Journal of Information System and Technology Management
JISTM
EISSN: 0128-1666
Volume 9 Issue 37 (December 2024) PP. 185-202
DOI: 10.35631/JISTM.937015

JOURNAL OF INFORMATION SYSTEM AND TECHNOLOGY MANAGEMENT (JISTM)
www.jistm.com

BUILDING INFORMATION MODELLING IN CONSTRUCTION: CHALLENGES AND IMPROVEMENT OF FACILITIES MANAGEMENT

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Article Info:

Article history:
Received date: 27.10.2024
Revised date: 11.11.2024
Accepted date: 15.12.2024
Published date: 24.12.2024

To cite this document:

Manap, N., Lye, L. H. J., Sulaiman, N., Alshehi, F. A. S. T., & Chen, J. (2024). Building Information Modelling In Construction: Challenges And Improvement Of Facilities Management. *Journal of Information System and Technology Management, 9* (37), 185-202.

DOI: 10.35631/JISTM.937015

Abstract:

This research aims to investigate the challenges of BIM adoption in facilities management and suggest improvements in facilities management. Interview sessions were conducted with six construction experts who have been construction experts in the construction field for at least ten years. The research collected several challenges to the adoption of BIM in facilities management, which include limitations in the adoption of BIM in facilities management and integration of BIM to transfer information and data to the facilities maintenance stage. The improvements suggested by the respondents were converting the facilities management process, which currently is manual, into a digital tool, and cultivating BIM talents and BIM teams.

Keywords:

BIM in Facilities Management, Challenges, Improvement, Facilities Management Software

Journal of Information System and Technology Management
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Introduction

Building Information Modelling (BIM) is a three-dimensional digital design method that integrates various relevant construction project information and is a digital representation of the entity and functional characteristics of engineering projects (Cassandro et.al, 2024). It is notable for its simulation, coordination, visualisation and optimisation capabilities. BIM's main objective is to create a virtual, three-dimensional model of the construction project, followed by digital technology to provide the model access to a more comprehensive and consistent library of project information.

Adopting BIM in the facilities management phase replaces traditional control, maintenance, documentation, and analysis approaches. Through the adoption of BIM, facility managers can obtain facility information in just a few minutes, whereas receiving the same information without the aid of BIM could take hours of effort. Facilities management departments implement BIM technology to improve the appropriateness of control systems, minimise maintenance and operation costs, and continuously offer cost-effective services to facility occupants.

This study aims to investigate the challenges of adopting BIM in facilities management and recommend improving facilities management in Malaysia. This research is limited to the construction industry in Malaysia. The study mainly focuses on construction companies legally certified by Malaysia's Construction Industry Development Board (CIDB). This research aims to study how BIM technology was implemented in facilities management. This research also identifies the challenges of BIM implementation in facilities management. Besides, it also helps to suggest how to overcome the difficulties of the BIM application. This research will benefit construction players by assisting them in better understanding and knowing about BIM technology in facilities management; with this research presence, more construction players will adopt BIM technology in facilities management throughout their project activity, as suggested.

The utilisation of BIM is currently accelerating rapidly in the construction industry. Although Building Information Modelling (BIM) has demonstrated that it has provided many significant advantages for facilities management, the focus of Malaysia is still more on the aspect of the design and construction process. According to the most recent definition provided by the International Facility Management Association (IFMA), facilities management is an activity that uses multidisciplinary expertise to integrate people, sites, processes, and technologies to ensure the proper operation of buildings. Facilities management has gradually developed into a comprehensive and multi-functional management task with the advancement of management level and enterprise informatisation. In addition to managing and maintaining the physical environment of the building, its service scope also covers managing and serving building occupants and managing and keeping track of the building's assets. This is because different departments frequently have many information islands in the traditional enterprise information management system due to their functions and authority; modern FM functions may span multiple departments within the organisation. As a result, FM work procedures are

Journal of Information System and Technology Management
JISTM
EISSN: 0128-1666
Volume 9 Issue 37 (December 2024) PP. 185-202
DOI: 10.35631/JISTM.937015
complicated, processing and approval times are excessively long, which causes decisions to be delayed, work to be done inefficiently, and unnecessary losses to occur (Naghshband, 2016). According to the "BIM for Facility Managers" case study, Building Information Modelling and facilities management can be linked to undergoing maintenance information systems and operations. Namely, the BIM model and the facilities management package are easily connected, and any modifications in the model should update automatically in a preferable condition.

BIM use has risen globally in recent years, particularly among commercial contractors. In North America, the adoption rate increased from 28% in 2007 to 71% in 2012, with contractors having the highest adoption rate (74%) compared to architects (70%) and engineers 64%. The government of the United Kingdom mandated the use of BIM in 2016. As a result, during the last three years, the adoption rate has risen from 60% to 95%. This shows that even though the utilisation rate of BIM among construction firms in Malaysia was only 5.2% from 2007 to 2013, the Construction Industry Development Board (CIDB) has expanded the number of seminars, presentations, and conferences on BIM adoption, so the number is projected to rise. However, there are some pain points in this aspect. Many problems have not been solved to achieve a more practical level of BIM implementation for facilities management. Based on the research, there is some phenomenon in which the construction industry does not understand facilities management well (Williams et.al, (2014). The construction industry's culture requires the acceptance of facilities management as a part of the process. Some facility managers cannot classify the necessary data and results using a widely used reactive approach. Subsequently, some of the owners and facility managers lack knowledge of BIM. They are probably not too clear about the internal operation of BIM (Williams et.al, (2014). There is also a lack of solid evidence and practice case studies to show the advantages of BIM for facilities management.

Literature Review

Facilities Management in Malaysia

Facilities Management is a new multidisciplinary topic that incorporates elements from construction science, management science, engineering technology and behavioural science (Shen at.al, 2010). The concept of facilities management arose as an outgrowth of property management. Foreign countries withdrew it from the purview of traditional property management in the late 1980s and early 1990s, and it progressively expanded into an independent new industry known as facilities management. Facilities management has advanced rapidly in Western developed countries in recent years, evolving into a professional integration approach that helps many private institutions, educational institutions, and government departments better manage their property facilities and support services.

However, domestic awareness of facilities management is fragile, and systematic study is limited. With France successfully hosting the 2024 Olympic Games, numerous industrial norms, including facilities management, are now required to meet international standards. As a result, Malaysia should study facilities management theory and practice as soon as possible. Business leaders' perspectives of facilities management are changing as the facilities management industry evolves and adapts to new influencers, technologies, and issues. These changes have emerged in various ways, affecting how corporate executives regard facilities management and whether the facilities management industry can successfully present itself as a valued strategic partner for businesses. According to the experts who assisted this research,

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the primary influencer of executives' opinions of the value of facilities management may be tied to the impact facilities or locations have on a business's success. As a result, it's critical to comprehend these variables and their implications for how today's corporate executives view the facilities management function (Mohanta and Das, 2016).

Facilities management administrations are tightly integrated with various real estate administrations in developed markets, such as rent collecting and lease management (Kyle, 2000). However, in Malaysia, the concept of facilities management has not reached the mature level of providing comprehensive property management methods (BIFM, 2012). To ensure safety, healthiness and cleanliness, facilities management is requested to increase the provision. For example, UiTM has developed a facilities management division responsible for the entire maintenance of the surrounding campus and building. The Facilities Management Division contains four units: the Mechanical, Public Unit, Electrical and Telecommunication Unit, and the Assembly Unit.

Apart from that, another example of facilities management adopted in Malaysia is in the office buildings. This type of building typically has its management team to monitor the situation of the buildings. Maintenance or building managers commonly lead this management team. Building managers provide cleaning, maintenance, landscaping, lighting, ventilation, heating, air conditioning (HVAC), lifts or escalators, sanitary and plumbing, mechanical and electrical, signage, access, and parking.

Building Information Modelling (BIM)

Building Information Modeling, commonly known as BIM, is a concept for digitising building data (Smith and Tardiff, 2009). Designers in various industries use professional BIM modelling software to deliver and store building-related professional information. A virtual 3D building with engineering information is utilised as a data carrier in the BIM model and can be used at any building's life cycle stage. In recent years, BIM has been the focus of technology advancement in construction. There have been numerous projects, from design and planning to construction and completion. BIM was created to enhance the traditional operation procedure. The entire BIM model, as well as the use of BIM auxiliary tools, can be used in a variety of projects. The stage aids in management decision-making by assisting in resolving issues such as engineering communication, dispute resolution, timetable management, and engineering simulation.

BIM is the process of developing and managing building data throughout its life cycle (Arayici and Aouad, 2010). On the other hand, BIM is classified as more than just a software tool or a technology that can be purchased and deployed. It's more of a paradigm in the industry that mixes technology with people and process difficulties. As a result, the way we deliver the built environment undergoes a tectonic shift. The building's completion information is essential because facilities management is centred on the building as the central body. However, in the past, much of the completion information was only given to the 2D project due to technological limitations and long-term habits. In the operation stage, the as-built drawing is used. The necessary information for operation and maintenance is not transmitted completely, correctly, or consistently. Missing data is a very regular occurrence. Integrating the data for actual operation involves more time and money for the operator. When equipment is damaged and needs to be replaced or repaired, knowing the compatible model of the equipment is impossible without complete information, causing problems in facilities management activities.

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As the data carrier for the building's whole life cycle, the BIM model provides a consistent data exchange method in the information integration process at each project stage, which benefits engineering information sharing. BIM can ensure that the data input in the early stages can be utilised in the future operation stage. It saves time for data consolidation or data gathering in the past, enhances the reuse rate of data, and lowers labour expenses and the risk of human mistakes during the operating phase. Furthermore, the virtual 3D building data provided by the BIM model can provide a convenient and visualised environment for the complex pipeline system, allowing maintenance personnel to grasp the overall picture of the building more clearly. They can be extended as the data basis of the facilities management system for research and development. The digital management technique of future operation can analyse the building classification structure, examine the data items and contents of equipment management, and set up a digital management system during the research and development process. Integrate the management process with the BIM model so that data from the management process can be associated with building data from the BIM model, enhancing data interaction and helping to improve facilities management quality.

Methodology

Research Design

This section will explain how the research elements are designed and implemented to provide the reader with a better understanding. It is divided into four stages: preliminary, information gathering, data collection and analysis, and the final phase is recommendations and conclusion. Phase 1 is the beginning of this research. The process during phase 1 is selecting the research title, identifying the problem statement, developing the research question and objective and ending with the research scope. Phase 2 will involve a literature review to examine the difficulties and strategies for promoting the use of BIM in Malaysian facilities management. Next, phase 3 is the data collection and data analysis process. Primary and secondary data are the two categories into which the data collected would be divided. The primary data came from respondents who were interviewed using a qualitative approach and had previous experience in facilities management. The secondary data was gathered from various sources, including books, newspapers, journal articles, online databases, and thesis papers relevant to the study's subject. Phase 4 will analyse the information gathered from the interviewees' responses to the questions. This phase will use content analysis to ensure the data gathered matches the research objectives. Phase 5 will wrap up the overall research project based on data analysis, discussion, and recommendations after the study.

Research Population

A research project's population is the total number of participants or relevant objects. The entire group is referred to as the population. The population's subset was sampled. In research, it is occasionally impossible for the researcher to study every element of the population because of the size of the population's elements and the researcher's limited time and resources. Hence, the population for this research was six facilities management companies registered with CIDb Malaysia.

Research Sampling

The sampling method involves selecting a sample representative of the entire population and using the data gathered as research data. A sample is a "Subgroup of a population". The process of choosing individuals from a research target population is known as sampling. Since the

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population includes a wide range of people, including researchers, the sampling's primary purpose is to reduce large groups to minor ones, which may present challenges when conducting research. Therefore, research sampling is a straightforward way to get around those limitations. This research used snowball sampling to gather data. This is due to the small sample size of respondents and the researcher's difficulty collecting data from those using BIM in facilities management. The researcher can quickly obtain new respondents using snowball sampling, which valuable respondents introduced. A non-probability sampling method is snowball sampling. It doesn't involve probabilities like simple random sampling, where each participant's probability is the same. Non-probability sampling is centred on sampling methods chosen by researchers based on their expertise. Hence, the sampling from this research was respondents who are related to BIM in facilities management and have sufficient data and information to support the research objectives. Six respondents from six facilities management companies from various backgrounds were chosen based on their experience in the construction industry and knowledge of facilities management. Their working experience in the construction industry should be more than a decade, implying that they have sufficient facilities management experience and scope of work.

Data Analysis

The data will be analysed in two parts. The first part will investigate the challenges of adopting BIM in facilities management. The second part will analyse the data collected to examine suggestions for improving facilities management in Malaysia. By the end of this analysis, the results should answer the research question, the effectiveness of using facilities management digital tools, and a list of recommendations to propose to the construction industry to improve facilities management sustainability. In this research, the researcher will adopt a thesis through interviews in this study, in which the respondents will be interviewed in real time. Furthermore, the questions that will be answered must be well-developed to facilitate the data collection procedure and meet the research objectives. The "how" queries were the most common, requiring a more in-depth investigation of the problem. The primary data was obtained from respondents via a qualitative approach in which respondents with experience in BIM in facilities management were interviewed. The data collection methods are individual, online, face-to-face, and telephone interviews. Secondary data was gathered from various sources, including books, newspapers, journal articles, online databases, and a thesis paper on BIM in facilities management. Electronic media includes materials and information obtained from websites via internet access. Secondary data include theories and definitions related to BIM in facilities management. It also contains previous research done by the researcher. It is critical to demonstrate the accuracy of the primary data used in this research.

Results and Discussion

Respondents Demography

The six respondents from various backgrounds were chosen based on their experience in the construction industry and knowledge of facilities management. Their working experience in the construction industry ranged from 10 to 28 years, implying that they have sufficient facilities management experience and scope of work. As a result, the interview results are both sympathetic and reliable.

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Respondent R1 was a Managing Director, and he completed his Degree in Geomatic, Surveying Engineering and Master of Science in Engineering Business Management and attended Level 6 at the British Institute of Facilities Management (BIFM). His involvement only focused on digital management. Respondent R1 has 22 years of working experience in the construction industry, specialising in facilities management. Respondent 2 was appointed as a facility manager with a background in Mechanical Engineering. He has gathered experience in Facilities Maintenance and Management for 28 years from local and multinational companies. Respondent R3 is a Facilities Administrator & Maintenance Manager with 18 years of experience in Facility Maintenance Engineering, Operations Management and Services in Malaysia with a Bachelor of Engineering in Electrical Power and Machines. Respondent R4 is a facility administrator with ten years of experience in facilities management and a bachelor's degree in mechanical engineering technology. Respondent R5 is a Maintenance Manager with a bachelor's degree in Intermedia and a Master of Science in Management Information Systems. He has been involved in facilities management for about 15 years. The last respondent, R6, has 16 years of experience in the construction industry. He holds a Master of Science in Engineering Business Management.

Digital Facilities Management Tools

R1's company uses Archibus to combine real estate, equipment, facilities, people, and data into a platform and form an integrated building management system. Their company uses intelligent, efficient, convenient, and fast information technologies and software to connect various complex facility systems in the building and support the core business better. The respondents', R2 and R4, companies use Condo Master to track space usage, control costs, and adapt to rapidly changing business needs, such as social distancing and enhanced cleaning regimens, using space utilisation data. Respondent R3 implemented CSS Property Management Solution to maximise operations and maintenance efficiency to improve efficiency and reduce operating costs of their company. Respondent R5 uses the Gprop System to provide real-time visibility into massive amounts of data generated by Internet of Things (IoT) sensors, wi-fi, and smart devices to perform predictive facilities maintenance and create a more cost-effective environment.

Training Frequency

According to respondent R1, they do provide training to the clients. They will be attending the technology update training on utilising Archibus. The training frequency depends on the updated technology, which means the company will train the client once the technology is updated. According to his experience, it should be twice a year. Respondent R2 stated that their company would give monthly training for their staff. When there is a new site, new admin, or new manager, there will be a person there to train them for about one to two weeks personally. For monthly meetings, they have a seminar room in their company. Their manager and administration staff will visit the site monthly for updated information. Apart from that, R2 also provides the statement, "Once we find a new approach to tackle the problem, we will share that. So that everyone in the company can work using the same SOP. Let's say Admin A on site A is on leave; even though Admin B go to Site A, they know how to do it." The response given by respondent R3 is they will be having training once a year in their company. The company training is carried out online using Zoom. Respondent R4 mentioned that training is conducted by class, which is face-to-face once every three months, while the last respondent mentioned that training is carried out with the same method as respondent R3 online twice a year.

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Challenges Of Adoption Of BIM In Facilities Management

Three respondents agreed that the limitations of adopting BIM in facilities management were one of the challenges. Three respondents agreed that software limitations exist in this field. 2 respondents face the cost issue requiring substantial capital. Other than that, only one respondent agrees that lack of talents and skills, the immaturity of operation and maintenance environment, hard to maintain up-to-date, over workload, recording and storage of historical data could not be traced and tracked and wide management area as the challenges.

Limitation In The Adoption Of BIM In Facilities Management

The limitation of adopting BIM in facilities management was a challenge to three respondents. Respondent R1 said, “A lack of BIM knowledge and skills in the FM sector limits the adoption of BIM. This is particularly important because the BIM model for FM applications is regarded as a unique building asset that needs ongoing upkeep to maintain its value for the building and its owners.” The FM industry is quite conservative when it comes to new technology. Without BIM's demonstrated benefits, its adoption in the FM industry will remain low (Isa et.al, 2016). Respondent R2 makes the same point as Respondent R1, which is that the adoption of BIM in facilities management is limited. Respondent R2 stated, “So far, the application of BIM technology in facilities management is not being used thoroughly, and the relevant laws of our country have not provided legal provisions for the matters involved.” Therefore, once a dispute arises in the application of BIM technology, this will affect the interests of the parties concerned and society's fair and just development. For example, after a conflict occurs, one party may abdicate its responsibility so that the law cannot make a judgment that would oppose the party's interests.

Respondent R4 also stated, "Compared with foreign countries, the operation and maintenance environment was not mature enough.” Using BIM technology in project design, construction, operation, and facility maintenance isn't easy. Malaysia's construction industry invests more in BIM in the design and construction stages; they will invest a lot of workforce, material resources, and financial resources in the design and construction stages. Since the building will be delivered after completion, it will be unproductive for later facility operation and maintenance. BIM modelling is relatively easy, and the operation of BIM software is not complex. Many people use BIM to turn over the model and do not play the role of BIM technology. The advantages of BIM are undeniable, but the difficulty is it is hard to apply. This is not something that an individual can decide, and it is closely related to the large market environment. Without the support and guidance of a sound policy system, it is not easy to go through the whole process. The project is designed in various fields later in the stage, and coordinating and cooperating is not easy. The number of participants is increasing and becoming messy, making implementing BIM technology in facilities management more challenging.

Software Limitation

Respondent R1 stated, “It is hard to integrate the BIM model to transfer information and data to the facilities maintenance stage”. It is necessary to have data standardisation and open systems repositories that any facilities management system can access. Facilities departments are forced to impose proprietary information systems or manually enter data into facilities management systems without using a non-proprietary format. This will require massive amounts of information within a building, consuming a lot of workforce and time.

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Besides that, respondent R2 also said, “Currently, BIM is limited to its technology platform and supporting software; it is difficult to communicate and interact with other software.” Currently, it only has access to its own supporting software and technical platform, and it isn't easy to communicate and interact with other software that can maximise operations and maintenance efficiency to improve efficiency and reduce operating costs. Although BIM technology has the functions of data sharing and information collaboration that can integrate different periods and different types of information such as time, price, and quality in the design and construction phases and efficiently and accurately transfer the information in the design and construction phases to facilities management, it overcomes the disadvantages of the traditional project cost management mode. Still, its means of realising project cost management are too limited, and it can only be integrated with the system's supporting software. It will not run smoothly if it is linked to other software to share information. Furthermore, current BIM technology development reflects that the level of BIM technology in facilities management is uneven, and the regulations and standards in the application process are not uniform, which will significantly impact the quality of information exchange and the effect of collaborative work.

Respondent R3 stated that “BIM is a system, not just Revit, though at the moment Revit is the most widely used in the construction sector. The software configuration needed for this software is strict. My standard BIM computers right now are essentially 8,000 mainframes.” The implementation of BIM in the construction sector needs to be done at the project level, so the project department needs to have the guts to buy a specific number of high-end computers. However, the project management team is unwilling to take this step. Additionally, respondent R3 stated that the software operation is complicated, rigid, and challenging to learn (Mohanta and Das, 2016). “The first 3D modelling software that I learned was Sketch Up. By then, I was still thrilled to use Sketch, which is easy to learn. You can start modelling with Sketch Up in about a week, and after that, keep researching plug-ins. I enjoy the joy of modelling. So, after I started to learn Revit, I was very awkward. Modelling with it felt very mechanical and no fun at all. I'm still a person who is more interested in this software, and I almost didn't keep learning. In the construction industry, most employees are 30 to 50 years old, people with a low level of education, and the ability to use CAD is based on years of work experience. It is tough for them to learn to use Revit. Fortunately, many young people who have just entered the industry, including me, have a high level of acceptance and are willing to try new things. This group of people welcomes BIM, and I think they are the hope for the development of BIM in Malaysia.”

Strong Capital Requirement

Other than that, the challenges given by respondents R2 and R4 involved cost issues. Respondent R2 said, “The early stages of research and development for BIM technology demand significant investment, the hiring of numerous high-end technical staff, and ongoing technical research to develop a BIM technology platform compatible with construction companies and necessitates expensive facilities management”. Furthermore, BIM technology is not just one technical system that operates independently. Databases and auxiliary software must be supported. This software must be built and formed. When BIM software is implemented in practice after development is complete, there are rigorous software and infrastructure requirements. A significant amount of human, material, and financial resources must be committed to develop or implement BIM technology. Many small and medium-sized businesses cannot handle the pressure because it is also a lot for large construction companies to handle. This is also the main principle that BIM technology has made it difficult to achieve

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widespread popularity in construction engineering. Therefore, in future development, we should continue to develop universal technology to enable more construction companies to pay for the development of BIM technology's economic cost over an extended period, and the formation cycle is long and complicated.

Respondent R4 also stated that the volume of complete BIM data is massive, but it is meaningless to exist in isolation. It must be combined with other data, cross-analyzed, and used comprehensively to improve cost reduction and efficiency. Several software devices are required, including sensors, control boxes, smart meters, etc. This part necessitates significant additional funding, mainly when numerous devices are to be monitored and many sensors deployed. To accomplish the above requirement, the platform must support the data of super-large models, which requires a large amount of funds.

Lack of Talents

Respondent R3 also stated that there is a lack of talent in Malaysia. This is because the BIM industry is still considered too new; workers employed for three or more years can be regarded as veterans. Many of them entered the enterprise to do BIM right after leaving school. Such people are generally proficient in software but lack experience with on-site construction; since many of the models they create do not correspond to the site, they cannot implement them. He said, “Therefore, I’m more inclined to engage in this industry after having certain on-site construction experience, but there are not many of them. Not every practitioner has the willpower to change. One point stands out in particular. From the perspective of upper-level leaders, everything is fine as long as the model is drawn. However, the results will differ if different people draw the same model. This is also the issue of model quality that I have brought up with my colleagues.” A model drawn by a serious and responsible person with construction experience is critical in guiding on-site construction. It was also agreed that once the FM team mastered the necessary BIM skills, geometric record maintenance would be more efficient in cost and quality (BOFM, 2012).

The Immaturity Of Operation And Maintenance Environment

Respondent R4 also stated that the volume of complete BIM data is massive, but it is meaningless to exist in isolation. It must be combined with other data, cross-analyzed, and used comprehensively to improve cost reduction and efficiency. Several software devices are required, including sensors, control boxes, smart meters, etc. This part necessitates significant additional funding, mainly when numerous devices are to be monitored and many sensors deployed. To accomplish the above requirement, the platform must support the data of super-large models, which requires a large amount of funds.

Hard To Maintain Up-To-Date Information

For respondent R5, he stated that it is hard to maintain up-to-date. Some of the information needs to be updated daily. He states, " But sometimes there is the lack of admin or even the manager, so they need to do some tracks for them to follow up. For example, monthly maintenance confronts monthly maintenance schedules using digital tools to track whether forging has been done, whether the swimming pool has been serviced and whether the pump and tank have been checked. It is all in the system. So when they are doing Condo Master, it will remind them to follow up.”

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Over Workload

Respondent 5 also stated that "when they take over from another company, the previous company data is not up to date, meaning that they have never done any data update, for the first two to three months are the big workload. This is because they must key all the data to ensure knowing everything at the fingertips."

The Recording And Storage Of Historical Data Cannot Be Traced And Tracked

Respondent R6 has stated that "the recording and storage of historical data cannot be traced and tracked." More and more enterprises have started the digital transformation of enterprise management, realising paperless management in equipment management, making the initially complicated and messy equipment management standardised, scientific and efficient. The work efficiency of employees is greatly improved, the efficiency of equipment management is improved, the maintenance cost of equipment is continuously reduced, and the operation data of various equipment is precise at a glance. The administrator can control the running status of the equipment in real-time.

The Wide Management Area

Respondent R6 also stated that the management area is too wide, the installation of various facilities and equipment is relatively scattered, and the staffing increases accordingly, increasing expenses. Equipment costs are rising, and effective repair and maintenance methods are lacking. Managing using only telephone and paper maintenance documents is not easy. Next, respondent R6 also claimed that if the elevator and central air-conditioning system are subcontracted by Party A, it will increase the difficulty of coordination between Party B and the maintenance unit in actual operation. There are many types of equipment, and the total number is tens of thousands. Relying solely on spreadsheets is too inefficient for management, and the error rate is frequent.

Suggestion To Improve Facilities Management In Malaysia

The result shows that 1 of the respondents suggested converting every facilities management process, which uses manual, into a digital tool, two respondents indicated that cultivating BIM talents and BIM teams, one respondent suggested that cultivating BIM talents and BIM teams, one respondent suggested improving the operability and functionality of BIM software, 1 of respondent suggested to learn from foreign BIM application experience, 1 of respondent suggested to increase the professional quality, 1 of respondent suggested to improve management of facilities inspection and 1 of respondent suggested to improve fault type and knowledge base management and 1 of the respondent indicated that implement into be an application.

Convert Facilities Management Process Used In The Manual Into A Digital Tool

Respondent R1 suggested, "Convert everything facilities management process which more is used in the manual into a digital tool. We have to move into an era of digital tools to save time. For example, Big Data." Big data is large-scale data; its primary value is storing and analysing massive amounts of information (Albastaki and Manap, 2024). The strategic importance of big data technology is not in mastering a large amount of data information but in professionally processing meaningful data. If big data is compared to industry, the key to its profitability lies in improving data processing capability and realising data value through processing. It is a comprehensive concept encompassing five areas: business analysis, data analysis, data mining, machine learning, and artificial intelligence.

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Cultivate BIM Talents And BIM Teams

Respondent R2 also suggested cultivating BIM talents and teams. He stated, "The large level of BIM may be difficult for us to touch. Few people know how to do modelling in a project alone. Based on my experience in the front line, popularising and promoting front-line modelling is still necessary. Currently, many BIM training institutions have BIM training courses, and the Institute of Graphics is also organising BIM skills examinations. This benign phenomenon will help strengthen the mastery of BIM talents' skills and improve their capabilities." Apart from that, respondent R2 also suggests improving the operability and functionality of BIM software. Respondent R2 said, "So far, the development of BIM software in Malaysia is still immature, and foreign software is not completely suitable for our practical use. In this case, developing domestic BIM software is also significant for developing the entire BIM industry." Respondent R4 also gave his suggestion, which is to increase the professional quality. Training institutions for facilities management personnel should be built to train specialised facilities management personnel and impart facilities management theory and practical knowledge to practitioners, and relevant courses related to BIM used in facilities management should be established. Simultaneously, with Malaysia's current situation, conditions must be created to implement a qualification certification system for facilities management practitioners gradually.

Learn From Foreign BIM Application Experience

Additionally, Respondent R3 suggested that we learn from foreign BIM application experience. Respondent R3 said that "the development and application of BIM in Malaysia is later than that of many advanced countries abroad. Therefore, many excellent foreign cases are worthy of our study and reference, and we will follow our own BIM development path based on Malaysia's national conditions." Respondent R5 emphasised maintenance, malfunction and knowledge base, and facilities inspection management. Respondent R5 stated, "The facility manager can formulate different maintenance plans according to different conditions of the facilities, and the system can automatically generate corresponding work orders according to the preset maintenance cycle, prompting in advance to realise facilities maintenance monitoring and data analysis. Through effective maintenance process management, preventive maintenance of facilities is carried out according to the plan, and the rational allocation of personnel and resources is realised."

Management of Facilities Inspection

Other than that, respondent R5 also emphasised the management of facilities inspection. The system will automatically set work orders for inspections and point inspections according to the time. It can be set that the inspection must be carried out according to the predetermined route, or the inspection and positioning can be turned on, and the device can be photographed. He said that "Facilities administrator can view the execution status and inspection records of work orders through computers and mobile devices. The inspectors can scan the QR code of the equipment with their mobile phones to complete the inspection. When the facilities are found to be abnormal, they can report for repairs and generate maintenance work orders in conjunction with each other to realise the intelligent inspection of the inspection points and record and analyse the inspection data."

Fault Type And Knowledge Base Management

Next, respondent R5 also responded that facilities management has to reinforce the management of malfunction and knowledge base. He said, "The system supports setting fault

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types and knowledge bases, which can save drawings and documents required in the maintenance process, past maintenance experience, and so on. The facilities maintenance personnel can search for relevant operating procedures and plans as needed."

Implement The Digital Facilities Management Tools In An Application

Respondent R6 suggested, "Implement the digital facilities management tools in an application rather than a web-based one." If it is directly downloaded to the device, all tracking and operations will become very convenient; fast operation saves time and effort, faster speed, high performance, and high overall user experience satisfaction. In addition, the facilities manager can be used offline because it is used on the platform instead of the web. These characteristics mean that after the app is developed, its use will significantly increase the connection between customers and businesses and establish a relationship more conveniently and quickly. Facilities managers can track facility information, facilities operation and control, and planned equipment facilities more conveniently.

Conclusion and Recommendation

The research findings section will answer the research questions raised previously. The first research question is: What are the challenges of implementing BIM in facilities management? The second research question is, how can facilities management in Malaysia be improved? The research findings are developed based on the primary data analysis in the previous chapter and the secondary data collection in the literature review.

Objective One: The Challenges Of Adopting BIM In Facilities Management In Malaysia

The challenges of adopting BIM in facilities management in Malaysia were identified by each of the respondents in the construction industry. According to the statements and responses given by the respondents interviewed, respondent R1 indicated that the challenges of adopting BIM in facilities management in Malaysia were adoption of BIM in facilities management is limited and integration of BIM model to transfer information and data to the facilities maintenance stage. It is necessary to have data standardisation and open systems repositories that any facilities management system can access. Facilities departments are forced to impose proprietary information systems or manually enter data into facilities management systems without using a non-proprietary format. This will require massive amounts of information within a building, consuming much of the workforce and time.

Respondent R2 indicated that the challenges faced were high costs, difficulty in generalising, and hardware limitations. Many small and medium-sized businesses cannot handle the pressure because it is also a lot for large construction companies to handle. This is also the main principle that BIM technology has made it difficult to achieve widespread popularity in construction engineering. Although BIM technology has the functions of data sharing and information collaboration that can not only combine design, different types of information, quality of different periods, cost and construction phase time, make the building model more accurate and efficiently transmit design and construction phase information to facilities management, it overcomes the disadvantages of the traditional project cost management mode, but its means of realising project cost management are too limited. It can only be integrated with the system's supporting software. It will not run smoothly if it is linked to other software to share information.

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Respondent R3 stated they lacked talents, skills, and software limitations. A model drawn by a serious and responsible person with construction experience is critical in guiding on-site construction. Once the facilities team has acquired the necessary BIM skills, geometric record maintenance will be more efficient in terms of cost and quality, which is unanimously agreed (Mohanta and Das, 2016) (BIFM, 2012).

Respondent 4 indicated that the challenges were the immaturity of the operation and maintenance environment and the vital capital requirement. The responses of all respondents about the difficulties of adopting BIM in facilities management in Malaysia differed. Once the building is delivered after completion, it will be unproductive for later facility operation and maintenance. BIM modelling is relatively easy, and the operation of BIM software is not complex. Many people use BIM to turn over the model and do not play the role of BIM technology. The advantages of BIM are undeniable, but the difficulty is it is hard to apply. Furthermore, it must be combined with other data, cross-analysed, and used comprehensively to improve overall cost reduction and efficiency.

According to the table, Respondent R5 agreed with the challenges of hard-to-maintain dates and workload when taken over from the previous company. Respondent R6 indicated they were facing more management issues: the recording and storage of historical data and the wide management area cannot be traced and tracked. Due to the wide management area, equipment costs are getting higher and higher, and there is a lack of effective repair and maintenance methods. Managing only telephone repair and paper maintenance documents isn't easy.

The results demonstrated that the researcher had achieved the first objective, where the researcher concluded the data analysis result that BIM has challenges in facilities management but that these challenges can be solved by the method that each respondent suggests.

Objective 2: The Suggestion To Improve Facilities Management In Malaysia

Respondents suggested improving the facilities management to encourage the first objective, the challenges of applying BIM in facilities management in Malaysia. The response from respondent R1 emphasised converting all information into digital tools such as Big Data. The strategic importance of big data technology is not in mastering a large amount of data information but in professionally processing meaningful data (Albastaki and Manap, 2024). If big data is compared to industry, the key to its profitability lies in improving data processing capability and realising data value through processing. It is a comprehensive concept encompassing five areas: business analysis, data analysis, data mining, machine learning, and artificial intelligence.

Respondent R2 suggested cultivating BIM talents and teams and improving the operability and functionality of BIM software. Respondent R3 indicated that we have to learn from foreign BIM application experience. However, the domestic construction industry's informatisation foundation remains very weak compared to other countries. Many businesses still rely on manual queries and uploads to the system for data collection. It is not only time-consuming, but it also has low precision, making it unsuitable for subsequent data interaction and model docking. In contrast to its positioning as a platform in other countries, BIM is now primarily used as software in Malaysia, with less involvement in BIM facilities management.

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Respondent R4 suggested increasing the professional quality, training specialised facilities management personnel, and imparting facilities management theory and practical knowledge to practitioners. Training institutions for facilities management personnel should be built, and relevant courses related to BIM used in facilities management should be established. Simultaneously, with Malaysia's current situation, conditions must be created to implement a qualification certification system for facilities management practitioners gradually.

For the next respondent, respondent R5 emphasises facilities maintenance management, malfunction and knowledge base management and facilities inspection management. The system will automatically set work orders for inspections and point inspections according to the time. It can be set that the inspection must be carried out according to the predetermined route, or the inspection and positioning can be turned on, and the device can be photographed. R5 also responded that facilities management must reinforce malfunction and knowledge base management. The system supports setting fault types and knowledge bases, saving drawings and documents required in the maintenance process, past maintenance experience, and so on. The facilities maintenance personnel can search for relevant operating procedures and plans as needed.

The last respondent, R6, suggested implementing the digital facilities management tools in an application rather than a web-based one. If downloaded directly to the device, all tracking and operations will become very convenient, allowing for more time-saving and effort-saving operations, higher performance, faster speed, and improved user satisfaction.

Since its inception, BIM has evolved from an information management strategy to a construction management method to create an integrated environment of up-to-date distributed building information adaptable to new information (Becerik et.al, 2012)(Sandirasegaran and Manap, 2016)(Isikdag, 2015). As a result, BIM can track changes and update them in the form of accurate information for facilities management purposes. Besides that, BIM can solve the inherent information deficit associated with the facilities management. In other words, the emergence of BIM as a facilities management tool would reduce information loss by standardising the data format. However, managing information throughout the lifespan for various building components and equipment based on the type of services (Mohanta and Das, 2016). The findings revealed that the researcher had met the final goal by obtaining suggestions from respondents to improve facility management in Malaysia.

Limitations of the Research

The researcher encountered the following limitations while conducting these studies: several respondents. Due to the difficulty in obtaining precise respondents for this study, the number of respondents who participated was limited. Not many respondents are engaged in adopting BIM facilities management; some potential respondents use digital facilities management tools in their company, and some likely only use BIM for engineering design, construction and engineering management. A communication problem between the researcher and the respondents also causes constraints in carrying out this research. Communication issues will cause the data collection process to be delayed. Aside from that, two respondents initially agreed but declined because they were too busy. This could be due to time constraints and the inability to provide feedback for this research. In Malaysia, BIM is mainly used for engineering design, construction, and project management. Construction players mainly apply it for sharing and transmission, sharing and transmitting data, information, project planning, and so on. The

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EISSN: 0128-1666
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data will be produced during the data construction process so that the project's construction participants can accurately understand the building information and respond quickly. The utilisation rate of BIM in facilities management is relatively less, so it will reach a certain degree of difficulty.

Recommendation

Several recommendations were expressed to improve BIM adoption in Malaysia's facilities management. The recommendations were made to resolve the issues raised by respondents. The researcher would like to suggest the adoption of ARCHIBUS in facilities management in Malaysia. After a series of investigations, the researcher found that the utilisation of ARCHIBUS is extremely low in Malaysia. Very few people have heard of ARCHIBUS in the construction industry in Malaysia. For over twenty years, ARCHIBUS has been the world's leading provider of TIEM (Total Infrastructure and Facility Management) solutions for overall asset and facilities management. ARCHIBUS can not only used in everyday life; its business scope encompasses nearly every aspect of facilities management. ARCHIBUS is the world's most comprehensive, integrated, mature asset and facility management solution. Secondly, the knowledge of BIM used in facilities management within the construction industry was still unfamiliar and unclear among contractors. As a result, the researcher suggested that contractors who had adopted BIM in facilities management share their experience with contractors unfamiliar with BIM in the construction sector to prevent potential disasters while lowering operating and maintenance costs.

Several recommendations are made based on the research findings for future studies. The following recommendations for future research are a study that compares the "adoption of BIM in facilities management and traditional facilities management in the construction industry" suggested by the researcher. Next, the researcher recommends conducting the following research: “Investigate the awareness of adoption of BIM in facilities management in Malaysia.” Lastly, the researcher suggests that the following research can be carried out: "Study on the level of implementation of BIM in facilities management in Malaysia.” It is also recommended that a mixed-method approach be adopted in future research. According to the research results that the researcher collected, the researcher suggested some recommendations to encourage BIM application in Malaysia's facilities management. Based on the knowledge and experiences gained while conducting the research from the first to the final stages, the researcher would like to recommend several research improvements for future research. These recommendations are designed to overcome research limitations and increase research relevance. Firstly, the researcher would like to suggest the adoption of ARCHIBUS in facilities management in Malaysia. After a series of investigations, the researcher found that the utilisation of ARCHIBUS is extremely low in Malaysia. Very few people have heard of ARCHIBUS in the construction industry in Malaysia. ARCHIBUS has been the world's leading provider of Total Infrastructure and Facility Management (TIFM) solutions for overall asset and facilities management for over twenty years. ARCHIBUS is used in everyday life, and its business scope encompasses nearly every aspect of facilities management. ARCHIBUS is the world's most comprehensive, integrated, mature asset and facility management solution. The ARCHIBUS solution focuses on asset and facility life cycle management, provides a visual management tool for significantly tracking assets, and provides targeted strategic long-term planning. The ARCHIBUS solution focuses on asset and facility life cycle management and includes a visual asset tracking tool. This plan is implemented systematically throughout the process regarding

Journal of Information System and Technology Management
EISSN: 0128-1666
Volume 9 Issue 37 (December 2024) PP. 185-202
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financial arrangements, space management, periodic work organisation, and predictive risk planning.

Overall, the research was carried out to achieve the objective in the study's early stages. Based on the analysis findings, this study successfully identified the challenges of BIM in facilities management and obtained suggestions for improving facilities management in Malaysia. The report began with chapter one, which described the research background, the problem statement, the research questions, the research objectives, the research scope, the research importance, and the methodology. The theories and necessary information related to the research topic and objectives were then presented in chapter two. In the following chapter, Chapter 3 describes the research methodology and approach used to collect data from respondents. The fourth chapter then analyses the data gathered from the interviews to derive findings that can answer the research question and thus achieve the research objectives. Finally, chapter five included a summary of findings, discussion, recommendation, and conclusion in which the research findings were integrated with secondary data to answer the research question and achieve research objectives. This paper concludes that the data analysis is valid and relevant even though the study was conducted using a qualitative method and that the first and second objective data were analysed using content analysis. Most data analysis findings correspond to secondary data collected in the literature review, supporting the findings' relevance. However, the research discovered a new finding that can be investigated further and considered for future secondary data research. Overall, the research successfully answered the research questions and thus met the research objectives. By completing these two tasks, the research is guaranteed to serve several important purposes for the parties mentioned in the research importance.

Acknowledegment
This research is supported by Universiti Tun Hussein Onn Malaysia (UTHM) through Tier 1 (vote Q392).

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