



Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943



Optimizing The Best Practice of Building Maintenance Management System (BMMS): Modern Computerized System at Strata Title Residential Property in Malaysia

Norsafiah Norazman^{1,*}, Nuzaihan Aras Agus Salim¹, Siti Balqis Mohd Shukri¹

¹ Department of Building Surveying, School of Housing, Building and Planning, 11800 Minden, Universiti Sains Malaysia, Pulau Pinang, Malaysia

ARTICLE INFO

ABSTRACT

Article history:

Received 24 June 2023
Received in revised form 25 Aug. 2023
Accepted 31 August 2023
Available online 2 November 2023

Keywords:

Best Practices; Computerized System; Maintenance; Management; Strata Title

Investment in building maintenance management is an effective strategy to control the quality of building performance and its condition. In most countries, maintenance activities are based on the basic management concept, which includes planning, monitoring, and controlling. Thus, building maintenance management system (BMMS) should be applied to various types of properties to allocate the relevant maintenance procedures to the specific building that requires the implementation of maintenance activities. Ordinarily, residential property is more concerned with the building maintenance management system (BMMS) due to the well-maintained assets and facilities, while also retaining the building aesthetically to provide an opportunity for future property investment. The value of buildings depends on their quality and current condition, and this also points out that accurate maintenance activities for residential property in Malaysia provide maximum benefit to the building's performance. However, building maintenance management in Malaysia is mostly based on the conventional system (also known as a paper-based report) rather than the modern computerized system, which makes it ideally difficult to determine the root causes. This commonly proposes inaccurate maintenance activities for strata-title residential buildings. The weaknesses of the current procedure may affect the overall building performance, besides, building defects can also become more critical without any remedial actions from the building owners. Thus, this research will aid in identifying the fundamental shortcomings of paper-based conventional systems and investigating how a modern computerized BMMS might cope with these challenges. However, this study will focus on strata title properties in Peninsular Malaysia. The variables were measured and assessed using a mixed-methods approach that included both qualitative and quantitative components. Twelve (12) building experts from public and private entities, including the public works department (PWD), local authority (LA), and Construction Industry Development Board (CIDB), were interviewed using a qualitative technique. The results from semi-structured interviews were analyzed using descriptive and thematic analyses. Then, 125 respondents were given a questionnaire as part of a quantitative approach, and SPSS version 28 was used to examine the results. The findings are expected to highlight the best practice attribute for improving BMMS implementation via modern computerized strata title property in a more effective method as well as the importance of modern computerised BMMS.

* Corresponding author.

E-mail address: safiahazman@usm.my

<https://doi.org/10.37934/araset.33.1.449470>

1. Introduction

Strata title properties mainly residential type have been built by the local government in Malaysia basically to provide affordable living houses for low to moderate-income communities and overcome the issues of illegal squatters in urban areas [1]. Within limited space of land, multiple-storey residential may provide many dwelling units to be built. Due to affordability in urban areas, particularly in Peninsular Malaysia, strata residential property becomes a key alternative solution for low to moderate-income groups to acquire residential real property. As a result, strata residential property may alleviate inhabitants' challenge to maintain a comfortable standard of living. Furthermore, the local government provided numerous stratum housing programmes to both urban and non-urban residents [2]. Over the last three decades, the high rate of migration to urban centres among citizens and the demand to own affordable residential property in many cities have been extremely increased. To deal with this shortage, the development and construction of strata title residential properties may provide the optimum buyer in current demand [3].

In the local context, strata title property is a significant type of residential building that is ideally more affordable compared to landed property. According to earlier investigations by Azian *et al.*, [4], a year after post-construction, specifically the public strata residential property, had deteriorated, progressively increasing vandalism issues, poor functionality of basic facilities, and badly organized management in maintenance aspects. To prevent the building and its facilities from functioning well, continuous maintenance planning and implementation are important strategies to improve the property's quality. Therefore, the Building Maintenance Management System (BMMS) also may strategise the accurate implementation of maintenance by technical skills. Thus, the quality of building performance is crucial to measuring the determination of building comfort and occupant well-being.

Maintenance management practices become the main role for effective maintenance works implementation to fulfil the building needs, be well maintained, function, and provide convenience to the tenant and occupant in the building. Therefore, poor maintenance management systems commonly applied for strata title property may bring constraints to building operations. This led to the lack of knowledge of maintenance scope as it is a crucial matter for maintenance works to have proper management and good leadership [5].

The maintenance management also often neglected the old strata residential property due to the limited financial resources, unskilled technical, outdated systems and unorganized records and documentation which become the key shortcoming of BMMS effectiveness in Peninsular Malaysia. This practice is such a financial waste considering the higher cost involved in the future to restore the house. Delay of maintenance work may result in high damage in future. Other than that, uncontrolled rates of maintenance fees for strata residential properties may contribute to the failure of building maintenance management procedures and reduce the effectiveness of total building performance [6].

Therefore, the upgraded method of building maintenance management system (BMMS) from a conventional to modern computerized system may increase the high performance of strata title property and demand in urban areas for affordable property. The current building maintenance management systems (BMMS) approach in Malaysia, according to past research by Ismail [7], still relies on the conventional method known as a paper-based report and also lacks systematic data management, aside from a manual checklist for any maintenance work that is scheduled. However, this conventional approach is not always appropriate due to the unorganized procedure for work, which can also have an impact on the financial situation if the planned maintenance work is difficult. By organizing the database to be more systematic and incorporating costing, workmanship, technical

skills, schedule, materials, complaints, and reports, this study will highlight the adaptation of the modern computerized system as the technological innovation for developing a maintenance management system (BMMS) in strata title properties in Peninsular Malaysia to overcome the challenges that arise in conventional approach for BMMS.

Additionally, a computerized maintenance management system may promote the successful execution of maintenance work progress, including reducing the time to address complaints, tracking records for prior complaints, managing workmanship, working in scheduling, and managing financial resources [8]. As the discussion continues, there are still challenges to overcome beforehand modern computerized BMMS may be fully adapted for strata title properties in Peninsular Malaysia. Therefore, in order to improve the building maintenance management system (BMMS) in strata properties in Peninsular Malaysia, the attribute of the best practice to optimize the modern computerized will be discussed in the discussion section of the paper in order to increase the high efficiency of building quality and performance.

2. Literature Review

2.1 Concept of Building Maintenance

Buildings are valuable assets that require ongoing maintenance and care to retain their value and operation. Thus, building maintenance is necessary for all buildings since it involves the process of ensuring that a structure, whether residential, commercial, or industrial, remains in excellent shape, works efficiently, and meets safety rules over time [9]. According to previous studies by Eisner [10], maintaining buildings involves a few jobs such as maintenance, landscaping, and electrical systems. Building maintenance, according to previous research by Wilke [11], is the process of ensuring that a building structure, regardless of its function, remains in good condition, operates efficiently, and meets safety standards, which includes a variety of activities and tasks aimed at preserving and prolonging the building life, system, and its components.

As claimed from previous studies [12], maintenance is "all administrative and technical operations, including monitoring, to preserve the item or return it to a location where it can fulfil the function for which it was designed", which will be beneficial for excellent building maintenance management. A successful building maintenance management system, as stated by Ismail [7], necessitates precise planning, scheduling, and performance of maintenance work. It might include anything, from regular check-ups and maintenance to quick fixes and upgrades. In order to fulfil the original design, building maintenance management also strives to keep the building's performance level at a high level [13]. Furthermore, maintenance management simulates proactively addressing difficulties in order to ensure that building assets, equipment, and systems remain in optimal condition, lowering the chance of breakdown and increasing repair costs. Maintenance management should be in place to ensure that these track maintenance buildings stay functional Breesam *et al.*, [12].

Furthermore, without appropriate maintenance management, residential structures would face issues such as efficiency, convenience, life duration, economic viability, and appearance [14]. As Malaysia is currently advancing technologically, a previous survey by Ismail [15] proposed implementing modern maintenance management. This modern maintenance method makes use of technology and data-driven approaches to streamline processes and optimize resource allocation. Building maintenance management is being improved in these days and age by the integration of smart sensors, Internet of Things (IoT) devices, and data analytics. These advancements enable predictive maintenance, which enables maintenance teams to foresee probable difficulties and take preventive measures, resulting in increased productivity and cost savings.

2.2 Building Maintenance Management System (BMMS)

A building maintenance management system (BMMS) is a software solution or platform designed to assist organizations in managing and tracking building maintenance activities Wilke [11]. It is an investment that aids the facility manager, property owner, or maintenance team in simplifying, enhancing, and guaranteeing the buildings in excellent shape. These improvements in information and computer technology have resulted in increased use of software solutions in building maintenance management. This advancement has aided in the construction of a modern computerized building maintenance management system for a building. Modern computational facilities have provided a tremendous opportunity for increased efficacy and efficiency in, for example, maintenance, claims [16]. It entails using a methodical and consistent approach that leads to a helpful assessment regarding maintenance strategy [17].

The standards-setting, inspection-planning, identifying and specifying of required repairs, cost estimation, planning, and organization of the execution of the repairs are all components of the building maintenance management process Breesam *et al.*, [12]. These systems might make it possible to track building maintenance efficiently. Additionally, Ofori *et al.*, [14] claimed that without adequate maintenance management, housing units will be affected by problems with efficiency, convenience, life span, economic viability, and attractiveness. It ought to begin right away when the housing unit or building is completed. Building maintenance management may have been lax due to the lack of a functional building maintenance model Ebekozien *et al.*, [17].

According to previous studies [18], maintenance management of buildings in Malaysia is often handled by the developer by Act 1966 (Act 118) of Housing Development (Control and Licensing) before the establishment of the Joint Management Body (JMB). The developer may employ an agent to deliver the services or perform the tasks themselves. Purchasers are required to pay maintenance fees to the developer in order for the developer's services to be carried out smoothly. As stated by Ismail [7], there are two approaches to maintenance management used in Malaysia: conventional methods and modern computerized methods.

2.2.1 Conventional approach

Ismail [7] claimed that some Malaysian buildings, particularly universities, continue to use the conventional method for their building maintenance system. This system provides a defect report from a complaint using a paper-based form. In addition to being inefficient, Microsoft Word and Excel databases are also a factor in the maintenance management system's inconsistencies. The absence of a decision-making mechanism to address complex issues with building and infrastructure flaws contributes to the lack of comprehensive maintenance management. Conventional approaches have been the mainstay of most maintenance management systems up to this point, with little attention paid to instruments for decision-making and defect diagnostics.

Ismail [7] also stated the conventional methods imply that all design and construction processes will be carried out sequentially to provide maintenance teams with in assessing building degradation, choice of optimal maintenance strategies for components or materials, and the least amount of life-cycle analysis of projects. A conventional approach to maintenance management has been criticized for several flaws including recurrent functional and aesthetic defects caused by a lack of technical experience, competent workers, and subpar quality control, according to the previous study [19]. Researchers [48] also emphasized that staff members could make a mistake when filling out the assessment form. To fix Malaysia's inefficient maintenance management systems first, past researchers [20] continued to perform case studies on the requirements of these systems.

Refer to research by Ismail [7,15,20], they found that lack of conventional maintenance management methods lack defect diagnosis tools and strategic decision-making for information analysis in maintenance-related project outcomes. Thus, the author suggests creating a modern computerized system to address every issue with the usual approach. This combination of traditional maintenance management concepts with industry 4.0 technologies changes the current maintenance practice [21]. This complex process is congruent with digital transformation in that these technologies reduce inefficiencies in maintenance management [21,22].

2.2.2 Modern computerized

The effectiveness of a building's systems, equipment, and components is improved via maintenance procedures. Growing reliance on software solutions for managing building maintenance is a result of developments in information and computer technology. In the context of a modern computerized building maintenance management system, it alludes to the application of modern software and electronic tools to the streamlining and improvement of building and facility maintenance procedures. These applications enhance the efficacy, efficiency, and efficiency of building maintenance chores by utilizing the power of computers, data analytics, and automation. As a country that is still in development in technology, these software systems can be counted as a new technology in Malaysia.

Ismail [20] mentioned that some of the maintenance staff were generally introduced to information and communication technology (ICT) of building maintenance management to provide maintenance inspection records and results, including checklists, specifications and maintenance procedures. These modern computerized software are Computerized Maintenance Management System (CMMS) and Computer Aided Facility Management (CAFM). From previous studies [23], computerized maintenance management system (CMMS) applications to maintain a large number of buildings with quality methods can offer various reports regarding repair and maintenance issues that ensure better management of maintenance activities and achieve better quality in the transfer and evaluation of information among internal staff maintenance.

The computer-aided facilities management (CAFM) system may assist decision-makers by enabling them to automate a lot of labour-intensive data for maintenance management duties that will typically result in lower expenses [24]. In addition, online platforms like mySPATA and *E-Aduan* which were developed as software to manage government databases are currently available according to Ismail [15]. While *E-Aduan* is an application or online database for processing complaints from users regarding any issue on government infrastructure, mySPATA serves as a database of data inventory for government assets initially in government-based buildings.

All of the mentioned software was specifically tailored to the Malaysian system, and some management teams used it as part of their implementation process for a more effective system for managing building maintenance. Overall, modern computerized building maintenance management systems are intended to optimize the whole maintenance process, increase building performance, and extend asset lifespan while lowering operational costs and downtime.

2.3 Strata Title Property

Section 4 of the Strata Titles Act 1985 (Act 318) and Section 2 of the Strata Management Act 2013 (Act 757) interpret common property as a piece of land in the strata owned by two or more parcel owners and without including any specific subdivision of parcels. It can alternatively be defined simply as a single property within a bigger integrated complex that shares common facilities.

Stratified properties are governed by several Acts, including the National Land Code (1965), the Housing Developers (Control and Licensing) Act 1966 and its Regulations, the Strata Titles Act 1985 (Act 318), the Building and Common Property (Maintenance and Management) Act 2007 (Act 663), and the Strata Management Act 2013 (Act 757), which took impact as of June 1, 2015. According to Khalid *et al.*, [5] the establishment of multiple laws governing stratified/high-rise structures is meant to ensure the effectiveness of the upkeep and management of these properties.

According to Rabe *et al.*, [25], a stratum building consists of a building separated into portions consisting of the accessory parcel and a provisional block, with everything else, such as corridors, lifts, external walls, open space and water tanks, being classified as common property. Urban areas in Peninsular Malaysia often have a shortage of land available for the development of landed property, hence high-rise residential buildings are in high demand. Strata projects have changed from being a need for those living in pricey metropolises to a lifestyle trend among Malaysia's urban professional population, according to Chong *et al.*, [26]. In addition to that the distinct feature of strata housing is that tenants share facilities and common areas, which may include a multipurpose hall, playground, lift and hallways.

Thus, in order to preserve the building and facilities in good condition, residents are obliged to pay a service charge as a fee, while the Management Corporation (MC) is in charge of administering the facilities supplied. This is to ensure efficient strata property administration, which will help long-term development Rabe *et al.*, [25]. It is unavoidable given that both the government and private sector are delivering stratum homes to support various national housing plans, particularly to meet the needs of low and middle-income people [27]. Despite this, there are still prevalent issues in strata management [28]. According to the research that was conducted, these common 'on-paper' problems such as a lack of explicit provisions in the law, a lack of policy, and a lack of guidelines occurred in the early stages of Strata application. It then moves on to various flaws from the maintenance management team, such as Management Corporation (MC), Joint Management Body (JMB), and Commissioner of Building (COB).

The flaw was discovered to be an unscrupulous developer profiting by delivering a lesser quality service but inquiring about a high cost, issues with the payment of quit rent for the master title, and a lack of an enforcement team. Thus, Mohamad [28], summarized stratum management's weaknesses as meetings held for complaints, administration and management, maintenance and repair, financial issues, and management body enforcement. However, a few previous scholars have made recommendations to overcome this difficulty, such as:

i. Khalid *et al.*, [5]

-Impose more criteria before giving developer licenses to make sure that builders are more proactive in educating potential purchasers about shared living.

-To spread knowledge of the values of communal and shared living, authorities should use a variety of strategies.

-All parties participating in the stratified housing industry must understand the value of adequate maintenance and administration, not only when the project is completed but even after it has been occupied for more than ten years.

ii. Mohamad [28]

-One of the greatest ways to resolve a strata dispute is through mediation, which helps the parties involved save money and time while maintaining their social relationships.

Ownership of a strata title property has various benefits over ownership of an entire building, including access to shared facilities and services, shared responsibility for maintenance and repairs, and possibly lower expenses. This study, however, will only focus on strata title properties in Peninsular Malaysia, and in order to maintain orderly and effective property management, owners

must also collaborate while adhering to the established norms and rules. Due to the growing popularity of strata property development in Peninsular Malaysia, it is necessary to establish strong enforcement by authorities like the Commissioner of Building (COB) and compliance by all parties to Act 757's provisions in order to improve strata management.

3. Methodology

The methodology applied to achieve the purpose of the study is using a mixed method in order to identify the shortcomings of the conventional approach in building maintenance management systems (BMMS) and the challenges of modern computerized BMMS, as well as, the best practices for BMMS optimization in Peninsular Malaysia's strata title properties. It involves both qualitative in-depth analysis from semi-structured interviews and systematic literature review, and quantitative questionnaire surveys. Combining these two methodologies will aid in the broad understanding and current execution of maintenance management practices. Qualitative research is based on the phenomenological paradigm that uses a variety of interpretive methodologies [29]. Quantitative research technique, on the other hand, is a methodical way to investigate research topics or hypotheses through the use of numerical data and statistical analysis. Qualitative research also uses systematic procedures to study the research question in sufficient depth.

Besides, qualitative research generates both exploratory and highly descriptive knowledge while decreasing the emphasis on purely causative models and explanations that have historically dominated the research process [30]. The processes of the qualitative data approach are described in terms of strategies because many different types of practices of Building Maintenance Management Systems (BMMS) have been applied in residential properties in Malaysia. Meanwhile, the quantitative method in this study aims to quantify the patterns and trends in the best practice of BMMS measurably.

Table 1
List of Building Experts/ Participants

Participants (P)	Position	Agencies
P1	Engineer	PWD
P2	Engineer	PWD
P3	Assistant Engineer	PWD
P4	Building Surveyor	PWD
P5	Building Surveyor	PWD
P6	Engineer	LA
P7	Building Surveyor	LA
P8	Assistant Engineer	LA
P9	Assistant Engineer	CIDB
P10	Assistant Surveyor	CIDB
P11	Maintenance Officer	CIDB
P12	Assistant Operational	CIDB

3.1 Qualitative: Semi-structured Interview

The semi-structured interview has been conducted with twelve (12) building experts from public and private agencies, including the public works department (PWD), local authority (LA) and Construction Industry Development Board (CIDB) in order to determine the challenges of building maintenance management system (BMMS) in Peninsular Malaysia. The criteria of building experts

are based on the academic background related to building facilities, services and asset management, experiences in handling maintenance in strata residential property, and procedures and regulations involved for best practices of maintenance in Malaysia as involve purposeful sampling.

3.2 Quantitative: Questionnaire

The purposive sampling method of this study involves respondents from Klang Valley as the target population in Peninsular Malaysia, which is the largest city's area development of strata title residential buildings with a population of 9 million people in the year 2022 [31]. Therefore, a sample size of 125 respondents specifically the maintenance and technical team have been chosen from five (5) buildings of strata title residential property. This quantitative method aimed to assess the best practice to optimize the BMMS via modern computerized along with the current practice for BMMS in strata title residential properties in Peninsular Malaysia. The data was next analyzed using the Relative Importance Index (RII). The criteria of building selection are based on the location and maintenance practices, whereas the urban area is the focus location for this study, the regular maintenance practices are the main concern to carry out with a more realistic response. This

3.3 Relative Importance Index (RII)

The Relative Importance Index (RII) is a statistical tool for determining the relevance or importance of various aspects or variables in a data set, notably in the context of surveys or questionnaires. It is a simple and uncomplicated method for determining each variable's relative contribution to affecting an outcome or dependent variable. Given the large number of respondents in this study, a questionnaire was chosen as an appropriate technique. It was carried out to examine respondents' options for best practices for optimizing the Building Maintenance Management System (BMMS) through the adoption of current computerized strata title property. A confidential agreement was attached to ensure that no leaking information about the respondent.

In order to boost the response rate and encourage potential respondents to participate in the survey, a confidentiality declaration and the researcher's contact information were attached to the questionnaire distribution [30]. The questionnaire evaluated respondents using a five-point scale ranging from "Extremely not recommended" to "Extremely recommended" and "Highly unimportant" to "Highly Important" to optimize the building maintenance management system. The results were quantitatively analyzed using SPSS version 28. According to past surveys [33], statistical techniques should be appropriate for the number of variables being examined (univariate, bivariate, or multivariate analysis), the level of measurement of the variables (nominal, ordinal, or interval data), and the purpose for which the data is used (descriptive or inferential).

As a result, the following strategies were used to analyse the acquired data using SPSS software:

- i-Descriptive analysis – to analyse the general demographic analysis of the findings;
- ii-Relative Importance Index (RII) – to rank the best practices to optimize building maintenance management; and
- iii-Satisfaction analysis – to assess the elements of service performance factors.

The equation for RII is as follows [34] and [35], written as [Equation 1]

Relative Importance Index [Equation 1] =

$$\frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N} (0 \leq index \leq 5)$$

where:

w = weighting given to each factor by the respondent, ranging from 1 to 5;

n1 = number of respondents for most unimportant;

n2 = number of respondents for unimportant;

n3 = number of respondents for slightly important;

n4 = number of respondents for important;

n5 = number of respondents for most important;

A = the highest weight (i.e. 5 in the study); and

N = total number of respondents.

4. Findings and Discussion

The explanation of the study's findings will be divided into a few sections since it uses both qualitative and quantitative methods for data analysis. The analysis for part one (1) will use a qualitative approach with interviews of 12 respondents to gather data on the current state of Malaysia's Building Maintenance Management System (BMMS) and the significance of using modern computerization in BMMS. Along with that, it emphasizes the challenges of building maintenance management systems (BMMS) that arise in strata title properties in Peninsular Malaysia. The second section will explain the quantitative analysis and results from the questionnaire distributed to 125 respondents. The current practices of BMMS in Strata Title Residential Property in Malaysia will be discussed too along the writing. Following that, as the primary goal of this research, it will explore the best practices for optimizing BMMS through Modern Computerized in Strata Title Property.

4.1 Maintenance Management Issue in Strata Title Property in Malaysia

Maintenance management for strata title property is the process of planning, organizing, and carrying out maintenance tasks in multiple unit properties governed by strata or condominium title arrangements. Individual units in this sort of strata property were owned by various individuals or entities, while common areas and facilities were jointly owned by all unit owners. It was created to overcome the difficulties associated with managing and maintaining multiple-story buildings with multiple owners. To ensure that maintenance management runs efficiently, some strata management fees must be paid by unit owners (Strata Management Act 2013). Section 21(2) of Act 757 outlines the duties of the Joint Management Body (JMB) and Management Corporation (MC) regarding the maintenance and oversight of strata property. These duties include collecting fees and contributions to the sinking fund from parcel owners based on the allotted share units, performing maintenance and management of the buildings, and recovering any costs incurred by the JMB from parcel owners. The issues mentioned in this section were based on a systematic review that was undertaken, which was then discussed with all interviewees in order to highlight the maintenance management issue that remains constant in strata title properties in Malaysia.

The fundamental issue in strata maintenance management is financial funding as asserted in Shuhaimi *et al.*, [36] and Yusoff *et al.*, [37] due to insufficient collection of maintenance fees from unit owners. According to a thorough assessment of the literature, the following problems could occur if the unit owner didn't cover the funding expenses. According to a past survey [38], the non-payment of maintenance fees is a prevalent issue for JMB and MC. Some unit owners may fail to pay

their maintenance fees on time, compounding the management bodies' financial problems. This could occur as a result of insufficient finances in the maintenance routine which can result in delay of maintenance work. This problem demonstrates how the Malaysian Management System's lack of effective financial planning practices leads to disputes between unit owners and strata managers bodies claimed Chong *et al.*, [26] and Mohamad [28].

The next issue arises as a result of ineffective management bodies. These management groups, which are in charge of property maintenance, might be inept or unskilled at times, resulting in mismanagement and delays in addressing maintenance issues. Repairs and maintenance work may be delayed due to bureaucratic processes or financial constraints, causing further deterioration of the property and associated safety hazards. According to the annual report of the Commissioner of Buildings (COB) in 2016, from the Department of Strata Management, Ministry of Housing and Local Government (KPKT), administration and management issues continue to contribute to the highest number of complaints received in Malaysia.

Chong *et al.*, [26] mention that further stress that the majority of occupants in high-rise buildings in Malaysian Strata Title Properties are concerned about the strata managing agent and issues with repairs and maintenance. Furthermore, it states that the most prevalent sorts of problems in stratum living are administration and management difficulties. This financial crisis has complicated strata-building management. The ineffective collection of these strata maintenance fees may also have an impact on the overall maintenance and management budgets in order to provide effective building maintenance stated by Suhaimi *et al.*, [36]. At one point, disputes between unit owners also started to affect how strata title property is managed.

Living in a neighbourhood with several residences means that some unit owners may dispute over repairs, renovations, or the distribution of finances, which can obstruct problem-solving and effective decision-making. Apart from disagreements over money, disputes frequently arise when strata owners are not aware of the rules and regulations before renovating their apartments [39]. According to Chong *et al.*, [26] these circumstances may result from poor communication between the owner and management body unit, which causes misunderstandings, disinformation, and a lack of awareness of maintenance-related issues. As a result, the satisfaction level of strata owners towards maintenance and management decreased as stated by Suhaimi *et al.*, [36]. These emerging issues make it harder for strata management bodies to secure support from unit owners through maintenance fee contributions.

According to the literature study and interview, the following related difficulty with strata building maintenance management is a lack of transparency. It has become essential to be transparent in decision-making and finances in order to keep the trust of unit owners. This issue may arise as a result of poor communication between management entities and unit parcels, which could then result in misinterpretations, inaccurate information, and a lack of awareness of maintenance-related issues according to Chong *et al.*, [26]. This subsequent transparency can make the parcel unit suspicious and unsatisfied. According to Mohamad [28], there are numerous examples of unethical developers attempting to make a profit by delivering lower-quality services while demanding a high charge for strata maintenance, particularly in high-rise structures. She also noted that there are more complaints about financial concerns, such as a violation of trust and money misuse. This may be a flaw in the present strata maintenance management administration.

Commonly, the issue that occurs in strata property building maintenance management is related to safety, which may involve building conditions and security. Other types of strata disputes, are safety concerns and building ageing stated Chong *et al.*, [26]. The building's ageing structure and building condition as a high-rise building must be calculated in this context of a strata management challenge. As can be seen, some of these strata title properties in Malaysia are ageing, which

necessitates high maintenance costs for older infrastructure, causing financial problems for management bodies Nur 'Afiqah Jaini *et al.*, [37]. Based on previous studies [40], assert that managing older strata buildings requires knowledge and experience. The lack of these individuals in the management team may undermine confidence in the ability to address maintenance issues and contribute to maintenance issues in strata buildings.

Chong *et al.*, [26] mentioned that the next safety concern is related to security elements such as fire safety packages and closed-circuit television service (CCTV), which has become a required basic service to protect the safety and security of residents in strata buildings. However, these conflicts are typically limited to management and the security provider. In order to meet the growing demand for security services, several security firms hire unskilled and unqualified security personnel. As a result, the number of security-related complaints has grown as time passes Mohamad [28].

To overcome these maintenance issues, strata-owned properties must be governed by effective rules and regulations that are effectively enforced and monitored. Unit owners and management companies should work effectively together to adhere to payment schedules and maintenance inspection work in order to have maintenance costs paid for promptly, establish clear communication channels, and implement transparent financial practices. The Strata Management Act 2013 in Malaysia attempts to address some of these issues by establishing a framework for the management and maintenance of strata title property. However, effective execution and coordination among stakeholders are needed to guarantee the proper upkeep and administration of strata title assets across the country.

4.2 Building Maintenance Management System (BMMS) Challenges in Strata Title Property in Malaysia

A qualitative method was utilized with semi-structured interviews with 12 experts from public and commercial entities to address the challenges of the building maintenance management system (BMMS) in Strata Title Property in Malaysia, and the results are displayed in Table 2. As mentioned in the Literature Review topic from earlier, this section will dive into the implementation of a BMMS software system to expedite and optimize the management of building maintenance activities and operations. Implementing contemporary computerized BMMS and building operations can be viewed as an innovative way to carry out maintenance operations and tasks. Strata properties are multiple-unit buildings, and maintaining them needs careful planning and cooperation among numerous parties. However, there are various flaws associated with the deployment of this BMMS in Malaysia strata properties. Building Maintenance Management Systems (BMMS) in Malaysia may encounter a variety of difficulties that limit their performance and have an impact on building maintenance practices. Some of the prevalent challenges in BMMS in Table 2 will be discussed here by referring to the respondent's agreed terms.

Table 2

Challenge of Building Maintenance Management System (BMMS) in Strata Title Property in Peninsular Malaysia

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Less Competent in Technical Skills	/	/		/	/	/	/	/	/		/	/
Poor Workmanship	/	/	/				/	/	/	/	/	/
Contractor without CIDB registration	/	/						/	/			/
Risk management competency	/	/			/					/		
Safety and welfare	/	/	/	/	/	/	/		/		/	/
Critical defects involved	/	/	/	/	/						/	/
Less efficient maintenance	/	/	/	/	/	/	/	/	/	/	/	/
Lack of work coordination	/		/		/				/	/		/
Improper maintenance records	/	/	/	/	/	/	/	/	/	/	/	/
Maintenance work delay		/			/	/	/	/			/	
Lack of periodic review			/	/	/	/	/			/	/	/
Poor monitoring system	/	/	/	/	/	/						
Unsystematic procedure	/	/	/	/		/	/	/				/
Complaints lodged unsettle		/		/				/	/	/	/	/
Less technology advancement	/	/	/	/	/	/	/	/	/	/	/	/
Unsystematic database	/	/	/	/	/	/	/	/	/	/	/	/
Limited funding	/	/	/	/	/	/	/	/	/	/	/	/
High life-cycle cost	/	/	/			/			/			/
Maintenance fee irrelevant	/	/	/		/		/			/	/	
Poor quality of materials	/	/	/			/	/	/	/	/		
Poor component repair			/	/	/		/	/		/	/	
Poor mechanical and electrical facilities	/	/		/		/		/		/		/

Source: Interview session with 12 respondents (author's work)

The first challenge that garnered a perfect score from the respondents was inadequate maintenance. Maintenance efficiency can be impacted by a variety of factors and aspects that make maintenance less efficient. Reactive maintenance, a lack of preventative maintenance, and poor planning can all contribute to less effective maintenance, which can negatively impact building performance and result in difficulties with maintenance tasks. According to Ismail [20], effective maintenance contributes significantly to the constant expenses of buildings and infrastructure throughout their useful lives. In addition, the author added that reactive maintenance is sometimes handled only after problems develop and turn into emergencies, which then raises repair costs and causes disruptions to deliveries. This issue will contribute to inefficient maintenance workflow. Maintenance work may be delayed if BMMS is not well-organized or simplified [41]. As a result, all

respondents believe that one of the issues with BMMS in strata buildings in Malaysia is inefficient maintenance.

The second challenge that all respondents agree on is faulty maintenance records. This maintenance report is critical since it contains particular information about previous maintenance actions, costs, and asset performance. Most stratum buildings continue to use conventional methods that may involve an "assessment form" to evaluate any flaws in the structure of the building [48]. Furthermore, Ismail [20] mentions that there are various parts in the form that require specific information, which some untrained and unacknowledged personnel will find difficult to fill out due to the many technical terms and skills required for that activity. In the end, several parts will be left blank, resulting in an incomplete maintenance report.

Table 2 shows that the unsystematic database gained 100% agreement from all 12 respondents when it comes to negligent database. This unorganized database could be the result of an incorrect maintenance record from the conventional process stated Ismail [15]. This could be owing to the inconsistency of many conventional formats that influence how information is recorded. Throughout the evaluation form-filling process, there may be missing or incomplete significant details regarding the detail, resulting in difficulty in data analysis [42]. This will make specific information entering tough in order to analyse the reoccurring issue and make decisions. This problem will then affect the maintenance backlog during the BMMS implementation in the record file.

The next drawback is the adoption of BMMS via a modern computerized had a less significant technological impact on stratum properties in Malaysia. Since Malaysia is currently undergoing development, claimed Zahid Rasool *et al.*, [42] contend that it may take some time for these new technologies to be adopted in Malaysia. Zahid Rasool *et al.*, [42] further added that even though everyone knows of the advantages, Malaysia has been hesitant to allow building maintenance systems to be established. These problems subsequently result in inferior technical expertise, which is acknowledged by ten (10) of the over 12 respondents, and poor workmanship, which was acknowledged by nine (9) of the over 12 respondents (refer Table 2). These two issues are linked to technological expertise. Due to the lack of technical training, technology providers and the fact that some of this technology is not user-friendly as believed by Zahid Rasool *et al.*, [42] there is a risk of reporting errors while using the system, and some staff may have difficulty assessing and maintaining instantly, contributing to negligent database management Ismail [15].

Furthermore, there will be a discussion about BMMS in strata title properties in Malaysia due to a lack of funds. As demonstrated in Table 2, these issues appear to receive unanimous support from all 12 respondents. The issues of funding and new technologies are inextricably linked. In their 2019 research, Zahid Rasool *et al.*, [42], also concluded that there is still concern about expense when implementing this new technology for building maintenance management. Some property owners, particularly those in older or smaller buildings, may lack the financial resources to invest in a comprehensive BMMS for their strata properties. As a result, they may choose reactive maintenance over proactive and preventive procedures. As an outcome, some strata building owners may be averse to change since integrating BMMS with existing building management processes and systems may be difficult. Compatibility issues may reoccur, leading to delays and inefficiencies in data administration and reporting.

Strong data protection procedures and adherence to pertinent laws and regulations are additional ways to manage data privacy and security problems. In order to streamline maintenance procedures and enhance the general state and durability of buildings in Malaysia, efficient BMMS implementation necessitates a cooperative effort from building owners, occupants, management bodies, and outside service providers. It is crucial to raise awareness of these problems and provide knowledge about the advantages of BMMS adoption. A good collaboration with relevant industry

stakeholders such as property management companies and regulatory organizations can provide valuable workmanship, perspective and insights during the process to address this linked issue of building maintenance. Government agencies and private sector organizations can also offer assistance and rewards to persuade building owners to utilize BMMS and other effective maintenance techniques.

To ensure uniformity and simple acceptance across various properties, standards and guidelines for BMMS implementation can be defined. Building management businesses should invest in personnel training to maximize the system's potential and, if necessary, consider outsourcing technical expertise. An investment in qualified and expert staff in developing a maintenance team will boost stakeholder trust in the company's service, which will benefit both stakeholders and unit owners with the efficacy of an expert technical team. Due to its constant readiness and use of an innovative building maintenance management system, this team will also be able to overcome the shortcomings of maintenance frequency and response time.

4.3 The Importance of Adaption Modern Computerized Building Maintenance Management Systems (BMMS) in Malaysia.

Following the discussion of various challenges and issues with BMMS in Malaysia in the preceding subtopic, this study will continue to investigate the significance of these systems to strata properties in Malaysia. This analysis was based on the results of an interview with 12 respondents, as shown in Table 3. Semi-structured questions were used as a qualitative approach to data collecting. Table 3 shows a common programme used for building maintenance management in Malaysia. There is also a common and options platform that respondents choose to demonstrate how some of these products can benefit the user. Adopting current computerized building maintenance software in Malaysia provides several benefits and advantages for efficient and effective building maintenance practices.

According to Table 3, all respondents stated that Microsoft Word and Excel are both common platforms for keeping records. However, these two programmers are not considered modern computerized since they are only ideal for simple data entry due to perceived barriers. Due to the fact that these two applications are a part of the standard routine, some respondents raised concern about it. According to Table 3, only nine (9) out of 12 respondents chose Microsoft Word, while six (6) chose Microsoft Excel. This suggests that these two programmers may not be the best choice for managing complicated building maintenance data. These Microsoft applications, according to Sean Peek [43], are not a complete Document Management System and are not secure for a comprehensive enormous record. As a result, it is not recommended to use Microsoft since it has limitations in terms of data organization, analysis, and automation. It is recommended to use specialized software or database solutions designed for whole building maintenance management, as these Microsoft applications do not fit the preferences for BMMS system features.

Computerized Maintenance Management System (CMMS) is a popular software that gained unanimous approval from 12 respondents. A Computerized Maintenance Management System (CMMS) is software that is designed to streamline and optimize maintenance management operations for organizations and facilities. According to Ismail [15], CMMS covers a wide range of building and infrastructure components such as identifying work location, manpower, material, and equipment required, as well as the intended completion date. In addition, CMMS helps the maintenance management budget and long-term financial commitment to achieve financial management returns. The system is used to collect a variety of data from paperwork and forms to

streamline information administration and optimize building maintenance. It is an all-in-one piece of software that will organize and make it simple to track the maintenance management database [44].

Table 3
 Importance of Adaptation Modern Computerized Building Maintenance Management Systems (BMMS)

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Ms Word	/	/	/	/		/	/			/	/	/
Ms Excel			/	/	/	/			/	/		
CMMS	/	/	/	/	/	/	/	/	/	/	/	/
CAFM	/	/			/	/	/	/	/		/	/
EAM	/	/	/	/	/	/			/	/		
mySPATA	/	/	/	/	/			/				/
SCADA			/	/	/	/	/	/	/			
BAS									/	/	/	/
E-aduan	/	/		/	/	/	/	/				

Source: Interview Session with 12 respondents (Author's work)

note

- CMMS - software for managing maintenance
- CAFM - software for facilities and building management
- EAM -software for asset management
- mySPATA - system database of data inventory for facilities
- SCADA - software for monitoring and controlling building systems
- BAS - software for detecting the performance of heating, ventilation and air conditioning system
- E-aduan - database for managing complaints

A CMMS mainly deals with maintenance operations such as work orders, preventive maintenance, and inventory [45]. Since BMMS enables centralized and well-organized data storage, this software will improve data management. Maintenance records, asset information, work orders, and historical data can all be accessed, updated, and analysed with ease, resulting in better decision-making and maintenance planning. Aside from that, modern computerized BMMS enables automated procedures such as work order production, scheduling, and assignment that show high attitudes toward technology adoption. This improves the maintenance process by minimizing manual errors and administrative demands on maintenance staff. As a result of these benefits, CMMS gained widespread acceptance.

The next software choice chosen by respondents is Computer Aided Facilities Management (CAFM) software, with nine (9) respondents, and Enterprise Asset Management (EAM) software, with (8) respondents over 12. According to Suhaimi *et al.*, [36] it is also used alternatively with computerized maintenance management systems (CMMS), integrated workplace management systems, and enterprise asset management software (EAM). Additionally, CAFM offers maintenance management features including routine maintenance and preventative maintenance, which cost a lower price than urgent repairs or even replacements. CAFM systems feature asset monitoring modules to help customers keep a close check on asset conditions in addition to maintenance scheduling and support Suhaimi *et al.*, [36].

On the other side, it will require managing all planned and unplanned maintenance work in order to prevent overlooking important details of the maintenance component. The result monitors incoming maintenance requests, produces maintenance schedules, tracks work in progress and

arranges maintenance work with outside contractors [46]. As a result, both of these applications will provide real-time monitoring and notifications. Computerized BMMS can connect to Internet of Things (IoT) sensors and monitoring devices to collect real-time data and track performance. This feature enables preventive maintenance, spotting possible problems before they become costly breakdowns. As a result, these respondents support the use of these technologies in building maintenance management systems in Malaysian strata buildings.

MySPATA, SCADA, and E-aduan received around half of the agreement from respondents, with seven (7) agreeing on each substance. This software is similar to an insider platform, and some data collecting may come from an outsider's issue complaint. Supervisory Control and Data Acquisition (SCADA) is a computer-based system for gathering and analysing real-time data to monitor and control equipment that deals with important and time-sensitive materials or events, according to Oleum Tech [47]. MySPATA and E-aduan software were used to manage citizen complaints regarding any defect or breakdown in government structures. It is also necessary to provide some detail when reporting a defect, and a proper or special unit will be dispatched to the location to perform some maintenance work.

Therefore, this contemporary BMMS can aid in ensuring adherence to building codes and professional standards. It makes it easier to create the reports and supporting materials needed for certifications, audits, and inspections. Additionally, it has communication tools that make it possible for building occupants, property managers, and maintenance crews to work more effectively together. Sharing notifications, status updates, and reporting is simple and improves communication effectiveness. As a result, it will make the task of the local government easier.

Building Automation System (BAS) received the fewest votes from respondents, receiving only four votes. It is a centralized system that enables the automated control, supervision, and administration of numerous building systems and pieces of equipment inside a facility. BAS is intended to improve energy efficiency, occupant comfort, building performance, and facility management operations [48]. From previous survey [49], stated that BAS only seek to increase building efficiency; any malfunction or system outage can cause disruptions in building operations and cause discomfort for occupants. Therefore, the majority of respondents did not concur that this software may be beneficial for BMMS for strata title properties in Malaysia.

Todd [49] also mentioned that this programme would somehow have limited system upgrades, limited functionality, and limited flexibility. Despite these drawbacks, facility managers can still improve building efficiency, optimize energy use, and increase occupant comfort by using BAS. Working with knowledgeable BAS suppliers, putting strong cyber security protections in place, training users, and performing routine maintenance and updates are common strategies used to address these problems. As a result, it might still be helpful at a particular BMMS.

4.4 Current Practices of Building Maintenance Management System (BMMS) in Strata Title Residential Property in Malaysia.

This section's discussion will be based on a quantitative approach to the questionnaire that was distributed to 125 respondents with a variety of backgrounds. Table 4 displays the demographic data for the 125 respondents in both frequency and percentage. This survey was conducted to determine whether conventional or modern computerized BMMS are still used in Malaysia nowadays. Table 5 and Chart 1 show that out of 95 respondents (76%) chose the conventional approach as the preferred way for BMMS in Malaysia today. Without the use of sophisticated automated control, this conventional method is the typical or standard approach to manually controlling and managing building systems. As a demonstration of this conventional approach, fill out an "assessment form"

according to Ismail [15]. Furthermore, adding to this, Ismail [20] stated that the customary method is regarded as a paper-based report or an ad hoc computational database for managing buildings.

Table 4
 Respondent positions demographic data

Position	Frequency (n=125)	Percentage (%)
Maintenance Officer	35	28.0
Building Manager	23	18.4
Building Technician	41	32.8
Building Executive	17	13.6
Administrative	6	4.8
Others	3	2.4

Source: Interview Session with 12 respondents (Author's work)

Table 5
 Current Practices of Building Maintenance Management System (BMMS) in Strata Title Residential Property in Malaysia

	N	%
Conventional	95	76
Modern Computerized	30	24

Source: Interview Session with 12 respondents (Author's work)

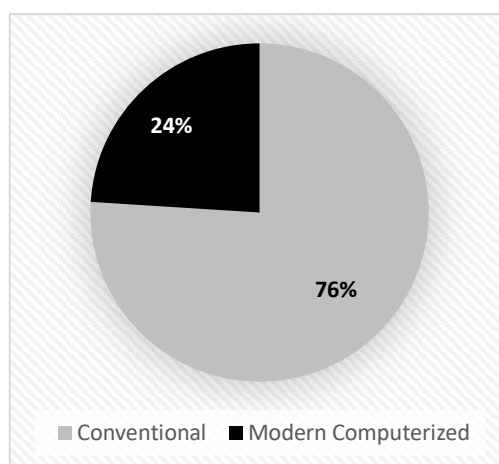


Fig. 1. Current Practices of Building Maintenance Management System (BMMS) in Strata Title Residential Property in Malaysia

The conventional method involves individually or in small subsystems controlling and monitoring each of the building's systems, including the HVAC, lighting, access control, and security. Managers and operators of the facility manually change settings, turn systems on and off, and react to alerts or

problems based on their observations or complaints from users. The standard approach, it seems, is unable to record long-term maintenance management reports claimed Ismail [15]. This is what distinguishes the process from contemporary computerized systems, as it takes a lot less time and labour.

Building maintenance management has the potential to process and communicate an enormous quantity of information efficiently due to the development of information and communication technology (ICT). Only 30 respondents (24%), as shown in Table 5, concur that the BMMS now uses modern computerization. It is evident that when compared to the conventional approach, Modern Computerized has just a modest group consensus (Chart 1). However, a recent innovation that includes a strategy, methodology, and instruments for corrective and preventative management is the concept of a modern computerized system stated Ismail [15]. Besides that, Ismail [20] also believed that maintenance management procedures for BMMS with strata title properties are more effective when they are modern computerized.

4.5 Best Practise to Optimize BMMS via Modern Computerized in Strata Title Property.

This discussion of questionnaire survey findings is included in the ranking of best practices for optimizing BMMS. The full RII value was presented in Table 6 with RII values ranging from 0 to 1, with the greatest RII showing the most significant attribute factor to the best practice with Rank 1 and the second-most important attribute with Rank 2 and so on. The highest and lowest percentages of respondents who agreed on the optimal practice for optimizing BMMS were 86.2% and 77.1%, respectively. The findings indicate that improving basic knowledge of the current computerized is the greatest attribute of the best practice of BMMS, with 86.2% of respondents agreeing on it. This was followed by the obligation to hire adequate technical skills. Chong *et al.*, [26] also stated that, in order to optimize a modern computerized BMMS, the hired management team must be a skilled individual or technician, or at the very least, someone who understands the fundamentals of these systems, in order to increase trust between the owner and management bodies.

Table 6
 Best Practices to Optimize BMMS via Modern Computerized in Strata Title Property

Ranking	Attributes	RII Value	Weightage (%)
1	Improve the basic knowledge of modern computerized	0.862	86.2
2	Fulfil the requirement to hire competent technical skills	0.842	84.2
3	Provide intensive training to introduce the software or tool for maintenance	0.837	83.7
4	Hire an expert consultant to be hands-on with the maintenance software	0.834	83.4
5	Controlling the budget allocation for maintenance of the modern computerized system	0.830	83.0
6	Encourage the implementation of basic software applications for maintenance	0.824	82.4
7	Efficient Management Body-Subsidiary management	0.814	81.4
8	Systematic monitoring of documentation via computerized	0.808	80.8
9	Coordination of maintenance work orders using a database	0.802	80.2
10	Produce the specific maintenance planning in detail	0.798	79.8
11	Prepare a basic database to record complaints	0.784	78.4
12	Data entry of the previous maintenance records in simple Excel	0.771	77.1

Source: Author's work

This was followed by another attribute with an RII value of 0.837, to provide intense training for implementing the software, tool, or maintenance, and to recruit expert consultants to hand on the maintenance software with an RII value of 0.834. In ranking 5, with controlling budget allocation of maintenance modernized computerized system with RII value of 0.830 and encouraging the implementation of basic software application for maintenance with RII value of 0.824, and encouraging the implementation of basic software application for maintenance with RII value 0.824 in ranking 6. In their studies, Suhaimi [36] indicated that regulating financial allocation may allow certain buildings to agree to the adoption of some basic software to optimize Modern Computerized strata property in Malaysia.

The next attribute of the best practice with their RII Value is efficient management body-subsidary management [0.814], systematic monitoring of documentation via computerized [0.808], coordination of maintenance work order using database [0.802], producing the specific maintenance planning in detail [0.798], prepare the basic database to record complaint [0.784] and data entry the previous maintenance record in simple excel [0.771]. This RII Value indicated that respondents believe that having expertise and experienced management bodies, will allow any system will work in its best way accordingly.

5. Limitation and Area for Further Research

Even though the scope of this study is limited to the implementation of a contemporary computerized in-building maintenance management system (BMMS) in strata-title properties in Peninsular Malaysia, it emphasizes more in-depth both the challenges and benefits of the BMMS practice over the conventional method. However, this study solely concentrated on West Malaysia, which has more urban areas. The results might not accurately reflect Malaysia's wide variety of strata titles and geographical areas. Future research might identify the potential challenges of establishing a computerized system, estimate the long-term influence on the value of the property, or compare the efficacy of various computerized BMMS solutions in Malaysia.

6. Conclusion

This study investigates how effective maintenance management can result in a variety of advantages, such as reduced downtime, increased equipment reliability, prolonged asset lifespans, improved safety, and cost savings. To overcome these concerns, better maintenance practices and a culture of regular upkeep and maintenance are required. Building owners and management should prioritize maintenance budget allocation, invest in training and upgrading maintenance personnel's abilities, and apply current technological solutions to improve maintenance operations and communication. Technology, such as computerized maintenance management systems (CMMS) and the Internet of Things (IoT), is frequently used in modern maintenance management to expedite procedures and enable data-driven decision-making. Modern computerized BMMS technologies provide substantial benefits for Malaysian strata-title residential complexes. Property developers and residents can benefit from greater energy efficiency, increased occupant comfort, simpler building administration, and cost savings by implementing these modern solutions.

Furthermore, these BMMS demonstrate the significance of understanding our sophisticated technology in terms of leading for the best practice to optimize BMMS via Modern Computerized in Strata Title Residential in Malaysia. Once the competence is established, it will alleviate the concerns of novice management bodies or the Joint Management Team (JMT). Moreover, this JMT can come from any business or public sector organization. Furthermore, government agencies can play a role

by offering incentives or financial assistance to encourage building owners to invest in proper maintenance practices and by enforcing building maintenance and safety legislation.

Improved coordination among stakeholders, such as building management, occupants, and outside maintenance contractors, can also lead to more successful building maintenance management in Malaysia. As a result of this comprehensive building maintenance management, it is hoped that the cost of any emergency maintenance will be decreased and that all unit owners will have the most comfortable living unit possible.

7. Acknowledgments

The authors would like to dedicate their heartiest thanks to the participants of the present study, the Public Works Department (PWD), the Construction Industry Development Board (CIDB), the Local Authority (LA) and University Sains Malaysia (USM) for providing support and assistance. This paper was funded by the School of Housing, Building and Planning, Universiti Sains Malaysia.

References

- [1] Ali, Azlan Shah, Shirley Jin Lin Chua, and D. B. Ag Ali. "Issues and challenges faced by government office buildings in performing maintenance work." *Jurnal Teknologi* 78, no. 11 (2016): 11-23. <https://doi.org/10.11113/v78.8363>
- [2] Azman, A. J. "RM2.2 Juta Ganti Lif Rosak" | *BH Online*, August 29, 2019. <https://www.bharian.com.my/berita/wilayah/2019/08/601388/rm22-juta-ganti-lif-rosak>.
- [3] Liat Choon, Tan, Muhamad Uznir Ujang, Thoo Ai Chin, Abu Hasan Mohd Hanif, and Shaidatul Nur Wahidah Muhamad Shah. New strata rights in Malaysia, 2016. <https://people.utm.my/tlchoon/files/2015/08/38-New-Strata-Rights-in-Malaysia-SIMPI-2016.pdf>.
- [4] Azian, F. U. M., N. Yusof, and E. M. Kamal. "Problems in high rise residential building: From management perspective." In *IOP Conference Series: Earth and Environmental Science*, vol. 452, no. 1, p. 012087. IOP Publishing, 2020. <https://doi.org/10.1088/1755-1315/452/1/012087>
- [5] Khalid, Mohamad Sukeri, Abdul Halim Ahmad, Rozana Zakaria, Rozita Arshad, and Yusuf Pon. "Towards Strengthening Building Maintenance and Management by Joint Management Bodies (Jmb) in High Rise/Stratified Housing in Malaysia." *International Journal of Social Science and Humanity* 7, no. 4 (2017): 239. <https://doi.org/doi:10.18178/ijssh.2017.7.4.827>
- [6] Dahlan, Farhan Md, Asniza Hamimi Abdul Tharim, Ashrof Zainuddin, and Mohd Hasrol Haffiz Aliasak. "Factors for Effective Repair and Maintenance Services in the Housing Industry: A systematic literature review." *Asian Journal of Environment-Behaviour Studies* 5, no. 15 (2020): 17-28. <https://doi.org/10.21834/aje-bs.v5i15.358>
- [7] Ismail, Zul-Atfi. "Improving maintenance management practices for building facility." *Journal of Construction Engineering and Project Management* 4, no. 3 (2014): 21-32. <https://doi.org/10.6106/jcepm.2014.4.3.021>
- [8] Ahmad, Tengku Noradeena Tengku, and Siti Zaleha Abd Rasid. "Implementation of Building Maintenance Management System in an Organization." *Journal of Advanced Research in Technology and Innovation Management* 1, no. 1 (2021): 1-8. <https://akademiabaru.com/submit/index.php/jartim/article/view/4395>
- [9] Zeni, Kassim Slim, and Geraldine John Kikwasi. "Factors affecting maintenance cost of public buildings: case study of Tanzania Buildings Agency and National Housing Corporation." *International Journal of Building Pathology and Adaptation* (2021). <https://doi.org/10.1108/ijbpa-08-2021-0107>
- [10] Eisner, C. "What Is Building Maintenance ?." *Getmaintainx.com*, June 20, 2023. <https://www.getmaintainx.com/learning-center/>
- [11] Wilke, Ethan. "What Is Building Maintenance Management?" *FTMaintenance CMMS*, September 1, 2023. <https://ftmaintenance.com/maintenance-management/what-is-building-maintenance-management/>
- [12] Breesam, Hatem K., and Zahraa A. Jawad. "Factors affecting maintenance procedures for public buildings." In *IOP Conference Series: Materials Science and Engineering*, vol. 1090, no. 1, p. 012120. IOP Publishing, 2021. <https://doi.org/10.1088/1757-899x/1090/1/012120>
- [12] Alves Tenório de Moraes, Gabriela, and Alberto Casado Lordsleem Júnior. "Building maintenance management activities in a public institution." *Engineering, Construction and Architectural Management* 26, no. 1 (2019): 85-103. <https://doi.org/10.1108/ecam-01-2018-0024>
- [13] Ofori, Isaac, P. Duodu, and Stanley Owuotey Bonney. "Establishing factors influencing building maintenance practices: Ghanaian perspective." *Journal of economics and sustainable development* 6, no. 24 (2015): 184-193.
- [14] Bin Ismail, Zul-Atfi. "Development of a defect monitoring system (DMOSYS) for building maintenance at polytechnic." *Facilities* 36, no. 7/8 (2018): 403-422. <https://doi.org/10.1108/f-09-2016-0090>

- [15] Besiktepe, D., M. E. Ozbek, and R. A. Atadero. "Computerized Maintenance Management System Data Utilization in Facility Management." In *Proceedings of the 6th International Project and Construction Management Conference (IPCMC2020)*, Istanbul Technical University, Istanbul, Turkey, pp. 12-14. 2020.
- [16] Ebekozi, Andrew, Mohamad Shaharudin Samsurijan, Clinton Aigbavboa, and Andrew I. Awo-Osagie. "Developing a framework for building maintenance: a case study of Malaysia's low-cost housing via soft system methodology." *International Journal of Building Pathology and Adaptation* (2022). <https://doi.org/10.1108/ijbpa-04-2022-0055>
- [17] Haniza Fakhrudin, Isma, Mohd Zailan Suleiman, and Roslan Talib. "The need to implement Malaysia's Building and Common Property Act 2007 (Act 663) in building maintenance management." *Journal of Facilities Management* 9, no. 3 (2011): 170-180. <https://doi.org/10.1108/1472596111148081>
- [18] Ogunde, Ayodeji O., Rachael Ayodele, Opeyemi Joshua, David O. Nduka, Abisola Ogunde, Kunle E. Ogundipe, Babatunde F. Ogunbayo, and Adekunle M. Ajao. "Data on factors influencing the cost, time performance of the Industrialized Building System." *Data in brief* 18 (2018): 1394-1399. <https://doi.org/10.1016/j.dib.2018.04.036>
- [19] Ismail, Zul-Atfi Bin. "Towards a BIM-based approach for improving maintenance performance in IBS building projects." *Engineering, Construction and Architectural Management* 28, no. 5 (2021): 1468-1490. <https://doi.org/10.1108/ecam-07-2020-0508>
- [20] García, S. Gallego, and M. García García. "Industry 4.0 implications in production and maintenance management: An overview." *Procedia manufacturing* 41 (2019): 415-422. <https://doi.org/10.1016/j.promfg.2019.09.027>
- [21] Tortorella, Guilherme Luz, Flavio S. Fogliatto, Paulo A. Cauchick-Miguel, Sherah Kurnia, and Daniel Jurburg. "Integration of industry 4.0 technologies into total productive maintenance practices." *International Journal of Production Economics* 240 (2021): 108224. <https://doi.org/10.1016/j.ijpe.2021.108224>
- [22] Bucoń, Robert, and Michał Tomczak. "Decision-making model supporting the process of planning expenditures for residential building renovation." *Technological and Economic Development of Economy* 24, no. 3 (2018): 1200-1214. <https://doi.org/10.3846/20294913.2016.1213208>
- [23] Róka-Madarász, Livia, Levente Mályusz, and Péter Tuczai. "Benchmarking facilities operation and maintenance management using CAFM database: Data analysis and new results." *Journal of building engineering* 6 (2016): 184-195. <https://doi.org/10.1016/j.jobe.2016.03.007>
- [24] Rabe, Noor Suzilawati, Mariana Mohamed Osman, Muhammad Faris Abdullah, Zakiah Ponrahono, and Izlan Fitri Abdul Aziz. "Issues faced by tenants in high-rise strata residential: case study of Klang valley." *Planning Malaysia* 19 (2021). <https://doi.org/10.21837/pm.v19i19.1070>
- [25] Chong, Kim Guan, Sabariah Eni, and Edie Ezwan Mohd Safian. "Impact of Having an Early Briefing among Residents/Owners in Reducing Strata Disputes in Malaysia." *International Journal of Real Estate Studies* 15, no. S1 (2021): 18-26. <https://doi.org/10.11113/intrest.v15ns1.113>
- [26] Ministry of Housing and Local Government. "Malaysia National Report 2022: The Implementation of the New Urban Agenda [Special Report]". *Putrajaya, Malaysia: Ministry of Housing and Local Government*. (2022). Retrieved from Ministry of Housing and Local Government website: https://www.kpkt.gov.my/kpkt/resources/user_1/GALERI/PDF_PENERBITAN/BUKU_LAPORAN_TAHUNAN/BUKU_LAPORAN_NUA_MALAYSIA_2022.pdf?mid=703
- [27] Mohamad, Nor Asiah. "Developing a model for pre-action dispute resolution for strata dispute management in Malaysia." *UUM Journal of Legal Studies* 6 (2015): 97-104. <https://doi.org/10.32890/uujls.6.2015.4592>
- [28] Kapoor, D.R., & Saigal, P. "Research Methodology: Methods and Techniques. Rajouri Garden, New Delhi": REGAL Publications. 2013
- [29] Hesse-Biber, S. N., and Leavy, P. (2011). *The Practice of Qualitative Research*. 2nd edition. Thousand Oaks, CA: SAGE Publications.
- [30] Dosm. Department of Statistics Malaysia. Accessed August 18, 2023. <https://www.dosm.gov.my/portal-main/release-content/c4c44586-8b7d-11ed-96a6-1866daa77ef9>.
- [31] Che-Ghani, Nor Zaimah, Nik Elyna Myeda, and Azlan Shah Ali. "Efficient operation and maintenance (O&M) framework in managing stratified residential properties." *Journal of Facilities Management* (2023). <https://doi.org/10.1108/jfm-10-2021-0124>
- [32] De Vaus, D.A. (1996). *Surveys in Social Research*, 4th ed. University College of London Press, London.
- [33] Bari, Nor Azmi Ahmad, Rosnah Yusuff, Napsiah Ismail, Aini Jaapar, and Rizan Ahmad. "Factors influencing the construction cost of industrialised building system (IBS) projects." *Procedia-Social and Behavioral Sciences* 35 (2012): 689-696. <https://doi.org/10.1016/j.sbspro.2012.02.138>
- [34] Holt, Gary D. "Asking questions, analysing answers: relative importance revisited." *Construction Innovation* 14, no. 1 (2014): 2-16.

- [35] Shuhaimi, Ainul Ashiqin Ahmad, Mariana Mohamed Osman, Noor Suzilawati Rabe, Sh Mazlina Syed Khuzzan Alhabshi, and Damira Aripin. "LOW-COST STRATA MAINTENANCE ISSUES AND COST IMPACT." *PLANNING MALAYSIA* 21 (2023). <https://doi.org/10.21837/pm.v21i26.1276>
- [36] Yusoff, Wan Zahari Wan, Mohd Hafizal Ishak, and Muhammad Azwan Sulaiman. "Penyelenggaraan Bangunan dalam Pengurusan Fasilitas: Elemen Mempengaruhi Kualiti Amalan Penyelenggaraan Bangunan." *Journal of Social Transformation and Regional Development* 4, no. 1 (2022): 18-26. <https://doi.org/10.30880/jstard.2022.04.01.003>
- [37] Musa, Zairul N., Abdul G. Sarip, Ainoriza Mohd Aini, W. N. A. W. A. Aziz, Noor Rosly Hanif, Z. Al-Sadat, and P. A. Tedong. "Issues in managing vertical residential building in Malaysia: homeowners' perspective." *Korean Housing Society Conference Proceedings* (2015): 583-590.
- [38] Fortino, F. "Publication - Best Practices for Managing Residents' Renovation Requests." Anderson Kill P.C. - Attorneys and Counselors at Law, November 28, 2017. <https://www.andersonkill.com/Publication-Details/PublicationId/1593>
- [39] Mohamad, Nor Asiah. "An Exploratory Study on Strata Residential Properties Problems in Peninsular Malaysia and How They Are Resolved." *Korean Housing Society International Conference Proceedings* (2015): 161-161. <https://doi.org/10.6107/jkha.2015.26.6.053>
- [40] Puķite, Iveta, and Ineta Geipele. "Different approaches to building management and maintenance meaning explanation." *Procedia Engineering* 172 (2017): 905-912. <https://doi.org/10.1016/j.proeng.2017.02.099>
- [41] Zahid Rasool, Waqar Tariq, Ir. Dr. Othman, and Dr. Jasronita Jasni. "What Building Management System Can Offer to Reduce Power Wastage Both Social and Economical: Brief Discussion by Taking Malaysian Power Infrastructure as a Sample." *The SIJ Transactions on Advances in Space Research & Earth Exploration* 7, no. 1 (2019): 1–5. <https://doi.org/10.9756/sijasree/v7i1/03030060402>
- [42] Sean Peek. "How to Build a Microsoft Document Management System." business.com, May 11, 2023. <https://www.business.com/articles/microsoft-document-management-system/>
- [43] Ismail, Zul-Atfi, M. Abdul Rahim, and Z. Md Ghazaly. "BIM and CMMS for IBS building maintenance in Malaysia." In *IOP Conference Series: Earth and Environmental Science*, vol. 476, no. 1, p. 012012. IOP Publishing, 2020. <https://doi.org/10.1088/1755-1315/476/1/012012>
- [44] Agarwal Kriti. "What Is CAFM? Computer-Aided Facility Management in 2023." SelectHub raquo, May 7, 2023. <https://www.selecthub.com/cmms/facility-management-cmms/computer-aided-facilities-management/>
- [45] Limble CMMS. "Enterprise Asset Management (EAM): A Functional Guide." Limble CMMS, August 29, 2023. <https://limblecmms.com/enterprise-asset-management-eam/>
- [46] Oleum Tech. "What Is SCADA? Supervisory Control and Data Acquisition." OleumTech, July 14, 2020. <https://oleumtech.com/what-is-scada>.
- [47] Author ADF Team. "All about Building Automation System (BAS)." ADF Technologies, May 5, 2021. <https://www.adftech.com.my/all-about-building-automation-system-bas/>
- [48] Todd, Steve. "What Is a Building Automation System (BAS)? (Functions and Benefits)." Open Sourced Workplace, August 4, 2023. <https://opensourcedworkplace.com/news/what-is-a-building-automation-system-bas-functions-and-benefits>