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FACILITY MANAGER'S ACCEPTANCE OF CMMS IN MALAYSIA: AN EXPLORATORY STUDY USING PLS-SEM APPROACH

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ABSTRACT

Computerised Maintenance Management System (CMMS) is a widely recognised software in Facilities Management (FM) that provides numerous advantages to facility managers by enhancing productivity at work. The objective of this research is to provide insight and assess the factors influencing the acceptance of CMMS among facility managers in Malaysia. As a result, an improved comprehension of CMMS technology acceptance can be formed, as well as a better understanding of other FM technology adoption. Multiple factors influence CMMS acceptance, and this study used a quantitative technique to verify the hypothesis, using the Technology Acceptance Model (TAM) in conjunction with a Partial Least Square-Structural Equation Model (PLS-SEM). In addition, 125 facility managers completed an online survey that was utilised to collect primary data. The quantitative and structural models were analysed using PLS-SEM. Based on the study's findings, perceived usefulness (PU) and perceived ease of use (PEOU) have a favourable impact on behavioural intention (BI), which influences actual usage (AU) of CMMS. The research aims to improve awareness of the degree of acceptance of CMMS among facility managers and to contribute to FM organisations' better understanding of future technology adoptions.

Keywords: CMMS, Facilities Management Malaysia, Facility Managers, PLS-SEM, TAM

1. INTRODUCTION

The FM industry in Malaysia has long been chastised for its lack of technological adoption (Firdauz et al., 2015; Kamaruzzaman & Ahmad Zawawi, 2010). However, limited research has been conducted to provide more details on the factors that influence technology adoption for FM in Malaysia. The dependency on manual processes has hindered the progress of FM in Malaysia to be more efficient and productive (Zawawi et al., 2016). Furthermore, despite the industry's continued growth and the establishment of a more strategic function than just building maintenance, it has not progressed adequately due to low technology adoption (Kamaruzzaman et al., 2018). While some technology is generally adopted, the barriers to acceptance must be thoroughly investigated.

It is undisputed that facility managers play a significant part in FM, and in recent years, facility managers' roles have evolved from operational and tactical to more strategic roles as mentioned by Roper (2017). Facility managers have been a central focus in any FM organisation. Assimilating to innovative technologies is among the challenges posed by facility managers as predicted by Alexader (1994). Hence understanding the elements that influence technology acceptance and rejection is crucial since facility managers will play a key role in technology adoption. This demonstrated the increased significance and involvement of facility managers in more strategic decisions within any organisation in comparison to a few years ago.

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Maintenance is among the key functions of FM. Essentially one of the main objectives of maintenance is to ensure the original intent of the building design can be delivered to the building occupants throughout the building's useful life (Zawawi et al., 2016). Maintenance is among the FM activity that has been computerised for many years with the introduction of several systems including Computerised Maintenance Management System (CMMS) (Rødseth et al., 2017). Additionally, CMMS has evolved to represent increased productivity and oversight of maintenance management procedures (Mather, 2002) and progressed from relatively straightforward mainframe planning of maintenance work, the software has advanced to a system that handles a wide range of maintenance tasks (Labib, 2004).

Furthermore, as a legacy technology with an elaborated history as highlighted by Teicholz (2013), CMMS will be able to provide a solid platform for this research to understand the perceptions towards the technology from facilities managers' point of view thus helping FM decision makers to understand the successful adoption of CMMS and future research for other key FM technologies. The Technology Acceptance Model (TAM) was utilised for this research to deepen the understanding of technology acceptance among facility managers, specifically adoption for CMMS. Researchers have long been interested in determining the elements that influence whether a technology is adopted or rejected, and the TAM is commonly employed in the field of technology research (Taherdoost, 2018). Numerous research studies have proven that the TAM is adequate for examining the variables influencing technology adoption.

2. LITERATURE REVIEW

2.1 Facilities Management (FM)

FM is a dynamic and multi-skilled industry encompassing people, place, process, and technology (IFMA, 2017; ISO, 2015; IWFM, 2017). FM plays a wide range of functions as it is highly complex and requires multidisciplinary skills, and buildings have grown in complexity over the years, with technology and sustainability elements thus affecting the role of FM over time (Atkin & Bildsten, 2017). Additionally, FM is critical to the success of any organization's primary business activities since it relieves occupants of problems that are unrelated to their core business (IFMA, 2017). In conclusion, FM is significant in supporting the core business with a variety of services and characteristics such as maintenance, facilities operations, cleaning services, and so on.

Since design and construction account for less than 15% of overall building ownership (Marocco & Garofolo, 2021), the facility operating cycle is the most costly and time-consuming element of facility ownership. The majority of the costs will be centred on maintenance activities, as cost competition in the FM business intensifies (Fraser, 2014). Since the last 10 to 15 years, organisations have recognised the importance of physical asset reliability through a robust maintenance regime, and maintenance is no longer considered a necessary evil for FM (Fraser, 2014; Khazraei & Deuse, 2011). Maintenance's evolving priority over the years, confirms its essential role in FM activities. The empirical evidence suggests that CMMS is an important instrument for streamlining maintenance practises, optimising resource allocation, and enhancing overall operational efficiency in FM. These findings highlight the importance of FM professionals and organisations prioritising the adoption and use of CMMS to remain competitive and achieve improved maintenance management outcomes.

2.2 Facility Managers

Keller (2012) mentioned that "facility managers are accountable to three masters: the organisation, the FM department, and the facility itself". Moreover, facility managers play a significant role in adopting technology for FM as they seek ways to improve the efficiency of their work (Araszkiewicz, 2017). It is plausible to presume that facility managers play significant roles in technology adoption. Furthermore, the function of facility managers is changing, and the capacity to adapt to ever-changing innovation will be one of the tasks that facility managers will play in combination with the increasing complexity of facilities. Teicholz (2013) further stated that facility managers are responsible for ensuring that the physical environment efficiently supports people and activities by providing the appropriate functionality and experience criteria. Hence facility managers need to investigate innovative technologies to improve the efficiency of their FM services while figuring out the accurate strategy to ensure the adoption is successful.

2.3 CMMS

CMMS has been around for a while and is utilised for FM purposes mainly for maintenance management (Araszkiewicz, 2017). As mentioned by Aziz et al. (2016) the software removes the needless, time-consuming, and redundant data collection effort and task that doesn't offer value for maintenance or FM in general. Maintenance is one of the areas that has been computerised for many years and with CMMS, real-time data collection is possible and facility managers will have the ability to make predictive actions and deduce the action based on lagging indicators (Labib, 2004; Mather, 2002). Rødseth et al. (2017) mentioned that the major anticipated change in the maintenance future will be the transition from preventive to predictive maintenance, and as a result, the need for precise data collection and analysis is critical for extremely accurate asset life cycle prediction, which can only be achieved with CMMS.

Due to the extensive number of tasks accomplished by FM, it has become essential for FM to make high-quality decisions, particularly when it comes to maintenance (Marocco & Garofolo, 2021). In addition to that, the problem of the enormous amount of data that has been gathered from the maintenance activities is fundamentally solved by CMMS (Balouei Jamkhaneh et al., 2018). Despite being a traditional technology for FM, CMMS has evolved significantly because of its features and functionality (Teicholz, 2013). It is evident that CMMS will be the foundation of a data-driven FM in the future and will be the main driver for system integration for FM as it moves towards the data-driven operation.

2.4 TAM

TAM was adopted in this study to determine the factors impacting CMMS acceptance among facility managers. Acceptance is characterised as "the affirmative decision to use an invention as opposed to the term rejection" (Taherdoost, 2018). The debate over whether to accept or reject technology as it becomes more integrated into users' personal and professional life is still an ongoing discussion (Marangunić & Granić, 2015). Davis (1985) devised TAM, which was based on psychology research on the Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB), and it has the potential to be a key paradigm for understanding the variables that affect how people will behave when utilising technology. TAM was first introduced more than 25 years ago and has since taken the lead in studies on the variables influencing users' adoption of technology (Chuttur, 2009; Marangunić & Granić, 2015; Salahshour Rad et al., 2018).

In his comprehensive study, Davis (1985) drew on earlier work by Fishbein & Ajzen (1975), who initiated the TRA, since he realised that most studies on technological acceptance had not shown significant and quantifiable results. Davis (1985) also suggested that user motivation directly influenced by external stimulation, may be used to determine how well a technology is used. The sufficiency of the TAM in exploring the factors influencing technology adoption has been supported by numerous research studies hence why it is selected for this research.

3. THEORITICAL FRAMEWORK AND RESEARCH

According to the TAM, a complicated link between system characteristics (external elements) and projected system utilisation will be mediated by two variables, Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) (Davis, 1985).

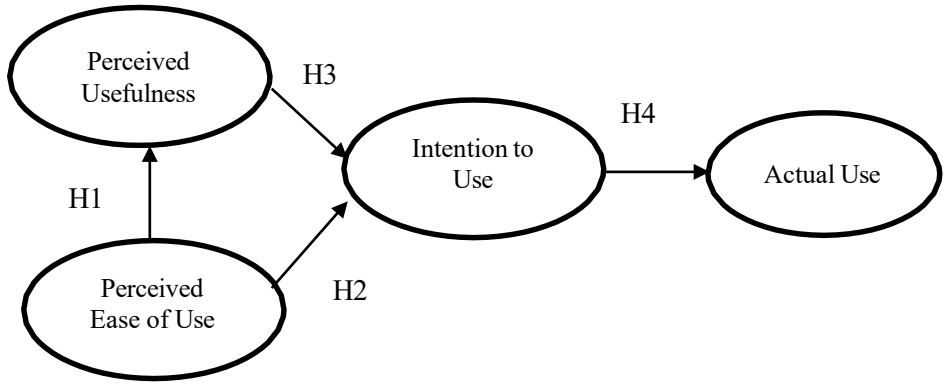

Figure 1. Technology Acceptance Model (TAM), source: Davis (1985)

TAM was adopted in this study to assess CMMS acceptance among facility managers. TAM provides a solid foundation for the success of modern technology in this regard, and it adds that a lot of factors may affect users' decision to accept a new technology when they become aware of it (Al-Maroof & Al-Emran, 2018). Hence, this research aims to test the following hypothesis by Davis's (1989) theory;

H1: "The perceived usage of CMMS is favourably influenced by perceived ease of use"
H2: "The behavioural desire to use CMMS is favourably influenced by the perceived ease of use"
H3: "The behavioural desire to utilise CMMS is substantially influenced by perceived usefulness"
H4: "The actual utilisation of CMMS is influenced by the behavioural desire to use"

4. METHODOLOGY

4.1 Questionnaire

A questionnaire was created for this research and distributed to facility managers who agreed to participate and are currently employed in the real estate and commercial property industries. The scope of the industry is narrowed into property and real estate since it is the single largest industry for FM in Malaysia and to give this research homogenous respondents. It is recognised that real estate and property represent 30% of the overall FM segment based on Moore et al. (2004) studies. Subsequently, the surveys are then analysed with PLS-SEM modelling.

The questionnaire was delivered to the respondent using an online survey created with Google Forms. The respondents were chosen from the platform's LinkedIn analytics feature and are facilities managers. The survey enables researchers to gather a wide range of information from sizable samples and extrapolate it to the wider population from whom the sample was taken (Leavy, 2017). A total of 750 facility managers who are currently employed in the real estate and commercial property industries were identified through LinkedIn analytics. Hence based on the guide by Collin & Hussey (2009), the identified population is 266. Therefore questionnaire was distributed to 266 facilities managers and the response was 125, hence the response rate is 46%. Hoxley (2008) mentioned a minimum of 30% is sufficient for a questionnaire survey.

The survey will gather details regarding the respondents in section A, including their educational background, number of years of FM experience, the sector of the industry they work in, the degree to which they have adapted to FM technology, and the extent to which biased they are towards technology. Every question in Section A will have a single response and be a multiple-choice question that examines whether they have adopted CMMS. In addition, section B of the questionnaire will use five measures to assess the degree of technology acceptance. The second set of questions for section B is dedicated to collecting data by the TAM.

Table 1. TAM Construct

Perceived Usefulness (PU)	PU 1	Using CMMS will enhance my efficiency
	PU 2	Using CMMS will enhance my productivity
	PU 3	Using CMMS will help me accomplish task
	PU 4	Using CMMS will improve my performance
	PU 5	Using CMMS can save time
Perceived Ease of Use (PEOU)	PEOU 1	I find that CMMS is easy to use
	PEOU 2	I find that CMMS will enable access data easily
	PEOU 3	I find that CMMS is convenient to use
	PEOU 4	I find that CMMS requires no training
	PEOU 5	I find that CMMS makes it easier for future work
Behavioural Intention to Use (BI)	BI 1	I intend to use CMMS if I have access to it
	BI 2	If I have access to CMMS, I will recommend to team member
	BI 3	If I have access to CMMS, I will use it more frequently
Actual Use (AU)	AU 1	I use CMMS every day
	AU 2	I use CMMS frequently

The questions used in this study were adapted from Davis (1989) with minor modifications to fit the scope of this study and factors used in this research are as follows: perceived usefulness (PU), perceived ease of use (PEOU), behavioural intention (BI), and actual use (AU). Table 1 summarised the TAM construct and each of the TAM constructs, PU, PEOU, BI and AU will be assessed by following Likert Scale; 1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree, and 5 – Strongly agree.

4.2 PLS-SEM

PLS is defined as "a technique best suited for prediction or exploratory modelling, and it is less than satisfactory as an explanatory technique due to its low power to filter out variables of minor causal importance" (Tobias, 1995). TAM was utilised in this study following the PLS-SEM modelling. The Technology Acceptance Model is being used to analyse four criteria namely; PU, PEOU, BU, and AU. PLS-SEM is the ideal approach for this study due to its being exploratory in nature (Al-Maroof & Al-Emran, 2018).

5. RESULTS AND DISCUSSION

Below is the breakdown of the respondents' demographics for the disseminated online survey. All of the respondents found on LinkedIn's social media were surveyed, and out of 266 surveys submitted to the intended facility managers, 125 were returned, accounting for 46.9% of the total response rate. According to Table 4.7, 67% of survey respondents had a bachelor's degree. A master's degree is held by 31% of facility managers, while 2% have a doctorate in philosophy. The majority of respondents consisting of 43% have 6 to 10 years of FM experience, 28% have 10 to 15 years, and 25% have more than 15 years. According to the findings, 53% of respondents, or the majority of respondents, have more than 10 years of experience. 100% of respondents work in real estate or property, and 58.4% belong to at least one professional organisation. Lastly, the survey was successful in reaching the intended respondents.

Table 2. Respondents Demographics

Demographics Background	Frequency	Percentage (%)
Role		
Facility Manager	125	100
Education Level		
Bachelor's degree	83	67
Master's degree	39	31
Professional Membership		
CIDB Certified FM	17	13.5
IFMA	9	7.2
IWFM	13	10.4
RICS	11	8.8
RISM	15	12.0
MAFM	8	6.4
None	52	41.6
Years of Experience		
1 – 5 years	5	4
6 – 10 years	54	43
10 – 15 years	35	28
More than 15 years	31	25
Industry		
Real Estate & Property	125	100

TAM attempts to offer conditions that drive technology adoption to explain user behaviour across several end-user computing platforms and user demographics and to be both practically and theoretically justified (Lee et al., 2012). The data analysis reveals that the factor loading data is measured to determine the reliability of each data set. A threshold value of 0.7 or greater for each item's loading is considered reliable (J.F. Hair et al., 2014). Additionally, Cronbach's Alpha and composite reliability scores should both be greater than or equal to 0.7.

Table 3. TAM Measurement Model result

Constructs	Items	Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Perceived Usefulness	PU1	0.837	0.881	0.913	0.679
	PU2	0.879			
	PU3	0.766			
	PU4	0.858			
	PU5	0.775			
Perceived Ease of Use	PEOU1	0.817	0.767	0.839	0.541
	PEOU2	0.836			
	PEOU3	0.891			
	PEOU4	0.205			
	PEOU5	0.709			
Behavioural Intention	BI 1	0.881	0.859	0.913	0.779
	BI 2	0.890			
	BI 3	0.876			
Actual Use	AU 1	0.919	0.859	0.933	0.875
	AU 2	0.951			

Table 3 shows that all the data observed satisfy the requirement and are hence considered reliable except PEOU4 which does not meet the loadings criteria of 0.700 value. Therefore, PEOU4 was taken out from the construct's structure. The average variance extracted (AVE), which is defined as the grand mean value of the squared loadings of the items connected to the concept, is also a standard measure for assessing convergent validity (J.F. Hair et al., 2014). When the AVE is at or above 0.5, the construct accounts for far more than 50% of the variance of its components. Table 3 also shows Cronbach's Alpha and composite reliability has more than 0.7, in addition to AVE to satisfy the requirement of 0.5. Consequently, the constructs' convergent validity is proven.

Table 4. Fornell-Larcker Criterion Result

	AU	BI	PEOU	PU
AU	0.935			
BI	0.567	0.882		
PEOU	0.591	0.553	0.816	
PU	0.515	0.544	0.486	0.824

To demonstrate the discriminant validity, the cross-loading result, the Heterotrait-Monotrait (HTMT) Ratio, and the Fornell-Larcker criterion must be examined. To satisfy the Fornell-Larcker criterion, the square root of AVE (diagonal value) for each variable must be greater than the correlation of latent variables, as indicated in the study as presented in Table 4.

Table 5: Cross Loading Result

	AU	BI	PEOU	PU
AU1	**0.919**	0.46	0.512	0.406
AU2	**0.951**	0.587	0.587	0.543
BI1	0.594	**0.881**	0.51	0.522
BI2	0.434	**0.89**	0.502	0.446
BI3	0.453	**0.876**	0.446	0.465
PEOU1	0.545	0.425	**0.817**	0.331
PEOU2	0.412	0.426	**0.837**	0.456
PEOU3	0.547	0.539	**0.891**	0.352
PEOU5	0.426	0.404	**0.709**	0.439
PU1	0.492	0.493	0.406	**0.837**
PU2	0.416	0.406	0.462	**0.879**
PU3	0.338	0.391	0.322	**0.766**
PU4	0.306	0.483	0.356	**0.858**
PU5	0.547	0.46	0.441	**0.775**

Table 6: Heterotrait-Monotrait Ratio (HTMT) Results

	AU	BI	PEOU	PU
AU				
BI	0.642			
PEOU	0.698	0.650		
PU	0.576	0.620	0.563	

Regarding the cross-loading result, each indicator's loading should be greater than the loadings of the indicators for its related variables. We can see from Table 5 that the cross-loading criteria are satisfied. Verification should be done on every HTMT result that is less than 0.85. The HTMT condition is demonstrated and met, as seen in Table 6, proving the discriminant validity.

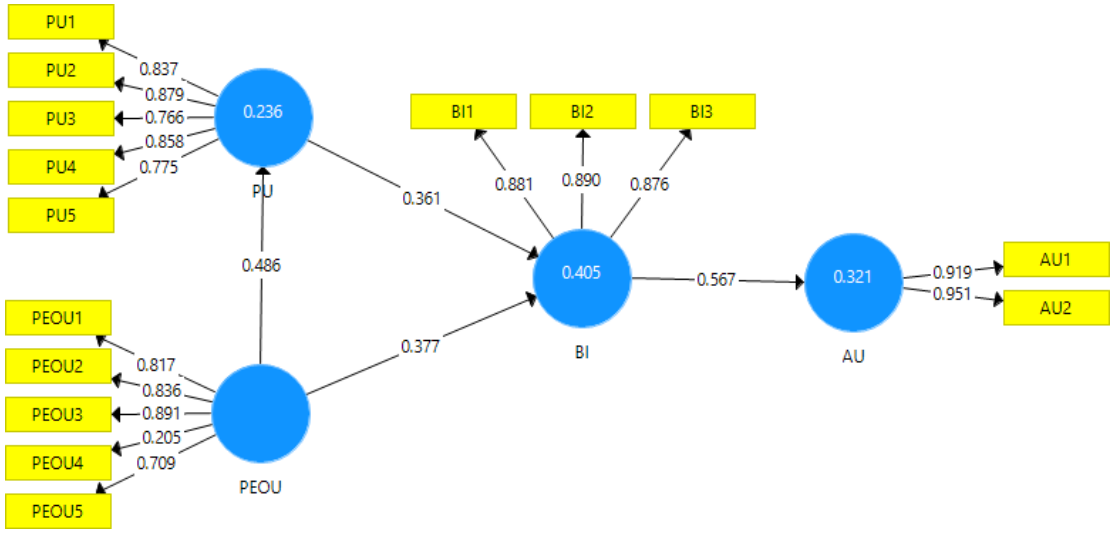

Figure 2: Path Analysis

The degree of disagreement between the model's dependent variables is used to determine the model's explanatory power. The R^2 and the path coefficients are the crucial metrics for evaluating the structural model according to J.F. Hair et al. (2014). According to Figure 2, the model's R^2 values for PU, BI, and AU are 23.6%, 40.5%, and 32.1%, respectively. In determining the hypothesis, the p-value must be lower than 0.005.

Table 7. Hypothesis Test Result

Hypothesis	Path	Path Coefficient	P Values	Remarks
H1	PEOU --> PU	0.486	0.000	Supported
H2	PEOU --> BI	0.378	0.003	Supported
H3	PU --> BI	0.361	0.003	Supported
H4	BI --> AU	0.567	0.000	Supported

For each hypothesis, the route coefficients and p-values are displayed in Figure 2 and Table 7. It is apparent that every hypothesis is valid, and this indicates that all possible connections between the independent and dependent variables are significant. The route between perceived ease of use and perceived usefulness is described by H1 (B = 0.486, p= 0.000), showing that the perceived ease of use improves the perceived utility of CMMS. The connection between perceived ease of use and behavioural intention is shown in H2 (B = 0.378, p = 0.03), indicating that the perceived ease of use influences the behavioural intention to utilise CMMS. H3 (B = 0.361, p = 0.03) illustrates the relationship between behavioural intention and perceived utility, showing that perceived usefulness has a favourable impact on behavioural intention to utilise CMMS. The following indicates a correlation between behavioural intent and actual usage; H4 (B = 0.567, p = 0.00), showing that behavioural intention strongly influences actual use of CMMS.

The data analysis produced riveting results, providing strong support for all of the empirically supported hypotheses. The study found PEOU as a critical element influencing the use of CMMS, emphasising its critical role in developing users' attitudes towards adopting and utilising CMMS. According to the findings, both the perceived simplicity of use and usefulness of CMMS has a significant role in users' inclination to use CMMS. The perceived ease of use improves the perception of CMMS as a practical and user-friendly technology, whereas the perceived usefulness establishes its value in meeting users' demands and objectives. The results also show that the actual use of CMMS is primarily determined by users' behavioural intentions. Facility managers' intention to use CMMS ultimately is determined by their perceptions of ease of use and usefulness, which affect their intention and actual usage of CMMS. Therefore, facility managers need to emphasize these two factors while considering procuring new CMMS or any other relevant technology for FM.

The findings of this research hold significant implications for facility managers, as they provide valuable insights into the factors influencing the adaptability of CMMS. These findings serve as indicators for FM decision-makers, aiding them in selecting the appropriate CMMS that will ensure a high level of acceptance and adoption by the FM team. Furthermore, the outcomes of this study can be extrapolated to other technologies, serving as a guideline for ensuring high acceptance rates of new technologies. By emphasizing the technology's perceived ease of use and usefulness, decision-makers can enhance the acceptance and adoption of various technologies across different domains or FM implementation areas. Finally, the study demonstrated that training was recognised as a key component in the process of adopting new technologies. The importance of the findings in this study arises from their contribution to addressing gaps in the current literature on the factors impacting the acceptability and adoption of CMMS. Certain parts of these characteristics have not been completely examined or adequately described prior to this research. As a result, the study's findings provide useful insights and fresh perspectives that improve our understanding of technology acceptance and adoption in the context of CMMS.

6. CONCLUSIONS

According to the study's findings, PEOU and PU positively impact facility managers' behavioural intentions to utilise CMMS. Therefore, it is possible to conclude that PEOU and PU strengthen the behavioural desire to utilise CMMS. Moreover, the study emphasizes that training is one of the key elements for CMMS adoption among facility managers. Notably, this study has several limitations that are worth citing. This research adopts TAM without further extension of adoption models thus limiting the factors in influencing the acceptance of CMMS. Additionally, because this study only focused on facility managers in the real estate and commercial property sectors, the findings from the

research cannot be applied to the rest of the FM sector, such as the healthcare and education sectors. The research also can be expanded into several other personnel in FM apart from other industries. Therefore, it can be summarised from the study that FM organization key decision makers will need to consider and acknowledge the research findings that concluded ease of use and usefulness will be key for CMMS adoption. The research shows CMMS is useful for facility managers to deliver their work effectively. A notable finding from this research shows that training will be an important factor to adopt CMMS practically. Further research should be made to explore other factors influencing the acceptance or rejection of CMMS, with the expansion of the research using other technology acceptance models.

7. REFERENCES

Alexader, K. (1994). A Strategy for Facilities Management. *Facilities*, *12*(11), 6–10.

Al-Maroof, R. A. S., & Al-Emran, M. (2018a). Students acceptance of google classroom: An exploratory study using PLS-SEM approach. *International Journal of Emerging Technologies in Learning*, *13*(6), 112–123. https://doi.org/10.3991/ijet.v13i06.8275

Al-Maroof, R. A. S., & Al-Emran, M. (2018b). Students acceptance of google classroom: An exploratory study using PLS-SEM approach. *International Journal of Emerging Technologies in Learning*, *13*(6), 112–123. https://doi.org/10.3991/ijet.v13i06.8275

Araszkiewicz, K. (2017). Digital Technologies in Facility Management - The state of Practice and Research Challenges. *Procedia Engineering*, *196*(June), 1034–1042. https://doi.org/10.1016/j.proeng.2017.08.059

Aziz, N. D., Nawawi, A. H., & Ariff, N. R. M. (2016). ICT Evolution in Facilities Management (FM): Building Information Modelling (BIM) as the Latest Technology. *Procedia - Social and Behavioral Sciences*, *234*, 363–371. https://doi.org/10.1016/j.sbspro.2016.10.253

Balouei Jamkhaneh, H., Khazaei Pool, J., Khaksar, S. M. S., Arabzad, S. M., & Verij Kazemi, R. (2018). Impacts of computerized maintenance management system and relevant supportive organizational factors on total productive maintenance. *Benchmarking*, *25*(7), 2230–2247. https://doi.org/10.1108/BIJ-05-2016-0072

Chuttur, M. (2009). Overview of the Technology Acceptance Model: Origins, Developments and Future Directions. *Association for Information Systems AIS Electronic Library (AISeL) All Sprouts Content Sprouts*. http://aisel.aisnet.org/sprouts_all

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quaterly*, *13*(3), 319–339.

Davis, F. D. Jr. (1985). *Technology Acceptance Model for Empirically Testing New End User Information System: Theory and Results*.

Firdauz, A. M., Sapri, M., & Mohammad, I. S. (2015). Facility management knowledge development in Malaysia: Added value in hospitality managerial competency. *Facilities*, *33*(1), 99–118. https://doi.org/10.1108/F-04-2013-0034

Fraser, K. (2014a). Facilities management: the strategic selection of a maintenance system. *Journal of Facilities Management*, *12*(1), 18–37. https://doi.org/10.1108/JFM-02-2013-0010

Fraser, K. (2014b). Facilities management: the strategic selection of a maintenance system. *Journal of Facilities Management*, *12*(1), 18–37. https://doi.org/10.1108/JFM-02-2013-0010

Hoxley, M. (2008). *Questionnaire design and factor analysis*. Blackwell Publishing Ltd.

J.F. Hair, G.T.M. Hult, C. Ringle, & M. Sarstedt. (2014). *A Primer On Partial Least Squares Structural Equation Modelling (PLS-SEM)*. Sage Publications.

Kamaruzzaman, S. N., & Ahmad Zawawi, E. M. (2010). Development of facilities management in Malaysia. *Journal of Facilities Management*, *8*(1), 75–81. https://doi.org/10.1108/14725961011019094

Kamaruzzaman, S. N., Myeda, N. E., Zawawi, E. M. A., & Ramli, R. M. (2018). Developing facilities management (FM) competencies for Malaysia: Reference from international practice. *Journal of Facilities Management*, *16*(2), 157–174. https://doi.org/10.1108/JFM-08-2017-0036

Keller, C. (2012). CAFM/IWMS—Balancing Technology, Processes, and Objectives. In *Technology for Facility Managers: The Impact of Cutting-Edge Technology on Facility Management* (pp. 1–20).

Khazraei, K., & Deuse, J. (2011). A strategic standpoint on maintenance taxonomy. *Journal of Facilities Management*, *9*(2), 96–113.

Labib, A. W. (2004). A decision analysis model for maintenance policy selection using a CMMS. *Journal of Quality in Maintenance Engineering*, *10*(3), 191–202. https://doi.org/10.1108/13552510410553244

Lee, S.-K., An, H.-K., & Yu, J.-H. (2012). *An Extension of the Technology Acceptance Model for BIM-based FM*.

Marangunić, N., & Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society*, *14*(1), 81–95. https://doi.org/10.1007/s10209-014-0348-1

Mather, D. (2002). *CMMS: A Timesaving Implementation Process* (1st ed.). CRC Press.

Moore, M., Finch, E., Asia, T., & Finch, P. E. (2004). *Facilities Management in South East Asia Content Indicators: Research Implications** Practice Implications** Originality** Readability**. 22*(10), 259–270.

Rødseth, H., Schjølberg, P., & Marhaug, A. (2017). Deep digital maintenance. *Advances in Manufacturing*, *5*(4), 299–310. https://doi.org/10.1007/s40436-017-0202-9

Roper, K. O. (2017). Facility management maturity and research. *Journal of Facilities Management*, *15*(3), 235–243. https://doi.org/10.1108/JFM-04-2016-0011

Salahshour Rad, M., Nilashi, M., & Mohamed Dahlan, H. (2018). Information technology adoption: a review of the literature and classification. In *Universal Access in the Information Society* (Vol. 17, Issue 2, pp. 361–390). Springer Verlag. https://doi.org/10.1007/s10209-017-0534-z

Taherdoost, H. (2018). A review of technology acceptance and adoption models and theories. *Procedia Manufacturing*, *22*, 960–967. https://doi.org/10.1016/j.promfg.2018.03.137

Teicholz, E. (2013). *Technology for facility managers- The impact of cutting edge technology on facility management*. John Wiley & Sons Inc.

Tobias, R. D. (1995). An introduction to partial least squares regression. *Proceedings of the Twentieth Annual SAS Users Group International Conference*, 1250–1257.

Zawawi, Z. A., Khazli, M., Khalid, A., Ahmad, N. A., Zahari, N. F., Aras, N., & Salim, A. (2016). *Operation and Maintenance in Facilities Management Practices: A Gap Analysis in Malaysia*. https://doi.org/10.1051/00116