EMERGING TECHNOLOGIES FOR MAINTENANCE MANAGEMENT OF RESIDENTIAL AND COMMERCIAL HIGH-RISE BUILDINGS: BARRIERS AND STRATEGIES FOR IMPROVEMENT

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ABSTRACT

The rapid development in the innovation of technologies facilitates the facilities management (FM) industry in terms of efficiency and sustainability. In recent years, the adoption of emerging technologies has been attracting a lot of interest among stakeholders. This is because Malaysia is in the process of transforming towards smart facilities management (Smart FM) from traditional facilities management (TFM). Therefore, this paper prepared to present the outcome of the study on the types of emerging technologies used, drivers, barriers and strategies towards the adoption of smart FM of residential and commercial high-rise buildings in Klang Valley. A semi-structured interview with facilities management (FM) professionals was conducted to identify the types of emerging technologies used in the Malaysian FM industry, drivers, barriers as well as strategies for adopting the advanced technologies for maintenance management of high-rise buildings. From the study, the FM professionals validated that Building Information Modelling (BIM) is the most effective and efficient technology to be used in the maintenance management of residential and commercial high-rise buildings. The emerging technologies help to increase building efficiency and are suitable for long-term investment planning. However, high adoption costs and the limited number of experts on the technologies in Malaysia are the major barriers. Despite the barrier, the significant strategy was found to be effective in improving the adoption through training and workshops. Thus, this paper provides a comprehensive understanding of emerging technologies and marks a turning point for an organisation to consider adoption.

Keywords: Emerging technologies, Maintenance management, High-rise buildings, Strategies

1.0   INTRODUCTION

In the new global economy, the National Construction Policy (NCP) 2030 stresses the transformation of the whole construction sector towards the digitalization era and achieving inclusive and sustainable national development by 2030. Hence, exposure to the adoption of emerging technologies has been shown to be related to endorsing the Construction Industry Development Board (CIDB) Strategic Plan. According to the CIDB Malaysia (2020), Building Information Modelling (BIM), Autonomous Construction, Augmented Reality (AR) and Virtualisation, Cloud and real-time collaboration, Big Data (BD) and Predictive Analysis, Internet of Things (IoT), Blockchain and Artificial Intelligence (AI) are the emerging

technologies defining Malaysia's construction 4.0 that closely related towards optimizing maintenance management of high-rise buildings in Klang Valley. Besides that, another significant aspect of the adoption of emerging technologies in the FM industry is to fulfil the Environmental, Social, and Governance (ESG), achieve the Sustainable Development Goals (SDGs) 6,7,9 and 11 as well as establish the Sustainable Facilities Management (SFM).

There is a growing body of literature that recognises some facilities management (FM) companies and contractors in Malaysia are still practising traditional facilities management (TFM) systems that involve reactive maintenance, manual process of maintenance management, space management, and record-keeping (Myeda & Pitt, 2014). A study by Hou et al. (2024) proved that TFM leads to serious problems because it is time-consuming, high cost, lacks real-time data, requires more manpower, and increases downtime. The adoption of emerging technologies in facilities management of high-rise buildings would likely overcome the problem because it provides real-time data, automated workflow, predictive analysis, and faster decision-making. The paper is prepared to present the outcome of the study on the development of emerging technologies and their significant drivers, barriers, as well as strategies to adopt smart FM in Malaysia. The objectives of this paper are as follows:

1. To identify the types of emerging technology used for optimizing maintenance management of residential and commercial high-rise buildings in Klang Valley.
2. To determine the drivers and barriers in utilizing emerging technologies for maintenance management of residential and commercial high-rise buildings in Klang Valley.
3. To identify strategies for improving the utilization of emerging technologies for maintenance management of residential and commercial high-rise buildings in Klang Valley.

2.0 LITERATURE REVIEW

2.1 Facilities Management in Malaysia

In the new global economy, Construction Strategic Plan 4.0 (2021-2025) stresses the process of implementing modern technology to encourage the digitalization of the facilities management industry. FM in Malaysia has fallen behind the technological curve due to a lack of technological advancement compared to other developed countries (Bakar & Kamaruzzaman, 2022). The development of smart FM will be a remarkable approach as it works concurrently with the goals of future facility management (Foo, 2024). Thus, there is a strong possibility that emerging technologies will help Malaysia achieve sustainable facilities management (SFM) by 2030, as mentioned in the National Construction Policy (NCP) 2030.

2.1.1 Traditional Facilities Management (TFM)

Traditional FM (TFM) involves the management of a facility by using manual processes such as paper-based systems, spreadsheets, and phone calls (KJ Technical Services Sdn. Bhd, 2023). Nowadays, TFM is found to be an inefficient way of managing high-rise buildings as it is time-consuming, space-consuming, and costly (Alam, 2021). A previous study of TFM conducted by Zhan et al. (2023) reveals that TFM is still using the reactive maintenance approach to sustain

building performance which most of the information systems are Computer-Aided Facility Management (CAFM). The Nest Integrated Facilities Management (Nest IFM) (2023) further explains that TFM lacks technology integration, which leads to slower response times, manual tracking, and a lack of real-time insight. In Malaysia's context, TFM is still widely used in the FM industry among the key players.

2.1.2 Smart Facilities Management (Smart FM)

Hou (2023) defines Smart FM as the integration of systems, processes, technologies, and personnel to enhance building facilities. Al-Kasasbeh et al. (2021) mention that traditional FM offers inefficient remote work and slow information updates. The implementation of smart FM influences the improvement of traditional FM and achieving sustainability in the built environment by enhancing workplace productivity and occupant well-being, as well as saving cost and time. Recently, the Malaysian government has taken into account the system to enhance the assets and facilities management to develop and transform the traditional FM into smart FM (Awang et al., 2017).

2.1.3 Sustainable Facilities Management (SFM)

Sustainable Facilities Management (SFM) is closely related to Smart FM, as both contribute towards building efficiency and eco-friendly buildings. Opoku and Lee (2022) are more concerned that SFM will help minimise energy, water, and waste in the maintenance and operation of buildings, create net zero energy buildings, and integrate data-driven technologies. Zakaria et al. (2018) created a SFM model consisting of social, environmental, and economic aspects that are designed to fulfil the aim of Smart FM and maintenance management. SFM and Smart FM shared the same target, which is to save costs, help in the decision-making process, access data using technology, and maximise efficiency and sustainability in energy management (Okoro, 2023). Thus, Malaysia aims to achieve SFM by adopting emerging technologies, as it shares the same purpose of increasing building performance and efficiency.

2.2 Maintenance Management of high-rise buildings

Abbood et al. (2021) pointed out that most residential and commercial high-rise buildings can be determined by their overall height exceeding 36 meters or the number of floors that exceed 12 floors. On top of that, high-rise buildings require maintenance management which refers to a systematic process of planning, organising, operating, and handling the maintenance activities of assets, including the management of resources (Ogunbayo et al., 2022). Maintenance management is significant towards high-rise buildings in terms of safety assurance, regulation compliance, energy efficiency, cost-effectiveness, user satisfaction, and property value. Au-Yong et al. (2019) identify the routine maintenance for residential and commercial high-rise buildings are water supply system, lift system, power supply system, security system, cleaning services, firefighting system, and air conditioning system. CIDB Malaysia (2020) listed out the issues and challenges of implementing maintenance management for high-rise buildings in Malaysia are unavailability of building maintenance policy, high maintenance cost, inefficient maintenance management, and unsatisfied end-users. However, these issues can be overcome by establishing proper planning, adopting emerging technologies, conducting proper routine maintenance, and enforcing building

maintenance policies. The following sub-sections will discuss the type of maintenance management that has been practised in the facilities management industry.

2.2.1 Reactive maintenance

Sari (2018) noted that reactive maintenance is a maintenance process that is performed once the breakdown occurs. In Malaysia, most facility management organisations still apply reactive maintenance strategies as they offer lower upfront costs and less manpower. Au-Yong et al. (2019) pointed out that the majority of condominiums conducted the maintenance works on a reactive basis because it offers lower upfront costs and less manpower to save costs for short-run planning. However, the cost of reactive maintenance can be absolutely higher when the breakdowns, defects, and repairs become more frequent in the building.

2.2.2 Preventive maintenance

Preventive maintenance is maintenance carried out at a predetermined time or to other prescribed criteria with the intention of reducing the likelihood of an item not meeting an acceptable condition (Yahya & Ibrahim, 2011). Chua et al. (2018) claimed preventive maintenance as an efficient maintenance strategy in order to guarantee the constant and effective usage of building systems and their components. It is believed preventive maintenance is one of the best maintenance management strategies because it reduces the maintenance cost for major damage, improves asset safety, and minimises downtime. For instance, Brazil utilises BIM during preventive maintenance to identify potential issues, damages, errors, and defects in high-rise buildings.

2.2.3 Predictive maintenance

Predictive maintenance is the process of analysing data in order to predict potential building failures through monitoring and processing, diagnosis and prognosis, and maintenance decision-making (Zonta et al., 2020). Furthermore, predictive maintenance involves data collection and analysis from sensors, historical maintenance records, and machine performance data and benefits maintenance management in terms of reducing equipment downtime, improving equipment reliability, lowering maintenance costs, and reducing the risk of damages (Gispert et al., 2023). By drawing the concept of predictive maintenance, Zonta et al. (2020) mention in their findings that predictive maintenance allows them to predict trends, behaviour patterns, and correlations in order to enhance the decision-making process for the maintenance task, namely preventing downtime, by foreseeing possible failures in advance.

2.3 Emerging Technologies

There are several types of emerging technologies that have been adopted by the facilities management (FM) practitioners for improving their maintenance management practices (Matarneh et al., 2019; Olimat et al., 2023). Table 1 presents in summary the outcome of review of the emerging technologies and their functions, which have been applied to improve the facilities management practice.

Table 1: Types of emerging technologies used in facilities management

Types	Function
Building Information Modelling (BIM)	Improve space management, streamline maintenance works, ensure efficient use of energy, undertake economical retrofits and renovations, and enhance lifecycle management (Matarneh et al., 2019).
Wireless Sensor Network (WSN)	Monitor and control the building's functions, such as HVAC, security, and lighting systems, from its environment by accessing the real-time data collection process (Bal, 2012).
Internet of Things (IoT)	Collect real-time information on the condition of facilities remotely, forecast the risk status of facilities, and recommend a critical decision-making solution (Sidek et al., 2022).
Information Communication Technology (ICT)	Improve information management, supply chain activities, and communication in FM by using email, maintenance management software, computer-aided facilities management (CAFM), building energy management (BEM), and agile software (Aziz et al., 2016).
Digital Twin (DT)	Optimise building lifecycle management by estimating and analysing dynamic changes. It integrates virtual information models with real-time data, enhancing decision-making from project initiation to demolition (Ozturk, 2021).
Geographic Information System (GIS)	Provides real-time map-based data to the facilities management teams in order for them to find asset information, report critical issues, make data-driven decisions, and monitor facility operations (Young, 2023).
Augmented Reality (AR)	Identify parts involved in the maintenance activity, measure conductor current and component temperatures, display technical paperwork, and display unforeseen components behind the walls, furniture, ceiling, and floor (Sadeghie, 2024).
Unmanned Aerial Vehicles (UAV)	Access real-time data on the inaccessible parts of high-rise buildings in a lower-cost and lower-risk approach, as well as help to perform maintenance and security activities by capturing images and video (Wood, 2020).
Artificial Intelligence (AI)	Forecast maintenance needs, enhance the security of buildings with AI-powered surveillance systems, analyse space utilization and optimization, and reduce carbon footprints by monitoring building sustainability in terms of carbon emissions, energy usage, water usage, and waste management (Datta, 2023).
Big Data (BD)	Streamline labour-intensive maintenance functions and expand sector operations into higher value-added activities. BD is automating maintenance activities, work orders, and energy management in order to reduce costs (Konanahalli et al., 2018).

2.4 Drivers of Utilizing Emerging Technologies for Optimizing Maintenance Management of High-Rise Buildings in Klang Valley

Smart FM, incorporating emerging technologies and innovative business practices is expected to significantly improve the future facilities management industry especially for high-rise

buildings. It enhances cost-effectiveness, energy efficiency, and safety for building users, while also contributing to sustainable built environments (Zhan et al., 2023). Moreover, it improves asset performance, allows for rapid response time, and meet government standards (Alam, 2021; Okoro, 2023). Ambient technology, such as AR, can enhance space utilization, workplace experience, and occupant comfort (Fairchild, 2019).

2.5 Barriers of Utilizing Emerging Technologies for Optimizing Maintenance Management of High-Rise Buildings in Klang Valley

Researchers have identified barriers to the adoption of smart FM, including high costs, lack of skills, poor data management, financial capability, and time (Hamid et al., 2021; Durdyev et al., 2021; Sulaiman et al., 2021). New barriers include lack of standards, guidelines, government support, cybersecurity risks and technological changes (Sari, 2018). The Nigerian FM industry faces insufficient awareness of BIM integration, lack of legal frameworks, limited knowledge, poor acceptance, and resistance to change (Okwe et al., 2022).

2.6 Strategies to Improve the Utilization of Emerging Technologies for Maintenance Management of High-Rise Buildings in Klang Valley.

The Malaysian FM market is experiencing a 5.54% compound annual growth rate (CAGR), necessitating a maintenance strategy to increase by 2028 as reported by Mordor Intelligence (2023). To achieve this, Malaysia is focusing on creating a 5G ecosystem for buildings, satellites, networking, and smart automation. According to Yahya and Ibrahim (2012), the Maintenance Achievement Index (MAI) can be developed to benchmark high-rise building maintenance performance. Next, the most effective strategies for the adoption of smart technologies in the construction industry are the training of a skilled construction workforce, the provision of government incentives, and communication management (Hwang et al., 2022). The government is also implementing policies to support Construction Revolution 4.0 in the FM industry, enhancing the life cycle of buildings (Hamid et al., 2021).

3.0   METHODOLOGY

Yahya and Ibrahim (2012), Awang et al. (2017), and Hamid et. al (2021) show that the adoption of emerging technologies for maintenance management of residential and commercial high-rise buildings is very rare and rudimentary in Malaysia. Hence, a qualitative research strategy is adopted in this study to confirm this statement. Also, a semi-structured interview was conducted to gather information and opinions from the FM professionals based on a set of criteria. This approach helps to obtain further in-depth information on the usage of emerging technologies for the maintenance management of high-rise buildings. The criteria of the respondents' selection are i) must have a few years' experience in the construction industry, ii) more than one (1) year of experience in the FM industry, and iii) possess knowledge or skills of using emerging technologies. An open-ended question was used to allow respondents to elaborate on their opinions and provide recommendations on the research topics. Meanwhile, the close-ended questions using the Likert scale act as a rating tool to measure the respondent's level of agreement in a convenient and faster way. However, in determining the types of emerging technologies used in the maintenance management of high-rise buildings, frequency distribution was used to identify the ranking of emerging technologies used in the Malaysian FM industry based on the multiple-choice

questions. Hence, this combination assists the researcher in analysing the data collected and presented in a structured manner. Then, the rank of the drivers, barriers and strategies have been analysed using descriptive analysis based on the mean score and standard deviation. The highest mean score represents the higher rate of agreement towards the statement. Meanwhile, the lower standard deviation indicates the higher accuracy of data to the mean.

4.0   RESULTS

4.1 Interviewees' Background

Table 2 summarises the interviewees' background consists of FM professionals that come from different organisations. All interviewees have involved with the maintenance management of residential and commercial high-rise buildings in Klang Valley area. Thus, this led to the conclusion that the interviewees engaged in the study met the specified criteria of respondents' selection.

Table 2: Interviewees Background

Interviewee	Company	Position	Years of experience	Type of high-rise
A	Sunway Property and Facilities Management	Property Executive	12	Residential & Commercial
B	Sunway Property and Facilities Management	Manager	2	Residential
C	APM Property Management Asia	Senior Building Engineer	7	Residential & Commercial
D	Sunway Property	Senior Engineer	17	Commercial
E	Fathaos Enterprise	Director	25	Residential & Institutional
F	Besteel Engtech	Quantity Surveyor	5	Residential
G	Satar Empire	Quantity Surveyor	1	Residential

4.2 Types of emerging technologies

Table 3: Emerging Technologies used in Malaysian FM industry.

Types	Frequency	Percentage (%)	Rank
Building Information Modelling (BIM)	7	36.8	1
Big Data (BD)	3	15.8	2
Artificial Intelligence (AI)	2	10.5	3
Internet of Things (IoT)	2	10.5	4
Geographic Information System (GIS)	2	10.5	5

The high demand for the types of advanced technology used in an organisation for the purpose of maintenance management of high-rise buildings in Klang Valley is BIM at 36.8% followed by BD system at 15.8%. The interviewees added that some organisation practicing BIM such as Building Science Technology (BST), Building Management System (BMS) as well

as Computerised Maintenance Management System (CMMS). Moreover, AI, IoT as well as GIS have a similar percentage, which is 10.5%, are rarely used for maintenance management work on high-rise buildings. Next, the ICT, AR, and UAV, WSN and DT have not yet been broadly applied in Malaysia FM industry as some facilities management companies have no interest in the adoption of these technologies. Furthermore, the cost associated per month with adopting advanced technology in their organization for the purpose of maintenance management of high-rise buildings is less than RM10,000.00 and RM30,000.00 to RM40,000.00 depending on the type of technology adopted.

4.3 Driver and barriers in adopting emerging technologies

Table 4: Drivers in adopting emerging technologies

Drivers	Mean	Standard Deviation	Rank
Increase building efficiency	4.57	0.53	1
Long term investment planning	4.57	0.79	2
Improve asset performance	4.43	0.53	3
Improve sustainability and ESG	4.43	0.53	4
Faster decision making and problem solving	4.43	0.79	5

Table 4 shown that most of the interviewees strongly agreed that the emerging technologies enable to increase building efficiency and good for long term investment planning. Moreover, the adoption of the emerging technologies also helps to improve the assets performance, sustainability and ESG in the built environment. Moreover, the results above shown that emerging technologies provide faster decision making and problem solving for maintenance works of high-rise buildings. In addition, cost effectiveness and optimise space utilisation were found to be the minor drivers in adopting the emerging technologies in Malaysian FM industry.

Table 5: Barriers in adopting emerging technologies

Barriers	Mean	Standard Deviation	Rank
High adoption cost	4.57	0.53	1
Lack of expertise	4.14	1.07	2
High cybersecurity risk	3.86	0.69	3
Lack of government supports	3.71	0.95	4
Poor data management	3.29	1.11	5

Table 5 presented the barriers in adopting emerging technologies for maintenance management of high-rise buildings in Klang Valley through mean score and standard deviation retrieved from the interview session. The adoption cost of emerging technologies is very high for an organisation that facing financial constraints. Moreover, lack of expertise on the emerging technologies found to be a major barrier in Malaysian FM industry. Besides, the barrier towards the adoption also includes high cybersecurity risk, lack of government supports and poor data management. One of the interviewees added a barrier that their organisation faces are difficulty to find the right person to manage the technology and evolving of new technologies in the future.

4.4 Strategies to improve the adoption of emerging technologies

Table 6: Strategies to improve the adoption of emerging technologies

Strategies	Mean	Standard Deviation	Rank
Provide training and workshop	4.43	0.53	1
Spread awareness	4.43	0.53	2
Implement predictive modelling system	4.29	0.49	3
Collaboration among facilities manager	4.29	0.49	4
Government develops a policy	4.14	0.38	5

Based on Table 6, the potential strategies found to be effective to adopt emerging technologies is by providing a training and workshop to the facilities management practitioners. Next, the FM organisation or authority need to spread the awareness on the application of emerging technologies to facilitates the maintenance of high-rise buildings. The other strategies to improve the adoption of emerging technologies are through implementation of predictive modelling system, collaboration among facilities manager, development of policy by government and focus on long-run business plan. Few interviewees shared their organisation strategies that may be helpful in the industry such as outsourcing company that have expertise or provide services of the emerging technology and enhance the adoption by following international standards.

5.0 DISCUSSIONS

5.1 Emerging Technologies towards FM

Bakar and Kamaruzzaman (2023) stated that the FM industry in Malaysia still lacked technological innovation and has been long criticised due to insufficient studies that indicate the actual adoption of FM technology. However, the findings explained that emerging technologies started to be used widely in Malaysia as they influence the efficiency of maintenance management in residential and commercial high-rise buildings in Klang Valley. The first research objective has been proved because it revealed the types of emerging technology used frequently in the maintenance management of high-rise buildings in Klang Valley which is BIM followed by BD at 36.8% and 15.8%, respectively. This result is consistent with findings by Ariffin et al. (2023), who found that 20% of FM organisations in Malaysia have been implementing BIM in their practices, such as Building Management System (BMS) and Computerised Maintenance Management System (CMMS). BIM for the maintenance of fire alarm systems, lifts, and pumps in high-rise buildings. This finding is in line with a previous study by Safayet et al. (2021) that emphasized the development of BIM for fire alarm systems in order to reduce the fire impact on high-rise buildings, complexes, and enclosed spaces.

Besides that, the other emerging technologies that have been used in the maintenance management of high-rise buildings in Klang Valley are AI, IoT, and GIS at 10.5% while ICT, AR and UAV at 5.3%. On the other hand, the majority of the interviewees (28.6%) agreed that the cost associated per month is less than RM10,000.00 and RM30,000.00 to RM40,000.00. In accordance with the present results, a previous study by ProV International Inc. (2022) described that the

factors that affect the adoption cost are the specification of the technology, the size of the buildings, the geographic location of the facility, and the frequency of operation.

5.2 Key drivers and significant barriers

The key driver of emerging technologies' adoption is to increase building efficiency in terms of maintenance and data management. This result is consistent with findings by another researcher who found that the maintenance work efficiency in a building, such as inspection work, is higher using an AR compared to the traditional paper-based approach (Chung et al., 2021). Besides, this finding may help us to understand the following key drivers towards the adoption of emerging technology long-term investment planning as it offers higher profitability (Peacock Engineering, 2021). Next, improvement of asset performance, sustainability, and ESG, are the important drivers. Previous research proves that emerging technologies will enhance sustainability and influence energy efficiency (Zhan et al., 2023). Perhaps, the least influential drivers of the adoption of smart FM for maintenance management of high-rise buildings are faster decision-making, problem-solving, cost-effectiveness and optimization of space utilisation.

Subsequently, the major barrier to adopting smart FM for maintenance management of high-rise buildings is high adoption costs. This finding is in accordance with recent studies indicating that this factor was the most significant barrier in their research on the barriers to the implementation of BIM for FM other than lack of expertise and unfamiliarity with the technology (Durdyev et al., 2022). Apart from the high adoption cost, another significant finding is the adoption of emerging technologies in FM is obstructed due to a lack of expertise among the FM team. This is aligned with the research conducted by Singh and Kumar (2024) on analysing the barriers to blockchain-enabled BIM adoption in FM. In this current study, poor data management by the FM organization was found to be a minor barrier because the FM practitioners have neutral perspectives on this barrier. However, this finding is contradicted by other research in the United Kingdom FM sector that considers data management issues to be one of the significant barriers (Konanahalli et al., 2020). Additionally, Zhan et al. (2023) findings in their research on the barriers to the adoption of smart FM in Singapore agreed with one of the interviewee's opinions towards the development of new technology in the future would affect the current technology.

5.3 Potential strategies

The findings from this study show a remarkable strategy for improving the adoption of smart FM for maintenance management of high-rise buildings is to provide training and workshops to learn the skills of using the technology. CIDB Malaysia has started to provide a training programme to develop skills and knowledge on BIM in FM for FM professionals (Hamid et al., 2021). From the study reported by Hamid et al., (2021), spreading awareness about the function of the technology may attract stakeholders to implement smart FM in their organisation. Next, the findings of this study show that the implementation of predictive modelling would help to improve the adoption of smart FM, followed by excellent collaboration among facility managers and the development of a policy framework. However, the strategy that focuses on the long-run business plan considering the ESG were believed as the least potential strategy in this study. Interviewee B added a strategy that was helpful towards their organisation which is outsourcing companies that can provide services using emerging technology to help make maintenance management more efficient and cost-effective. Macro (2024) supports interviewee B because they have a similar idea, which is to

outsource the maintenance work to the facilities management expert in terms of skills and technology.

6.0   CONCLUSION

This research provides a better understanding of the types of emerging technology used for the maintenance management of high-rise buildings as well as their associated costs per month. Building Information Modelling (BIM) was found to be the emerging technology used the most in the Malaysian FM industry with the cost associated per month being less than RM10,000.00. Moreover, the key drivers are increasing building efficiency, long-term investment planning, improving asset performance, improved sustainability and ESG and faster decision-making. In contrast, the significant barriers towards the adoption are high adoption cost, lack of expertise, high cybersecurity risk, lack of government support and poor data management. Also, this research confirms previous findings and contributes additional evidence on the strategies for improving the application of emerging technologies in FM. The potential strategies are providing training and workshops, spreading awareness, implementing a predictive modelling system, collaborating among facility managers and developing a policy. In addition, further research is recommended to estimate and compare the whole life cost and life cycle cost (LCC) of the emerging technology used in facility management practices due to limited resources. This would be a fruitful area for further research, as it would be beneficial for the players in facility management, including stakeholders and facility managers.

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