown, 2020).

The term research methodology refers to the methodical process that is followed in order to carry out research and collect data. It requires the selection of appropriate methods, techniques, and tools to guarantee accurate and objective results (Neuman, 2014). The research needs to be designed first, then a representative sample needs to be chosen, then data needs to be collected using a variety of methods, and finally, the data needs to be analysed to draw relevant conclusions (Yin, 2017).

3.1 Data Collection

Data collection is the systematic process of gathering and measuring information on variables of interest in order to answer stated research questions, test hypotheses, and evaluate outcomes. Data collection is a component of research that is shared by all fields of study, including physical and social sciences, humanities, business, and so on. While methods differ depending on the discipline, the emphasis on ensuring accurate and honest collection remains constant.

3.1.1 Primary Data

Primary data is information gathered for the first time through personal experiences or evidence, typically for research purposes. It's also known as raw data or first-hand information. The method of gathering information is costly because the analysis is performed by an agency or an external organization and requires human resources and investment. The investigator directly supervises and controls the data collection process. Observations, physical testing, mailed questionnaires, surveys, personal interviews, telephonic interviews, case studies, and focus groups, among other methods, are used to collect data.

3.1.2 Secondary Data

Secondary data is data that has already been collected and recorded by some researchers for their own purposes, rather than for the current research problem. It is available in the form of data gathered from various sources such as government publications, censuses, internal organizational records, books, journal articles, websites, and reports, among others. This method of data collection is inexpensive, readily available, and saves both money and time. The one disadvantage is that the information gathered is for another purpose and may not meet the current research purpose or be accurate.

3.2 Population and Sample

The population is the entire set of items from which data for a statistical study is drawn. It can be a group of people, a collection of items and so on. It constitutes the study's data pool. A population is the entire group about which you want to draw conclusions while a sample is the specific group from which you would collect data. The sample size is always less than the total population size. A sample is a more manageable and smaller representation of a larger group. A subset of a larger population that shares some of its characteristics. In statistical testing, a sample is used when the population size is too large to include all members or observations in the test.

3.3 Quantitative Research Method

The decision to employ a quantitative research technique for this study immediately highlighted the need to select an appropriate quantitative method that best addresses the research question and problem. Quantitative research involves a methodical empirical study of quantitative phenomena and their interrelationships. It aims to collect numerical data for statistical analysis by posing specific questions and utilizing various research designs such as experimental, correlational, or survey-based approaches. Quantitative methodologies help establish associations or causations between variables and rely on structured data collection instruments and random sampling. These methods generate results that are easily summarized, compared, and generalized. They are used to test hypotheses derived from theories or estimate the magnitude of phenomena. Quantitative research employs statistics and mathematics to report findings, occasionally collecting participant and situational data to statistically control their impact on the outcome variable. Probability sampling is used to generalize findings from research participants to a larger population if necessary.

4. Result and Discussion

This section explains related to the research conducted.

4.1 Cronbach's Alpha Reliability Test

Table 1 *Reliability test of Cronbach's Alpha Test*

Section	Cronbach's Alpha	N for item
Challenges of proper schedule maintenance in buildings.	.886	10
Risks that would occur of improper schedule maintenance in building.	.787	6

Potential of technology on prepare schedule maintenance in building.	.812	13
Total	.828	29

Cronbach's alpha reliability test, two academics and one industry expert were involved. The analysis was performed using SPSS software. Table 4.1 presents the Cronbach's Alpha values, indicating that the alpha value of the collected responses exceeded 0.6, which is the minimum acceptable threshold for reliability testing. According to existing literature, a higher Cronbach's Alpha value signifies greater data reliability. Consequently, the feedback data gathered is deemed reliable and appropriate for further.

4.2 Response Rate

Table 2 *Questionnaire Response Rate*

Sample Size	Returned questionnaires (valid)	Response Rate (%)
132	103	78

Table 2 illustrates the study's sample size comprised 132 respondents. The questionnaires were administered using Google Forms, resulting in 103 valid responses. Consequently, the response rate was calculated at 78%. It is worth noting that the target of 132 respondents was not fully met due to a lack of response and cooperation from some participants.

In the event of a survey attaining a response rate of just 30%, there is a nonresponse bias of 70%. Similarly, with a survey response rate of 20%, the nonresponse bias increases to 80% (Fincham J. E., 2008). To address the issue of lack of representativeness, Brick and Kalton (1996) propose a method of adjusting the study sample segments through weighting to better align with the broader population characteristics.

4.3 Data Analysis

This investigation involved surveying individuals engaged in maintenance roles, encompassing contractors, subcontractors, and maintenance/facilities managers via a digital questionnaire. All participants possess direct or indirect connections to the maintenance industry. The collected data demonstrates a strong Cronbach Alpha value and reflects the substantial expertise and experience within the maintenance sector. The questionnaire comprises four main sections: demographic details, challenges in scheduled building maintenance (Section B), potential risks in building facilities management (Section C), and technological advancements enhancing building facilities management (Section D).

In section A, there is information about respondent's background include gender, age, education level, job position, and experience in industry. Section B then discusses the challenges of proper schedule maintenance in a building. Therefore, section C discusses the type of risk that would occur in the building facilities management while section D focused on the technology improves the building facilities.

4.4 Item Analysis Based On Research Questions

Table 3 *Interaction of score mean table (Huang & Hew, 2016)*

Index Table	Interaction
1.00 to 2.33	Low
2.34 to 3.67	Moderated
3.68 to 5.00	High

The index range is utilized to determine the amount of agreement based on the mean of each question item. The amount of agreement based on the mean index range is presented in Table 4.3. The obtained mean score range is between 1.00 and 5.00. A mean score of less than 3.00 is considered "low level," a mean score of 3.00 to 3.49 is considered "moderate level," a mean score of 3.50 to 3.99 is considered "medium high level", and a mean score of 4.00 to 5.00 is considered "level high" (Huang and Hew, 2016).

4.5 Background of Respondents

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An outline of the respondents' demographic background is given in this section. In order to provide a thorough breakdown of the participants, a demographic analysis was carried out, concentrating on elements like gender, age, education level, employment positions, and industry experience. The data was organized and analyzed using frequency distribution methods.

As shown in the table, the most of respondents in are male which are 103 students (78%). Next 2030 years old employee is most involved in this research which is 67%. Furthermore, the respondents that have degree levels of education is more than other level of education level, this is because the data that surveyed, the total number of degree respondents have the larger number of students. Therefore, the major respondents involved in this research were contractors, which is 43 employees (41.7%). Lastly the most respondent involved is with 5 years and below experiences in the industry which is 66 responses (64.1%).

Table 4 *Summary of Demographic Background of the Respondent*

Respondents' Background	Frequency (n)	Percentage (%)
Gender		
Female	41	39.8
Male	62	60.2
Age		
20-30 years old	69	67
31-40 years old	24	23.3
41-50 years old	6	5.8
51-60 years old	3	2.9
60 years old and above	1	1
Education level		
Certificate	27	26.2
Diploma	33	32
Degree	40	38.8
Masters	2	1.9
PHD	0	0
Others	1	1
Job Position		
Contractors	43	41.7
Subcontractors	22	21.4
Maintenance	22	21.4
Facilities Manager	16	15.5
Experience in the industry		
5 years and below	66	64.1
5-10 years	33	32
11-15 years	4	3.9
15 years and above	0	0

4.6 Challenges of Proper Schedule Maintenance in Buildings

This section explains the challenges of proper schedule maintenance in a building. All the challenges mentioned in the questionnaire are based on the findings of the research review. The questions are classified into three (3) major categories: challenges in top management problems, challenges in human resource problems, and challenges in technical problems. In this section, respondents are requested to use a Likert scale of one to five to express their viewpoints on the extent to which these challenges of proper schedule maintenance in building.

Table 5 *Summary of the challenges of proper schedule maintenance in building.*

No.	Item	Mean	Level of Agreement	Ranking
B1) Top management problems				
1.	Lack of knowledge in the scope of maintenance	4.14	High	2
2.	The attitude of the contractor is not	3.90	High	11

	certified			
3.	Inconsistent government regulations	3.98	High	8
4.	Financial issues	4.11	High	5
B2) Human resource problems				
5.	Lack of supervision from the maintenance team	4.12	High	3
6.	Lack of engineers and specialists	4.01	High	7
7.	Unclear job description	4.17	High	1
8.	Lack of awareness	3.97	High	9
B3) Technical problems				
9.	Using outdated equipment	4.07	High	6
10.	Lack of spare parts	3.95	High	10
11.	Failure of preventive maintenance strategies	4.12	High	4

Based on Table 5, the analysis results revealed that "unclear job description," classified as a human resources problem, emerged as the predominant factor, scoring the highest median of 4.17 compared to other aspects like top management problems and technical issues. According to Zakaria and Hamzah (2007), It has been shown that most maintenance departments lack an appropriate plan for improving their maintenance operations. The subsequent observation revealed a second-highest mean value of 4.14, indicating a high level of significance. The most notable issue in this case was Lack of knowledge in the scope of maintenance, which had a big influence on the building facilities. Rahman *et al.* (2012) emphasized the pivotal role of effective management and leadership in maintenance operations, asserting that proper management and leadership are crucial as they directly influence the efficacy of the maintenance process. Finally, the concern of 'Lack of Supervision from the Maintenance Team' obtained the third position in the analysis, scoring a mean value of 4.12. Insufficient oversight cultivates an atmosphere in which workers lack responsibility. The main duty of designated supervisors is to approve the maintenance reports that contractors provide. They are only responsible for their supervision responsibilities and frequently lack technical understanding about maintenance tasks. Many supervisors are careless in their duties because they do not have a thorough comprehension of the management and operational framework (Ali and Chua, 2011).

4.7 Type Of Risk That Will Occur of Improper Schedule Maintenance In Buildings

In this section, there are several types of risk that would occur in the building facilities management that has been stated in the questionnaire and processed into statements that follow the current state. The researcher has listed two (2) main categories: Changes in building conditions and financial risk. Respondents can choose their level of agreement according to their circumstances and views on the type of risk that would occur in the building facilities management.

Table 6 *Summary of type the risks that will occur of improper schedule maintenance in building*

No.	Item	Mean	Level of Agreement	Ranking
C1) Changes in building conditions				
1.	The building would not be operational	4.27	High	2
2.	Buildings lose their physical appearance	4.15	High	4
3.	Reduce the comfort and safety of building use	4.29	High	1
C2) Financial risk				
4.	Affecting the national economy	4.11	High	6
5.	Low production due to hindered productivity	4.13	High	5
6.	Increased budget for untreated facility damage	4.22	High	3

In the realm of scheduled maintenance, our data analysis has highlighted several critical factors that directly influence the overall performance and well-being of a building. With a mean score of 4.29, the most expressed worry is the negative impact of improper maintenance on building occupants' safety and comfort. Building

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structure maintenance that is put off raises possible risks, endangering worker safety, lowering worker productivity, and interfering with business operations. (Oluwatoyin *et al.*, 2017). Following closely with a mean score of 4.27 is the concern that unscheduled maintenance could render the building non-operational. According to Wuni *et al.* (2018), many public institutions encounter limitations in executing extensive rehabilitation efforts, resulting in the abandonment of numerous Public Buildings (PB). The substantial cost associated with financing repairs or major rehabilitation poses a severe threat to the long-term financial sustainability of these institutions, often leaving such structures deserted. Lastly, our analysis indicates that disregarding scheduled maintenance can lead to an increased budget for untreated facility damage, as reflected in the mean score of 4.22. If a few minor maintenance issues go neglected, they would eventually become much worse. The backlog of expenditures that is created because of deferred repair on public buildings would be covered in the future. As a result, additional resources would be needed to ensure that government facilities are always fully operational condition (Alshibani, 2018).

4.8 Potential Of Technology on Prepare Schedule Maintenance In Buildings

With all the challenges and risk discussed in the previous discussion, it highlights how crucial it is to improve schedule maintenance on building facilities management. In this section, there are several improvements that can be made to improve the schedule maintenance on building facilities management that have been listed in the questionnaire and processed into statements that proposed. Researcher has listed four (4) main technologies: Building information modeling (BIM), Computerized maintenance management system (CMMS), Internet of things (IoT), and Mobile application. Respondents can choose their level of agreement according to their circumstances and perspectives to improve schedule maintenance on building facilities management, as there is no right or wrong answer in this section.

Table 7 *Problem summary for potential of technology to improve schedule maintenance in building*

No.	Item	Mean	Level of Agreement	Rank
D1) Building Information Modelling (BIM)				
a.	Shows digital pictures of what the building looks like and how it works	4.45	High	3
b.	Combine information from different sources	4.31	High	10
c.	Helping people work together in planning, design and maintenance	4.23	High	11
d.	Easy to schedule repair tasks	4.32	High	9
D2) Computerized maintenance management system (CMMS)				
a.	Management work is done automatically	4.18	High	13
b.	Put all the data in one place, and watch it in real time	4.39	High	6
c.	Help plan and perform maintenance work more efficiently	4.40	High	5
D3) Internet of things (IoT)				
a.	Connecting physical devices and sensors so that data can be collected and transmitted	4.33	High	8
b.	Be able to view equipment and systems and provide real-time data that can be used to plan maintenance	4.44	High	4
c.	Can be used to schedule repairs earlier and improve the way maintenance is performed	4.23	High	12
B4) Mobile Application				
a.	Provides access to repair information, work orders and schedules while on the go	4.34	High	7
b.	Can get information, update job status, and view related papers or manuals	4.67	High	1
c.	Easier communication and increased productivity	4.50	High	2

Ranked first in our analysis is the ability to access information, update job status, and view related papers or manuals with high rank (4.67). This functionality is critical for scheduled maintenance in buildings since it allows for easy access to pertinent paperwork, job progress updates, and critical data. Maintenance technicians can get alerts, update the status of their work, and look at relevant papers or manuals. This makes communication easier and boosts productivity (Cheng, 2018). Securing the second position is the aspect of easier communication and increased productivity. Ensuring that maintenance crews, supervisors, and stakeholders are all in agreement with scheduled maintenance activities requires effective communication. The productivity of the maintenance crew is increased when there are clear instructions, frequent updates, and cooperative problem-solving. Lastly, the incorporation of digital pictures depicting the building's appearance and functionality holds significant importance, securing the third position in our analysis with mean 4.45. Digital photos are used as a visual assistance during planned maintenance checks and offer important information about the state of the structure. BIM is a digital representation of the layout and functionality of a building. BIM makes it easy to schedule repair tasks because it gives a complete and visual picture of a building's parts and systems (Eastmen, 2011).

5. Conclusion and recommendations

This section explains the summary and conclusion of the research findings that have been carried out.

5.1 Summary of objectives

5.1.1 The Challenges of Proper Schedule Maintenance in Building

Table 8 *Three (3) main challenges for proper schedule maintenance in building*

Item	Ranking
Unclear job description	1
Lack of knowledge in the scope of maintenance	2
Lack of supervision from the maintenance team	3

The issue of 'Unclear Job Description' emerged as the most critical concern, earning the first highest mean which is 4.17. Ambiguous or vague job roles and responsibilities not only lead to confusion among maintenance staff but also contribute to inefficiency and reduced productivity. The lack of specific guidelines or expectations creates room for misunderstandings, conflicts, and difficulties in evaluating performance, ultimately impacting the overall efficiency of maintenance operations.

The problem associated with "Lack of Knowledge in the Scope of Maintenance" comes in second place with a mean score of 4.14. Workers who don't know enough about maintenance methods frequently produce mediocre or poor work. Their lack of experience could result in incorrect equipment handling, which would increase downtime and frequency of malfunctions. Insufficient knowledge also impairs their ability to solve problems, which delays the fixing of maintenance problems and interferes with the facility's seamless operation.

Lastly, the issue of 'Lack of Supervision from the Maintenance Team' secured the third position in analysis. The absence of proper oversight creates an environment where employees lack accountability. Without supervision, adherence to established protocols and best practices becomes lax. This lack of guidance results in inconsistent work quality and a higher likelihood of errors or oversights, further complicating the maintenance processes.

5.1.2 Type of risk that will occur of improper schedule maintenance in buildings

Table 9 *Three (3) main risks that will occur of improper schedule maintenance in building*

Item	Ranking
Reduce the comfort and safety of building use	1
The building would not be operational	2

Increased budget for untreated facility damage	3

The second objective was addressed via SPSS analysis to identify the factors contributing to understanding the types of risks prevalent in building facilities management. The study results showed that "Reduced comfort and safety of building use" stood out as the main danger, receiving the highest mean score of 4.29 out of all the concerned. focuses on how improper maintenance might negatively impact building occupants' safety and comfort. Inadequate or irregular maintenance plans can cause wear and tear on vital parts, jeopardizing safety features like flooring, handrails, and lighting. This degradation not only reduces the space's overall comfort level but also presents possible risks to its occupants.

Following, the second-highest mean value identified was "The building would not be operational," scoring 4.27 within the agreeable range Scheduled maintenance activities play a pivotal role in preventing unexpected breakdowns in vital systems such as electricity, plumbing, or heating. Failure to adhere to these schedules may result in abrupt failures, causing downtime and inconveniencing occupants.

Lastly, our analysis indicates that disregarding scheduled maintenance can lead to an increased budget for untreated facility damage, as reflected in the mean score of 4.22. If minor problems are neglected, they eventually get worse and require more extensive repairs or replacements. Ensuring the longevity of the building, limiting these escalations, and optimizing budget allocation for facility management all depend on well-planned and punctual maintenance plans. Maintaining the comfort, safety, and operational efficiency of any building requires carefully planned maintenance procedures to address these issues.

5.1.3 The potential of technology to improve schedule maintenance in building

Table 10 *Three (3) main technology that can improve schedule maintenance in building*

Item	Ranking
Can get information, update job status, and view related papers or manuals	1
Easier communication and increased productivity	2
Shows digital pictures of what the building looks like and how it works	3

Topping our analysis is the crucial functionality of accessing information, updating job status, and viewing relevant documents or manuals. This feature is pivotal for scheduled building maintenance, enabling easy access to necessary paperwork, real-time job updates, and vital data. It facilitates effective planning, execution, and monitoring of maintenance tasks, ensuring accessible resources and streamlined operations, ultimately enhancing efficiency and workflow.

Securing the second position is the aspect of easier communication and increased productivity. Effective communication among maintenance teams, supervisors, and stakeholders is pivotal in ensuring that everyone is on the same page regarding scheduled maintenance activities. The productivity of the maintenance crew is increased when there are clear instructions, frequent updates, and cooperative problem-solving. Setting up frequent meetings and making use of digital communication tools encourages teamwork, which leads to better coordination between members of the team. Improved communication has a direct impact on timely maintenance work completion, downtime reduction, and optimal building performance.

Finally, the integration of digital images portraying the building's condition holds significant value, ranking third in our analysis. These photos serve as visual aids during scheduled maintenance checks, providing crucial insights into the structure's state. Maintenance personnel can assess wear, identify issues, and schedule tasks more effectively. Tailoring maintenance based on visual cues helps address specific concerns, preventing further deterioration and ensuring proactive upkeep. This proactive approach prolongs component lifespan, reduces major repairs, optimizes maintenance budgets, and promotes long-term sustainability.

5.2 Limitation of the study

Throughout the research, despite meeting preset goals, notable limitations hindered various phases. Constraints on sample size and geographic focus limited findings' broader applicability. Data collection challenges, like reliance on self-reported data and biases, could affect credibility. Limitations in depth and breadth might overlook variables. Time, resource constraints, and external factors, like economic shifts or technological advancements, impacted research comprehensiveness. Acknowledging biases, such as researcher or selection bias, highlights transparency in addressing subjectivity in the study.

5.3 Recommendations for Future Study

For future researchers exploring building maintenance, a few key suggestions emerge from this study. Firstly, acknowledging that findings might not universally apply if reliant on specific sample sizes or geographic areas is crucial. Additionally, recognizing limitations in data collection, like biases in responses or reliance on self-reported data, is important for ensuring result validity. The study's focused scope and potential depth constraints warrant acknowledgment, emphasizing omitted variables or underexplored areas. Acknowledging time and resource limitations that affected research thoroughness, such as restricted survey periods or data accessibility issues, is also essential. Lastly, proposing future research directions, including unexplored facets and areas for improvement, could greatly advance knowledge in this field. These recommendations aim to guide and support future researchers in delving deeper into building maintenance, fostering progression and enhancement in this critical domain.

5.4 Conclusion

This study extensively investigated challenges, risks, and technological prospects within building maintenance. Through a thorough analysis involving input from maintenance staff, crucial factors such as ambiguous job roles, threats to building security, and technology's societal impact were uncovered. However, the study faced limitations in sample representation and potential biases, highlighting the need for future research. Suggestions for upcoming studies include focusing on sustainable maintenance practices, exploring new technologies, employing qualitative methods, and diversifying samples. Despite its shortcomings, this research offers valuable insights and lays the groundwork for further advancements in the critical field of building maintenance.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur' Adibah Izmahani Binti Hasanuddin, Mohd Hilmi Izwan Abd Rahim;* ***data collection:*** *Nur' Adibah Izmahani Binti Hasanuddin;* ***analysis and interpretation of results:*** *Nur' Adibah Izmahani Binti Hasanuddin;* ***draft manuscript preparation:*** *Nur' Adibah Izmahani Binti Hasanuddin, Mohd Hilmi Izwan Abd Rahim. All authors reviewed the results and approved the final version of the manuscript.*

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