

IMPLEMENTATION OF INTERNET OF THINGS IN FACILITIES
MANAGEMENT

ROSZITA INRA BINTI RAMLAN

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Project Management

School of Civil Engineering
Faculty of Engineering
Universiti Teknologi Malaysia

SEPTEMBER 2020

DEDICATION

In the name Allah SWT, I dedicated this to all my loved ones especially my angelic mother who always gives her support and gracious love at all times.

ACKNOWLEDGEMENT

Alhamdulillah. All praise to Allah SWT I managed to finish my study despite the struggles and hustles. I would like to express my gratitude to my supervisor, Ts. Dr. Aizul Nahar bin Harun for his patient and guidance throughout my journey to finish my Master Project 1 and 2. Without his guidance and advice I would not be able to finish my thesis. Thank you Dr for your time and the hard work you put in so that I can finish my thesis.

A special thanks to those who involved and became the respondents of this study. Especially Mr. C.S. Wong who was willing to arrange an appointment for an interview session with his staff as one of my respondents. Without your participation and involvement I would not be able to complete my data collection which is intending to contribute a few or more in the future to implement internet of things (IoT) in the facilities management (FM). I hope this thesis could contribute for future reference.

Last but not least, I would like to thank my mother and siblings who are always standing by my side through ups and downs.

ABSTRACT

The main purpose of this study is to enable implementation of the internet of things (IoT) in the facilities of high rise buildings as an upgrading and transformation to the new technology. The existing building system which are conventional building system and building automation system (BAS) in current FM in managing the facilities in the high rise building is seen could not be dependable as it provides limited information as well as highly expensive and difficult to justify for small to medium sized buildings. IoT can offer alternative mechanisms for success, using simple, low-cost sensor devices to provide valuable contextualized data in real-time. Hence, this study was carried out to identify the information that needs to be prioritized in order to have a comprehensive structure or a model to implement IoT in FM for improvement as well as for continuation towards sustainability in FM. The data collection for this study is qualitative data hence a semi – structured interviews' questions were conducted to five respondents which represent five high rise buildings whereas among the facilities manager and the building executives which are known as the person who has knowledge about managing the facilities of the buildings. The selected buildings for this study are located in Klang Valley. At the end of the study, there are some key information provided such as the information that should be prioritized to enable IoT application for facility management, the elements need to be completed to enable the information can be collected, stored, utilized and share through IoT to support the facility management as well as an implementation plan to apply IoT to improve facility management thus the building can be upgraded and transformed to building internet of things (BIoT). However, this study is only focused and limited to the selected high rise buildings located in the Klang Valley and for education purposes only.

ABSTRAK

Tujuan utama kajian ini adalah untuk membolehkan penggunaan internet kebendaan (IoT) di bangunan-bangunan bertingkat sebagai peningkatan dan transformasi kepada teknologi baru. Sistem bangunan yang sedia ada yang mana merupakan sistem bangunan konvensional dan sistem automasi bangunan (BAS) pada FM semasa dalam menguruskan kemudahan di bangunan tinggi yang tidak dapat diandalkan kerana memberikan maklumat yang terhad serta sangat mahal dan sukar untuk digunakan bagi bangunan kecil hingga bangunan bersaiz sederhana. IoT dapat menawarkan mekanisme alternatif untuk keberkesanan, menggunakan peranti sensor sederhana dan murah untuk menyediakan data kontekstual yang berharga dalam masa nyata. Oleh itu, kajian ini dilakukan untuk mengenal pasti maklumat yang perlu diutamakan untuk memiliki struktur yang komprehensif atau model untuk menggunakan IoT di FM untuk menambahbaik serta untuk kelanjutan menuju kelestarian di FM. Pengumpulan data untuk kajian ini adalah data kualitatif untuk setiap pertanyaan wawancara separa berstruktur yang dilakukan kepada lima responden yang mewakili lima bangunan tinggi yang terdiri daripada pengurus bangunan dan eksekutif bangunan sebagai orang yang mempunyai pengetahuan tentang menguruskan fasiliti bangunan. Bangunan terpilih untuk kajian ini terletak di Lembah Klang. Pada akhir kajian, terdapat beberapa maklumat penting yang diberikan seperti maklumat yang mesti diutamakan untuk membolehkan aplikasi IoT bagi pengurusan fasiliti, elemen-elemen yang perlu dilengkapkan untuk membolehkan maklumat dapat dikumpulkan, disimpan, digunakan dan dikongsi melalui IoT untuk menyokong pengurusan fasiliti dan juga rancangan untuk kaedah IoT untuk menaik taraf pengurusan bangunan boleh ditingkatkan dan diubah menjadi bangunan internet of things (BIoT). Walau bagaimanapun, kajian ini hanya tertumpu dan terhad kepada bangunan tinggi terpilih yang terletak di Lembah Klang dan untuk tujuan pendidikan sahaja.

TABLE OF CONTENTS

	TITLE	PAGE
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xi
	LIST OF FIGURES	xiii
	LIST OF ABBREVIATIONS	xiv
	LIST OF APPENDICES	xvi
CHAPTER 1	INTRODUCTION	1
	1.1 Introduction	1
	1.2 Problem Background	2
	1.3 Aim of Study	4
	1.4 Objectives	4
	1.5 Scope of Study	5
CHAPTER 2	LITERATURE REVIEW	7
	2.1 Introduction	7
	2.2 Definition of Facilities Management	7
	2.3 The Scope and Roles of Works in Facilities Management	11
	2.4 The Facilities Management Services	13
	2.5 Stakeholders Involvement in Facilities Management	16
	2.6 Facilities Management in Managing Intelligent Building	18
	2.7 Intelligent Building (IB)	20

2.8	Internet of Things in Facilities Management and Intelligent Building	22
2.8.1	The Current Applications of IoT in FM	26
CHAPTER 3	RESEARCH METHODOLOGY	31
3.1	Introduction	31
3.2	Research Design	31
3.2.1	Scope of the Study	32
3.2.2	Selection for the Buildings of the Study	32
3.2.3	Respondents of the Study	33
3.2.4	Limitation of Study	33
3.3	Research Procedure	34
3.4	Data Collection	35
3.4.1	Interview Question	35
3.4.2	Literature Review	36
3.4.3	Data Analysis	37
CHAPTER 4	DATA ANALYSIS AND FINDINGS	41
4.1	Introduction	41
4.2	Response Rate	41
4.3	Selected Buildings and the Respondents	42
4.4	Interview Question	42
4.5	Data Analysis	43
4.5.1	Coding the Data and Applying Codes	43
4.5.2	Review the Codes and Make Connections with Objectives	55
4.5.2.1	Objectives 1: To identify whether the facilities managers are aware on the IoT evolvement in FM.	55
4.5.2.2	Objectives 2: To identify the information that should be prioritized to enable IoT application for facility management.	56
4.5.2.3	Objective 3: To investigate how the information can be collected, stored,	

	utilized and share through IoT to support the facility management.	70
4.5.2.4	Objective 4: To develop a structured implementation plan or best practices on how IoT can be applied to improve facility management.	78
4.6	Findings and Discussion	83
CHAPTER 5	CONCLUSION AND RECOMMENDATIONS	89
5.1	Conclusion	89
5.2	Recommendations for future works	90
REFERENCES		91
APPENDICES		97

LIST OF TABLES

TABLE NO.	TITLE	PAGE
Table 2.1	Lists of summary definition of FM (Isa et al., 2016) (edited from original version)	10
Table 2.2	Results of responses to a survey question regarding a set of definitions of FM (Price, 2003) extracted from Azman et al. (2014)	11
Table 2.3	Examples of hard services and soft services (Caryl, 2018)	14
Table 2.4	Hard and soft services in FM Alexander (2009) and Atkin and Brooks (2009) cited by Jude et al. (2018)	15
Table 2.5	Organization's core and non-core business according to its priority (Ahmad et al., 2014)	15
Table 2.6	Standard services category suggested by various authors	16
Table 2.7	Current application of IoT in FM (IWFM, 2018)	27
Table 2.8	Current and possible application of IoT in FM (IWFM, 2018)	27
Table 2.9	Other resources that discussing the benefits of IoT application in FM	29
Table 3.1	The standardized open-ended questions to all respondents	36
Table 4.1	The selected buildings and the respondents' position involved	42
Table 4.2	Codes of data for each objectives	45
Table 4.3	The data gathered for each code	46
Table 4.4	The data gathered for each code	47
Table 4.5	The respondents are aware on IoT evolvement in FM	55
Table 4.6	The list of information gathered to enable IoT in FM	56
Table 4.7	Scoring reference to identify the priority of the information	58
Table 4.8	Scoring reference to identify the priority of the information	59

Table 4.9	Scoring results for each code to identify the sequence information need to be prioritized	60
Table 4.10	The data gathered for objective 3	72
Table 4.11	Extracted codes to identify the current equipment in the building	74
Table 4.12	Analysis data based on basic IoT components' checklist to enable IoT	74
Table 4.13	The requirements need to be followed for implementation plan or best practices in sequence to apply IoT to improve FM	81

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
Figure 2.1	General accommodation, services and equipment of facilities management	8
Figure 2.2	Functions and definition of Facilities Management (IFMA, 2019)	9
Figure 2.3	Reach of FM (ISO, 2016) adapted from Pegasus (2018)	12
Figure 2.4	Stakeholders involvement in FM (Edmond et al., 2012)	17
Figure 2.5	Stakeholders involvement in FM (IFMA, 2007)	17
Figure 2.6	Multiple proprietary building system in conventional method (Sinopoli, 2010)	21
Figure 2.7	Integrated building system in intelligent building (Sinopoli, 2010)	21
Figure 2.8	A conceptual framework for integrating IoT and FM in intelligent buildings (Suriyarachchi et.al, 2018)	25
Figure 3.1	Flowchart of methodology	34
Figure 4.1	Inducting coding process (Frampton, S., 2019)	44
Figure 4.2	The 4 stage of IoT architecture and components modified by author (Sikder A et al., 2018)	76
Figure 4.3	Services device sensors connected to internet cloud to enable IoT in the building, modified by author (Verma H et al., 2016)	77
Figure 4.4	The elements to enable information could be collected, stored, utilize and share through IoT management	85
Figure 4.5	Implementation plan to apply IoT to improve FM	87

LIST OF ABBREVIATIONS

AEC	-	Architecture, Engineering and Construction Community
API	-	Application Programming Interface
BAS	-	Building Automation System
BIoT	-	Building Internet of Things
BMS	-	Building Management System
BOMI	-	Building Owners and Managers Institute
CMMS	-	Computerized Maintenance Management System
CPU	-	Central Processing Unit
DLP	-	Defect Liability Period
FM	-	Facilities Management
FMS	-	Facilities Management System
GL	-	Gamuda Land
GST	-	Government Service Tax
HVAC	-	Heating, Ventilation and Air-conditioning
IB	-	Intelligent Building
IBI	-	Intelligent Building Institute
IEEE	-	Institute of Electrical and Electronics Engineers
IFMA	-	International Facility Management Association
IIS	-	Internet Information Services
IoT	-	Internet of Things
IR 4.0	-	Fourth Industrial Revolution
ISO	-	International Organization for Standardization
IWFM	-	Institute of Workplace and Facilities Management
JaGaApp	-	Jaga (Security/Guard) App
JLL	-	Jones Lang LaSalle Incorporated
LAN	-	Local Area Network
LTE	-	Long Term Evolution
MIT	-	Massachusetts Institute of Technology
N/A	-	Not Applicable
O & G	-	Oil and Gas

RFID	-	Radio-frequency Identification
RODB	-	Real-time Operational Database
ROI	-	Return on Investment
RS	-	Recommended Standard Platforms
US	-	United State
VMS	-	Vendor Management System Platform
WiFi	-	Wireless Fidelity
ZigBee	-	Zonal Intercommunication Global Standard
2G	-	2nd Generation
3G	-	3rd Generation

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Interview questions and answers	97
Appendix B	The list of information gathered to enable IoT in FM	119
Appendix C	The requirements need to be followed for implementation plan or best practices in sequence to apply IoT to improve FM	122

CHAPTER 1

INTRODUCTION

1.1 Introduction

Facilities management (FM) term had been used as early as in 1970s as a new profession with vast portfolio as stated by Varcoe (2000) cited by Tammo and Nelson (2012) whereas introduced by academia and practitioners due to its vast scope of functions. Isa, N. M., et al. (2016) stated that FM started in 1980s as a new developed management specialty whereas not focusing on managing facilities of the building but the connection with people as well as combination of administration's principles and the process of development.

In this 21st century, FM already evolves in parallel with the fast-growing development of the high-rise buildings whether the architecture and design of the buildings are complex or simple. The main focus of FM is to ensure that the building can be sustained whereas the operations and the maintenance of the buildings are crucial to FM. One of the things is the maintenance of the facilities in the building.

Nowadays, FM for the high-rise building or strata building i.e condominium, apartment, office building, and so forth are incredibly increase as well as the property developments. As stated in New Straits Times by Chan (2018), the high rise residential buildings either it is apartments or condominiums are more favorable among the clients because of its attractive packages which are including numerous facilities that offer modern lifestyles such as swimming pool, gym, lobby, gardens etc. In due to that, FM is crucial in managing high-rise building in term of its facilities as well as monitoring its operations.

1.2 Problem Background

Facilities management plays vital roles in order to ensure the building operation as well as the costing are running accordingly as per planned. Nowadays, the various services in the building especially the intelligent building (IB) requires viable FM with adaption to new technology trends which is moving fast for the sustainability in FM. Many building system technologies have been recognized in order to cater such requirements. One of the building systems is building automation system (BAS) widely used among IB. It is also recognized as building management system (BMS). However, the cost of BAS is very expensive as well as limited access to attain its data whereas the data collected is important for FM to predict and planning the building operation to improve the services and towards the sustainability of FM. The new technology which is implementation of internet of things (IoT) has the capabilities to provide FM needs and requirements to improve reliability and efficiency of the building operations.

Today, with the fast-growing development of building with various services in the building requires a lot of knowledgeable, professional, and expertise in FM as well as the building operation system. Hence, as the facilities management industry is moving fast, keeping pace with technological change and new trends is essential. FM team, especially the executives are always hands full and could not cover all possible issues to ensure the process in the structures under their care run efficiently as well as improving the efficiency of the properties. They need to continuously cultivate the good practices in order to ensure the lifespan of the building as well as the operation of the building with the extended and complexity facilities. It is merely impossible for FM to be fully aware of the whole building surrounding and condition in real time because of limited capabilities to control. In addition, it is also quite tough when it comes to access any useful information such as an evidence-based data in order to make the best decision due to inaccurate or inappropriate manual data gathered.

The function of building automation system (BAS) in intelligent building provides limited information to the facility manager to react well and optimize their performance since they only have limited information in regards with the building

operation. Intelligent building in Malaysia using BAS system basically more to sensor network-based services whereas the system services in the building only operated based on the sensor networking in the building to control the services only. Means, the data produced by the sensors unable to access by the organization meanwhile the organization need to access the data to find out any problems need to look into and any areas of inefficiency they can address well (Senseware.co, 2017). It is crucial to know that BAS is quite expensive and it is not easy to be used for small to medium sized buildings (Tushar et al., 2018). The internet of things (IoT), is seen can be used to collect and monitor many data from different resources of a building and transmit the data to the BAS's processor, generates a new opportunity to implant intelligence into the BAS to monitor as well as managing the building's energy consumption to reduce costs (Tushar et al., 2018). In addition, IoT can offer better, cheaper and faster alternative mechanisms whereas we also can use the low-cost sensor devices to collect real time data. The sensor device is the key enabler that can provide better information-based decisions as well as providing intelligent, reliable and efficient buildings.

It requires a lot of cooperation between FM, IT, Architecture, Engineering and Construction (AEC) communities for the building IoT to reach its potential because it will have to change the design and the construction of facilities. All of them should be well informed to each other's roles, and develop some or more new skills to improve an aspect of a building (Wales, 2019). However, previous researchers found that owners and facility managers lack of enough knowledge of IoT as they are lacking in understanding about IoT especially the function of IoT that can be used for facility management. Moreover, the construction industry does not understand facility management as well.

Thus, there is a need to have a comprehensive structured, planning, basic information or model that could assist FM professionals in order to consider implementing IoT in FM with aiming to improve as well as for continuation towards sustainable FM.

1.3 Aim of Study

This study was carried out to determine the level of building services adaption to the selected high rise building in Klang Valley as the case study as well as the operation and controlling of the facilities services in the building. Awareness of facility manager in using IoT in the facilities management plays vital role to pilot the organization readiness towards upgrading building management system i.e from the current building system either it is conventional building system or building automation system (BAS) to building internet of things (BIoT) with adoption of internet of things in managing the facilities.

In addition, this study will be carried out in order to identify the way data can be collected by the sensors of the building, the type of data from sensors, the type of data needed in the organization that they need to improve their organization performance. At the end of the study, the recommendations will be given based on the findings.

1.4 Objectives

The objectives of this study are as follows:

To identify whether the facilities managers are aware of the IoT evolvement in FM.

- i. To identify the information that should be prioritized to enable IoT application for facility management.
- ii. To investigate how the information can be collected, stored, utilized and shared through IoT to support the facility management.
- iii. To develop a structured implementation plan or best practices on how IoT can be applied to improve facility management.

1.5 Scope of Study

In this study, it focused on the implementation of IoT in FM in the scope of high rise building in Klang Valley. Particularly, the building manager, building supervisor and or the charge man for each intelligent building and building executives were the respondents in this study because they are the main key player in managing the facilities hence the primary data will be based on their experiences which play vital role in evidence-based practice whereby as the main contribution to obtain accuracy of the data needed.

REFERENCES

- Adama, U.J., and Michell, K.A., (2017) Potential Effects of Technological Innovations on Facilities Management Practice. *International Research Conference 2017 Shaping Tomorrow Build Environment Conference Proceedings*, page 211. University of Salford, Manchester.
- Ahmad Zawawi, Z., Ismail, F., Kamaruddin, N., & Kurdi, M. K. (2014). The Core Services of the Facilities Management Based Company in Malaysia. *MATEC Web of Conferences*, 15, 1–6. Retrieved from <https://doi.org/10.1051/mateconf/20141501016>.
- Anker Jensen, P. (2011). Organisation of Facilities Management in Relation to Core Business. *Journal of Facilities Management*, 9(2), 78–95. Retrieved from <https://doi.org/10.1108/14725961111128443>.
- Azman, N., Nor, M., Mohammed A et al. (2014). Facility Management History and Evolution. Retrieved from https://www.academia.edu/9962414/Facility_Management_History_and_Evolution.
- Barrett, P. & Edward (2013). *Facilities Management: The Dynamic of Excellence*. United Kingdom: John Wiley & Sons, 2013. Print.
- BOMI International (2002) *Facilities Check List Practical, Step-by-step Guides for the Busy FM*. Retrieved from <https://fmilink.com/articles/facilities-management-defined/>.
- Caryl, C. (2018). The Difference between Hard and Soft Services in Facility Management. Retrieved from <https://smartcsm.com/the-difference-between-hard-and-soft-services-in-facility-management/>.
- Chan, I., (2018). Management of Strata Property. *New Straits Times*. Retrieved from <https://www.nst.com.my/property/2018/04/359471/management-strata-property>
- Chavan, M.S., and Mogan A.A. (2018). IoT for Smart Building. *International Journal on Recent and Innovation Trends in Computing and Communication* Volume: 6 Issue:1, ISSN: 2321-8169 154-157.
- Christiansen, B. (2019). How Internet of Things (IoT) Aids Facility Management and Physical Security. Retrieved from <https://www.sourcesecurity.com/insights/>

internet-iot-aids-facility-management-physical-co-1544632565ga.1544627563.html.

Chaouchi, H., (2010). *The Internet of Things: Connecting Objects to the Web*. UK & USA: ISTE Ltd & John Wiley & Sons, Inc. 2010.

Digiteum Team (2019). *The Role of IoT in Facility Management*. Retrieved from <https://www.digiteum.com/iot-facility-management#4>.

Dudovski, J (2018). *Qualitative Data Analysis*. Retrieved 30th September 2019 from <https://research-methodology.net/research-methods/data-analysis/qualitative-data-analysis/>.

Edmond P. Rondeau, R. K. B., Paul D. Lapidés. (2012). *Facility Management* (2 ed.): John Wiley & Sons, 2012.

Fang, S., Da, Zhu Y., A. Jiaerheng, Pei et.al (2014). An Integrated System for Regional Environmental Monitoring and Management Based on Internet of Things. *IEEE Transactions on Industrial Informatics* (Volume: 10, Issue: 2, May 2014), doi: 10.1109/TII.2014.2302638.

Frampton, S. (2019). *Coding Qualitative Data: A Beginner's How to Examples*. Retrieved from <https://chattermill.com/blog/coding-qualitative-data/>.

Heriot Watt University (2016). Unit 2 - The Scope and Role of Facilities Management. *Facilities Management* 1.

Hills, B. (2019). *How IoT Technology Can Enhance Facilities Management*. Retrieved from <https://banyanhills.com/how-iot-technology-can-enhance-facilities-management/>.

International Facility Management Association, IFMA (2019). *Introduction of Facility Management*. Retrieved from https://www.ifma.org/Sitefinity/WebsiteTemplates/IntroductionToFacilityManagement/a001_1.0_definition_and_functions_of_facility_management_introduction.html.

International Facility Management Association, IFMA (2019). *What is Facility Management?* Retrieved from <https://www.ifma.org/about/what-is-facility-management>.

Isa, N. M., Kamaruzzaman, S.N., Mohamed, O., Jaapar, A., & Asbollah, A. Z. (2016). *Facilities Management Practices in Malaysia: A Literature Review*. *MATEC Web of Conferences*, 66, 00054. Retrieved from <https://doi.org/10.1051/mateconf/20166600054>.

Jorgensen, J. S. (2003). *What is Facilities Management?* Safma. Retrieved from

- <http://www.royjorgensen.com/wp-content/uploads/2016/07/What-is-Facilities-Management-RJA-Website-Posting.pdf>.
- Jude Fernando D, Dissanayake P, Naiduwa-Handi C et al. (2018). Key Performance Indicators for Measuring the Performance of Facilities Management Services. Retrieved from https://www.researchgate.net/publication/326826963_Key_Performance_Indicators_for_Measuring_the_Performance_of_Facilities_Management_Services_in_Hotel_Buildings_A_Literature_Review.
- Kelly, J., Hunter, K., Shen, G., & Yu, A. (2005). Briefing from a Facilities Management Perspective. *Facilities*, 23, 356-367. Retrieved from <https://doi.org/10.1108/02632770510600308>.
- Kujuro, A., and Yasuda H. (1993). Systems Evolution in Intelligent Buildings. *IEEE Communications Magazine* Volume; 31 Issue:10, doi: 10.1109/35.237978.
- Lavers, S. (2019). 5 Ways All Facility Management Teams can benefit from IoT. Retrieved from <https://www.servicefutures.com/5-ways-all-facility-management-teams-can-benefit-from-iot>.
- MAFM (2018). The Total Management that Integrates All Services to Support the Core Business of an Organization. Retrieved from <https://www.mafm.org.my/>.
- McClelland, C., (2020). What is IoT? – A Simple Explanation of the Internet of Things. Retrieved from <https://www.iotforall.com/what-is-iot-simple-explanation/>.
- Mohammed, A. H., Nor, N. A. M., & Baung Alias. (2014). Facility Management History and Evolution. *International Journal of Facility Management (IJFM)*, 5(1), no page number. Retrieved from https://www.academia.edu/9962414/Facility_Management_History_and_Evolution.
- Morgan, J., (2014). A Simple Explanation of the Internet of Things. Retrieved from <https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#6d3245fd1d09>.
- Myeda, N. E., & Pitt, M. (2014). Facilities Management in Malaysia: Understanding the development and practice. *Facilities*, 32(9-10), 490-508. Retrieved from <https://doi.org/10.1108/F-02-2012-0012>.
- Najib, Md., & Ridzuan, M (2009). Maintenance Management of High Rise Buildings

- in Malaysia: A Preliminary Study in Klang Valley. Proceedings of the International Conference on Construction Industry 2009, 30 Jul – 1 Aug 2009, Padang, Indonesia, p.2. Retrieved from http://irep.iium.edu.my/8424/2/ICCI_2009_8424.pdf.
- Nardelli, G., Scupola, A., & Jensen, P. A. (2014). Innovation in Services and Stakeholders Interactions: Cases from Facilities Management. *Roskilde University*, 269. Retrieved from http://orbit.dtu.dk/files/110825107/Innovation_in_Services.pdf.
- Omar, O., (2018). Intelligent Building, Definitions, Factors, and Evaluation Criteria of Selection. *Alexandra Engineering Journal*, (2018), 2903-2910, 57(4), doi: 10.1016/j.aej.2018.07.004.
- Pasek, J., and Sojkova V. (2018). Facility Management of Smart Buildings. *Int. Rev. Appl. Sci. Eng.* 9 (2018) 2, 181–187, doi: 10.1556/1848.2018.9.2.15.
- Patanapiradej, W., 2012. The Scope of Facility Management. *Nakhara: Journal of Environmental Design and Planning*, Volume 1, pp. 75-90.
- Pegasus (2018) ISO 41001:2018- The World's First International Facilities Management System (FMS) Standard. Retrieved from <https://www.pegasuslegalregister.com/2018/08/03/iso-410012018-worlds-first-international-fms-standard/>.
- Penny, J. (2018). What is IoT? How Smart Building Technology is Changing Facilities Management. *Buildings Smarter Facility Management*. Retrieved from <https://www.buildings.com/news/industry-news/articleid/21603/title/iot-smart-building-technology>.
- Petty, L. (2016). Soft and Hard Facilities Management: What's the Difference? Retrieved from <https://www.highspeedtraining.co.uk/hub/soft-hard-facilities-management-difference/>.
- Puddy, J., Price, I. and Smith, L. (2001), "FM Policies and Standards as a Knowledge Management System", *Facilities*, Vol. 19 No. 13/14, pp. 504-515.
- Salleh, H., S.A. Azlan & Nizam (2009). A Case Studies of Intelligent Buildings in Malaysia. *Malaysian Construction Research Journal*; Vol.4|No.1|2009, Retrieved from <https://pdfs.semanticscholar.org/3425/09bc9157adac9d66c09b85423c751906f82d.pdf>.
- Senseware.co (2017), How Building Automation Systems Work. Retrieved from

- (2018). Internet of Things for Green Building Management: Disruptive Innovations through Low-Cost Sensor Technology and Artificial Intelligence. *IEEE Signal Processing Magazine*, 35(5), 100-110. doi:10.1109/msp.2018.2842096.
- U Flick (2018). *An Introduction to Qualitative Research*, 6th Edition; Chapter 8 Planning the Process in Qualitative Research. SAGE, 2018.
- US Department of Energy (2010). *Operations and Maintenance Best Practices Guidelines*. Retrieved from https://www.energy.gov/sites/prod/files/2013/10/f3/omguide_complete.pdf.
- Verma H, Jain M, Goel K et al (2016). Smart Home System Based On Internet of Things. *Proceedings of the 10th INDIACom, 2016 3rd International Conference on Computing for Sustainable Global Development, INDIACom 2016*, (2016), 2073-2075.
- Villeneuve, M. (2019). Connected Buildings save Money, Improve Tenant Experience. *Buildings Smarter Facility Management*. Retrieved from <https://www.buildings.com/news/industry-news/articleid/21958/title/connected-buildings-save-money-improve-tenant-experience>.
- Wales, P., (2019). Challenges Facing Building IoT Adoption. Retrieved from <https://www.facilitiesnet.com/software/article/Challenges-Facing-Building-IoT-Adoption-Facilities-Management-Software-Feature—16674>.
- Wattsense (2019). IoT Applications in Facility Management. Retrieved from: <https://www.iotforall.com/iot-applications-facility-management>.
- Weglicki, M. (2019). Connected Buildings Increase as Companies Prioritize Advantages. *Buildings Smarter Facility Management*. Retrieved from <https://www.buildings.com/news/industry-news/articleid/22032/title/connected-buildings-increase>
- Wikipedia (2019). Facility Management. Retrieved from https://en.wikipedia.org/wiki/Facility_management.

APPENDICES

Appendix A Interview questions and answers

Interview Questions and Answers

Appendix A (1)

Interviewee Name: RESPONDENT A for BUILDING A ***The questions are referred to the building you manage currently.**
 Position: MANAGER TOWNSHIP
 Building Project: PANGSAPURI GAPURA BAYU
 Type of Building: LOW MEDIUM COST APARTMENT
 Date and time: 27/08/2020 at 10.00am

Interview Questions:

No.	Questions	Feedback
1	Do you aware on IoT evolvement in Facilities Management? (Yes/No)	Yes
2	Do you know what is IoT? (Yes/No)	Yes
3	Do you understand how IoT works? (Yes/No)	Yes
4	What system you used to run the services in your building? (Building Automation System (BAS)/ Building Management System (BMS)/ Conventional Building System etc)	Conventional Building System 1) Auto barrier gate system - the system to controlled ingress and outgress with RFID access card. All parcel owners entitled free RFID tag dedicated parking lots. 2) Water pump system to supply water to main water tank located at roof top level. 3) We used GL Oneapp platform to manage our soft services such as visitor registration, booking for multipurpose hall, helpdesk services etc. 4) Visitor registration - We need to know how many visitor and the visitor car as well as the identity of each visitor. We need to control the visitor car parking to avoid congested. The visitor identity need to be registered for safety and security purposes. 5) Online Helpdesk services - The informations we need: who is the complainer, which unit, what the complains, what we can do and act accordingly.
6	What type of connectivity platform provided in the building? Is it wire network or wireless interfaces?	Wire network and wireless interfaces.
7	Does the building services has a server to store all the information?	Yes, to store all data on daily and maintenance inspection checklist.
8	How does the facilities services in the building works? (HVAC, Automatic Door System and	N/A

Interview Questions:

No.	Questions	Feedback
	Fire Fighting System)	
9	Does all services are automation and have their own sensors embedded? Where the sensors embedded?	N/A
10	Let says, if the services can be linked to another services, what would be the services in your mind so that can ease FM job?	Current stand-alone system are very minimal, therefore is not crucial to intergrate on overall systems.
	What types of information you need to ensure the services provided well done?	Not at the moment. We are still in 24 month DLP
11	How the informations will be collected, where the informations will be stored and when the informations will reused ?	The data storage in Fieldview system, the technician will conduct daily inspections based on pre-set checklist in the system.
12	Where the overall control systems of the building's services located?	Lift supervisory panel located at common area and monitored by security guards.
13	Who can have the access and control the systems of the buildings?	Building Manager, Executive FM, Operation Management team.
14	In overall, what are the functions of the control room?	N/A
15	Does the services provided connected to another services at the same time or solely works?	All the services work individually and not connected to each others.
	How many times the maintenance works of each services been planned? Does it progress accordingly?	Annual preventive maintenance scheduled inclusive monthly maintenance will be established every year to ease the breakdown on each services, apparently breakdown still happened with minimal downtime.
16	When the maintenance works of the services will be notified and who notify to Manager?	All issues or breakdown will be notified to respective managers via whatsapp or mobile phones by building executive.
17	Does the standby team or any relevant parties will be notified at the same time?	Yes. Via whatsapp or phone call
18	Are there any predictive maintenances for the services?	Lift ,Auto barrier gate system & water pump system
19	What services are frequently non-predictive maintenance have to take over by the management team as at to date?	N/A
20	How long it takes the team to resolve the issues?	N/A
21	What difficulties the team have to face during the maintenances works, especially when handling the non-predictive maintenance?	N/A
22	In any emergency cases in the building, how the team response to it? Example: Passenger stuck in lift	Based on man trap cases, in-house technicians will respond upon emergency call button triggered and immediately attend, evaluate the issue and contact service provider accordingly.
23	Does the process of action to response on the emergency case takes short time, long hours	Approx 30 minutes to 1 hour.

Interview Questions:

No.	Questions	Feedback
	or at reasonable time?	
24	What consequences that can be identified if the process of action needed to be taken in any emergency cases take too long or delay? How does Manager resolve the issue? Is there any contingency planning?	Case example; frequent lift breakdown & man-trap, hence the service provider adhere on-time maintenance schedules. The Manager will demand full audit inspections on all lifts and all findings and issue to be resolve with-in agreed time frame.
25	Does the cost of operations increasing or decreasing from the past 3 to 5 years? If increasing or decreasing why does it happen?	At the moment the building still under 24 months defects liability period.
26	Usually, how they control the budget of the yearly or monthly operations? Is there any cut off cost in operations take over?	Appointments of service provider via e-auction process helps to adhere approved annual budget, with technical evaluation exercise in place all service provider can be measure equally based on their performance.
27	How the maintenance team will strategize the contingencies planning?	We will have management meeting every week to discuss any issues arising, keep the team with up to date informations, works progress, assigning tasks etc.
28	Does the owner of the building willing or has intention to upgrade the building equipment to implement IoT application of IoT in the facilities management of the building parallel to IR 4.0?	Not at the moment.
29	In your opinion, what the building owner can do to upgrade their building from Intelligent Building to Building of Internet of Things (BIoT) by implement IoT in application in the building facilities and	We are looking forward to exploring more of this IoT in the near future
30	As Manager and you know about IoT and your building well, in your opinion what the equipments should be install to enable your building with IoT?	N/A

Interview Questions and Answers

Appendix A (2)

Interviewee Name: RESPONDENT B for BUILDING B
 Position: BUILDING EXECUTIVE CUM ADMIN
 Building Project: Pangsapuri Merdeka Villa
 Type of Building: Low to Medium Cost Apartment
 Date and time: 31/8/2020

***The questions are referred to the building you manage currently.**

Interview Questions:

No.	Questions	Feedback
1	Do you aware on IoT evolvement in Facilities Management? (Yes/No)	Yes
2	Do you know what is IoT? (Yes/No)	Yes
3	Do you understand how IoT works? (Yes/No)	Yes
4	What system you used to run the services in your building? (Building Automation System (BAS)/ Building Management System (BMS)/ Conventional Building System etc)	Conventional Building System
5	What types of services provided in the building and what informations they need from the services?	<p>Hard services: Fire Fighting System. Monitored manually monthly.</p> <p>Fire Fighting System - We need to know where all the fire fighting system located, when to do the maintenance and how to detect and check the malfunction of Fire Fighting System from time to time to ensure it is functional and in good condition. We do not want any fire incidents failed due to Fire Fighting System problem because it will cause more disaster. Preventive is better than cure.</p> <p>In our apartment, we don't have any control system to monitor. All manually monitored by BE or Technician</p> <p>Soft services such as visitor recordings, hall rentals, renovations, moving in and out, delivery of items, complaints all are in manual format.</p> <p>1) Visitor registration - We need to know how many visitor and the visitor car as well as the identity of</p>

Interview Questions:

No.	Questions	Feedback
		<p>each visitor. We need to control the visitor car parking to avoid congested. The visitor identity need to be registered for safety and security purposes.</p> <p>2) Booking for multipurpose hall - We need to know which time and date the client wants to reserve so that we can arrange accordingly. The client also need to state the purpose of the usage and the total people involve because we will arrange which hall is suitable for them so that the space could accommodate them.</p> <p>3) Helpdesk services - The informations we need: who is the complainer, which unit, what the complains, what we can do and act accordingly.</p>
6	What type of connectivity platform provided in the building? Is it wire network or wireless interfaces?	Both. Wire network and wireless interfaces.
7	Does the building services has a server to store all the information?	Nil
8	How does the facilities services in the building works? (HVAC, Automatic Door System and Fire Fighting System)	Fire Fighting System - When there is fire, the heat detector can senses the increasing of the temperature or the smoke detector can senses some smoke both will response a signal to alarm system to function on the spot to warning the occupants of the building. At the same time, the water sprinkler will activate and release the water. For LV room and genset room, once fire occurs inside, the pilot cylinder inside the room will activate and sprinkles out CO2 powder and the fire curtain will released to prevent fire spreading.
9	Does all services are automation and have their own sensors embedded? Where the sensors embedded?	The fire panels are embedded at the active zone almost at all strategic places. The main panel is located at security post.
10	Let says, if the services can be linked to	Lighting. To indicates where the

Interview Questions:

No.	Questions	Feedback
	another services, what would be the services in your mind so that can ease FM job?	bulb is malfunction. It really can save time for technician to check and replace
	What types of information you need to ensure the services provided well done?	True information and quick access to data.
11	How the informations will be collected, where the informations will be stored and when the informations will reused ?	I'm not sure since we don't have any data storage for this low cost apartment
12	Where the overall control systems of the building's services located?	Management office
13	Who can have the access and control the systems of the buildings?	Building Manager, Executive FM, Area Manager, Operation Management team etc
14	In overall, what are the functions of the control room?	To oversee overall facilities especially the main facilities i.e safety and security, HVAC, fire fighting system, lift and elevators.
15	Does the services provided connected to another services at the same time or solely works?	All the services work individually and not connected to each others.
	How many times the maintenance works of each services been planned? Does it progress accordingly?	Monthly service and daily checking still required to ensure all utilities are in good condition
16	When the maintenance works of the services will be notified and who notify to Manager?	When the problem happens or any issues arising at that time. The subordinate at site will get the Manager be informed via whatsapp or phone call after received the complaints from the residents/occupants.
17	Does the standby team or any relevant parties will be notified at the same time?	Yes. Via whatsapp or phone call
18	Are there any predictive maintenances for the services?	Yes. For fire fighting system
19	What services are frequently non-predictive maintenance have to take over by the management team as at to date?	Lift system, pump system and fire fighting system
20	How long it takes the team to resolve the issues?	2 to 4 hours and some times more than that depends on the situation
21	What difficulties the team have to face during the maintenances works, especially when handling the non-predictive maintenance?	The related and relevants parties involve take more time to respon due to late to be informed.
22	In any emergency cases in the building, how the team response to it? Example:	Normally the residents directly call the emergency standby lift

Interview Questions:

No.	Questions	Feedback
	Passenger stuck in lift	technician number which included inside the lift. Security officer normally will standby outside to calm the residents that mantrap inside the lift
23	Does the process of action to response on the emergency case takes short time, long hours or at reasonable time?	Mantrap person must be released within 30mins by lift service provider. If more than that, Bomba will be called
24	What consequences that can be identified if the process of action needed to be taken in any emergency cases take too long or delay? How does Manager resolve the issue? Is there any contingency planning?	The passenger has health problem and got panic. Call for ambulance as well to check the passenger health afterwards. Contingency plan will only be planned if requested to do so from the top management because it will involve budgeting.
25	Does the cost of operations increasing or decreasing from the past 3 to 5 years? If increasing or decreasing why does it happen?	Increasing. The repair works for the equipments is quite expensive. For example, cost to repair for the lift.
26	Usually, how they control the budget of the yearly or monthly operations? Is there any cut off cost in operations take over?	Assign to the most affordable services to avoid over budget. Sometimes, there will be in need to cut off the cost in order to control the operations cost. For example reduce the number of general workers to do maintenance at common area from 4 numbers to 3 numbers only. Other time, there will be in need to change the contractor for certain services due to budgeting problem. We have to assign the contractor with lowest offer for the same services regardless their quality of works.
27	How the maintenance team will strategize the contingencies planning?	We will have management meeting every week to discuss any issues arising, keep the team with up to date informations, works progress, assigning tasks etc.
28	Does the owner of the building willing or has intention to upgrade the building equipment to implement IoT application of IoT in the facilities management of the building parallel to IR 4.0?	Depends on our budget.

Interview Questions:

No.	Questions	Feedback
29	In your opinion, what the building owner can do to upgrade their building from Intelligent Building to Building of Internet of Things (BIoT) by implement IoT in application in the building facilities and services?	“I don’t have much comment on this but if IoT can help to ease the FM jobs, I think the building owner should consider this application. Furthermore, I think our country has actively promote on IR4.0 which means the services in FM need to be upgraded with the current trend to avoid outdated.”
30	As Manager and you know about IoT and your building well, in your opinion what the equipments should be install to enable your building with IoT?	First, we might need Smart Water Meter to be installed individually at syabas meter. Easier for the maintenance team to monitor the usage of water and the readings can be disclosed to residents without any discrepancy. Second, BAS need to be installed to integrate all maintenance for easier monitoring. Thirdly, for security system, need to install rfid or other upgraded system to replace access card system.

Interview Questions and Answers

Appendix A (2)

Interviewee Name: RESPONDENT C for BUILDING C ***The questions are referred to the**
 Position: BUILDING EXECUTIVE CUM **building you manage currently.**
 ADMIN
 Building Project: PRIVATE AND CONFIDENTIAL
 Type of Building: CONDOMINIUM
 Date and time: 27/08/2020 at 2.00pm

Interview Questions:

No.	Questions	Feedback
1	Do you aware on IoT evolvement in Facilities Management? (Yes/No)	Yes
2	Do you know what is IoT? (Yes/No)	Yes
3	Do you understand how IoT works? (Yes/No)	Yes
4	What system you used to run the services in your building? (Building Automation System (BAS)/ Building Management System (BMS)/ Conventional Building System etc)	Building Automation System (BAS)
5	What types of services provided in the building and what informations they need from the services?	<p>Hard services: HVAC, Control System, Fire Fighting System, etc. These services will be controlled and monitored from our control room.</p> <p>1) HVAC - We need to know the average temperature for the building at common area so that the occupants in comfortable state. We need to determine when to control heat or cool the area based on in building temperature.</p> <p>2) Fire Fighting System - We need to know where all the fire fighting system located, when to do the maintenance and how to detect and check the malfunction of Fire Fighting System from time to time to ensure it is functional and in good condition. We do not want any fire incidents failed due to Fire Fighting System problem because it will cause more disaster. Preventive is better than cure.</p> <p>3) Control System - We need to know all the services and facilities in the building and to ensure all are functional and in a good state at all time. We need to know the duration of lifespan for all the services and when the maintenances and services</p>

No.	Questions	Feedback
		<p>should take over. The lifespan of the services also depends on the usage frequency but we only can know whether we should do maintenance and repair works when the problem happens apart from the scheduled maintenance.</p> <p>Soft services: We used JaGaApp platform to manage our soft services such as visitor registration, booking for multipurpose hall, helpdesk services etc.</p> <p>1) Visitor registration - We need to know how many visitor and the visitor car as well as the identity of each visitor. We need to control the visitor car parking to avoid congested. The visitor identity need to be registered for safety and security purposes.</p> <p>2) Booking for multipurpose hall - We need to know which time and date the client wants to reserve so that we can arrange accordingly. The client also need to state the purpose of the usage and the total people involve because we will arrange which hall is suitable for them so that the space could accommodate them.</p> <p>3) Helpdesk services - The informations we need: who is the complainer, which unit, what the complains, what we can do and act accordingly.</p>
6	What type of connectivity platform provided in the building? Is it wire network or wireless interfaces?	Both. Wire network and wireless interfaces.
7	Does the building services has a server to store all the information?	Yes. Company personal physical server to be used by the building management. We also used Dropbox as our virtual server as well.
8	How does the facilities services in the building works? (HVAC, Automatic Door System and Fire Fighting System)	HVAC - We control from our control room and it is centralized to entire building for common area. It has zone control system as well so that the occupants can control the temperature individually in their premise.

No.	Questions	Feedback
		<p>Automatic Door System - At the lobby, the door will open and close based on sound detector. For the occupants, they need to use access card to enter the premise and we have control to their accessibility whereas they can only access to their floor and to the common and public facilities area. This is for security and safety of the occupants.</p> <p>Fire Fighting System - When there is fire, the heat detector can senses the increasing of the temperature or the smoke detector can senses some smoke both will response a signal to alarm system to function on the spot to warning the occupants of the building. At the same time, the water sprinkler will activate and release the water.</p>
9	Does all services are automation and have their own sensors embedded? Where the sensors embedded?	Partially emdedded and the rest manually control. Normally it will be embedded near the facilities within radius 1 meter only. For example automatic entry door at lobby, the sensor installation at top of the door to detect the entrée
10	<p>Let says, if the services can be linked to another services, what would be the services in your mind so that can ease FM job?</p> <p>What types of information you need to ensure the services provided well done?</p>	<p>HVAC and lighting. Both can operate automatic at same time just based on the total number of people in the room whereas HVAC will automatically adjusted to accommodate the occupants and the lighting will turn on when there is people in the room and turn off automatically when they left the room. It can saves time, energy saving and cost of operation whereas it will only activated when occupied only and no waste of energy.</p> <p>Accurate and real-time data so that the maintenance can be arrange and schedule accordingly without any overbudget and at the same time can saves the cost of operations.</p>
11	How the informations will be collected, where the informations will be stored and when the informations will reused ?	Not sure. Because most of the services with sensor work individually and there is no data storage for any information from the sensors. If there is a complaint to any

No.	Questions	Feedback
		of the services then only we arrange for the repair works accordingly. For instance, if the automatic entry door malfunction, we just straight away will call the respective contractor to do the repair works immediately.
12	Where the overall control systems of the building's services located?	In one control systems' room
13	Who can have the access and control the systems of the buildings?	Building Manager, Executive FM, Area Manager, Operation Management team etc
14	In overall, what are the functions of the control room?	To oversee overall facilities especially the main facilities i.e safety and security, HVAC, fire fighting system, lift and elevators.
15	Does the services provided connected to another services at the same time or solely works?	All the services work individually and not connected to each others.
	How many times the maintenance works of each services been planned? Does it progress accordingly?	Monthly planning for the maintenance works. But the progress not well progress all the time.
16	When the maintenance works of the services will be notified and who notify to Manager?	When the problem happens or any issues arising at that time. The subordinate at site will get the Manager be informed via whatsapp or phone call after received the complaints from the residents/occupants.
17	Does the standby team or any relevant parties will be notified at the same time?	Yes. Via whatsapp or phone call
18	Are there any predictive maintenances for the services?	Yes. For fire fighting system
19	What services are frequently non-predictive maintenance have to take over by the management team as at to date?	Lift system and fire fighting system
20	How long it takes the team to resolve the issues?	2 to 4 hours and some times more than that depends on the situation
21	What difficulties the team have to face during the maintenances works, especially when handling the non-predictive maintenance?	The related and relevant parties involve take more time to respond due to late to be informed.
22	In any emergency cases in the building, how the team response to it? Example: Passenger stuck in lift	The trapman pushes the emergency button to alert everyone around and needs to call for the lift technician to come and repair the lift.
23	Does the process of action to response on	It takes long hours. More than 1

No.	Questions	Feedback
	the emergency case takes short time, long hours or at reasonable time?	hours.
24	What consequences that can be identified if the process of action needed to be taken in any emergency cases take too long or delay? How does Manager resolve the issue? Is there any contingency planning?	The passenger has health problem and got panic. Call for ambulance as well to check the passenger health afterwards. Contingency plan will only be planned if requested to do so from the top management because it will involve budgeting.
25	Does the cost of operations increasing or decreasing from the past 3 to 5 years? If increasing or decreasing why does it happen?	Increasing. The repair works for the equipments is quite expensive. For example, cost to repair for the lift.
26	Usually, how they control the budget of the yearly or monthly operations? Is there any cut off cost in operations take over?	Assign to the most affordable services to avoid over budget. Sometimes, there will be in need to cut off the cost in order to control the operations cost. For example reduce the number of general workers to do maintenance at common area from 4 numbers to 3 numbers only. Other time, there will be in need to change the contractor for certain services due to budgeting problem. We have to assign the contractor with lowest offer for the same services regardless their quality of works.
27	How the maintenance team will strategize the contingencies planning?	We will have management meeting every week to discuss any issues arising, keep the team with up to date informations, works progress, assigning tasks etc.
28	Does the owner of the building willing or has intention to upgrade the building equipment to implement IoT application of IoT in the facilities management of the building parallel to IR 4.0	Yes but depends on the budget and necessity.
29	In your opinion, what the building owner can do to upgrade their building from Intelligent Building to Building of Internet of Things (BIoT) by implement IoT in application in the building facilities and services?	I think, for the long term evolution the owner of the building should invest some of the budget to upgrade the building facilities by try to apply IoT in the building instead of using conventional building system and BAS. At first, it might costly because it is normal at initial stage we need to put some money to buy good things

No.	Questions	Feedback
		to upgrade existing things. But, to me in the long term it can pay off because IoT seems can help to saves the maintenance and repair works because it helps to ease the management by providing the real-time information of the lifespan for each facilities accurately and there will be no need for contingency plan but we can focus on preductive maintenance which is based on accurate information with the help of IoT.
30	As Manager and you know about IoT and your building well, in your opinion what the equipments should be install to enable your building with IoT?	Since we have control room and server, I think firstly we need an equipment which can help to connect all the services and facilities to our server to store all the data and information. Second, I think we need secure connection to cloud computing to share and store our data there. We need equipment to connect our server with the cloud. Third, a platform for us to easily get the information and control our assets and facilities.

Interview Questions and Answers

Appendix A (4)

Interviewee Name: RESPONDENT A for BUILDING A *The questions are referred to the building you manage currently.

Position: MANAGER TOWNSHIP

Building Project: PANGSAPURI GAPURA BAYU

Type of Building: LOW MEDIUM COST APARTMENT

Date and time: 27/08/2020 at 10.00am

Interview Questions:

No.	Questions	Feedback
1	Do you aware on IoT evolvement in Facilities Management? (Yes/No)	Yes
2	Do you know what is IoT? (Yes/No)	Yes
3	Do you understand how IoT works? (Yes/No)	Yes
4	What system you used to run the services in your building? (Building Automation System (BAS)/ Building Management System (BMS)/ Conventional Building System etc)	<p>Conventional Building System</p> <p>1) Auto barrier gate system - the system to controlled ingress and outgress with RFID access card. All parcel owners entitled free RFID tag dedicated parking lots.</p> <p>2) Water pump system to supply water to main water tank located at roof top level.</p> <p>3)We used GL Oneapp platform to manage our soft services such as visitor registration, booking for multipurpose hall, helpdesk services etc.</p> <p>4)Visitor registration - We need to know how many visitor and the visitor car as well as the identity of each visitor. We need to control the visitor car parking to avoid congested. The visitor identity need to be registered for safety and security purposes.</p> <p>5)Online Helpdesk services - The informations we need: who is the complainer, which unit, what the complains, what we can do and act accordingly.</p>

Interview Questions:

No.	Questions	Feedback
6	What type of connectivity platform provided in the building? Is it wire network or wireless interfaces?	Wire network and wireless interfaces.
7	Does the building services has a server to store all the information?	Yes, to store all data on daily and maintenance inspection checklist.
8	How does the facilities services in the building works? (HVAC, Automatic Door System and Fire Fighting System)	N/A
9	Does all services are automation and have their own sensors embedded? Where the sensors embedded?	N/A
10	Let says, if the services can be linked to another services, what would be the services in your mind so that can ease FM job?	Current stand-alone system are very minimal, therefore is not crucial to intergrate on overall systems.
	What types of information you need to ensure the services provided well done?	Not at the moment. We are still in 24 month DLP
11	How the informations will be collected, where the informations will be stored and when the informations will reused ?	The data storage in Fieldview system, the technician will conduct daily inspections based on pre-set checklist in the system.
12	Where the overall control systems of the building's services located?	Lift supervisory panel located at common area and monitored by security guards.
13	Who can have the access and control the systems of the buildings?	Building Manager, Executive FM, Operation Management team.
14	In overall, what are the functions of the control room?	N/A
15	Does the services provided connected to another services at the same time or solely works?	All the services work individually and not connected to each others.
	How many times the maintenance works of each services been planned? Does it progress accordingly?	Annual preventive maintenance scheduled inclusive monthly maintenance will be established every year to ease the breakdown on each services, apparently breakdown still happened with minimal downtime.
16	When the maintenance works of the services will be notified and who notify to Manager?	All issues or breakdown will be notified to respective managers via whatsapp or mobile phones by building executive.
17	Does the standby team or any relevant parties will be notified at the same time?	Yes. Via whatsapp or phone call

Interview Questions:

No.	Questions	Feedback
18	Are there any predictive maintenances for the services?	Lift ,Auto barrier gate system & water pump system
19	What services are frequently non-predictive maintenance have to take over by the management team as at to date?	N/A
20	How long it takes the team to resolve the issues?	N/A
21	What difficulties the team have to face during the maintenances works, especially when handling the non-predictive maintenance?	N/A
22	In any emergency cases in the building, how the team response to it? Example: Passenger stuck in lift	Based on man trap cases, in-house technicians will respond upon emergency call button triggered and immediately attend, evaluate the issue and contact service provider accordingly.
23	Does the process of action to response on the emergency case takes short time, long hours or at reasonable time?	Approx 30 minutes to 1 hour.
24	What consequences that can be identified if the process of action needed to be taken in any emergency cases take too long or delay? How does Manager resolve the issue? Is there any contingency planning?	Case example; frequent lift breakdown & man-trap, hence the service provider adhere on-time maintenance schedules. The Manager will demand full audit inspections on all lifts and all findings and issue to be resolve with-in agreed time frame.
25	Does the cost of operations increasing or decreasing from the past 3 to 5 years? If increasing or decreasing why does it happen?	At the moment the building still under 24 months defects liability period.
26	Usually, how they control the budget of the yearly or monthly operations? Is there any cut off cost in operations take over?	Appointments of service provider via e-auction process helps to adhere approved annual budget, with technical evaluation exercise in place all service provider can be measure equally based on their performance.
27	How the maintenance team will strategize the contingencies planning?	We will have management meeting every week to discuss any issues arising, keep the team with up to date informations, works progress, assigning tasks etc.
28	Does the owner of the building willing or has intention to upgrade the building equipment to implement IoT application	Not at the moment.

Interview Questions:

No.	Questions	Feedback
	of IoT in the facilities management of the building parallel to IR 4.0?	
29	In your opinion, what the building owner can do to upgrade their building from Intelligent Building to Building of Internet of Things (BIoT) by implement IoT in application in the building facilities and	We are looking forward to exploring more of this IoT in the near future
30	As Manager and you know about IoT and your building well, in your opinion what the equipments should be install to enable your building with IoT?	N/A

Interviewee Name: RESPONDENT D for BUILDING D *The questions are referred to the building you manage currently.

Position: FACILITY MANAGER

Building Project: CHENGALJATI SDN BHD

Type of Building: KOMPLEKS MAHKAMAH
KUALA LUMPUR

Date and time: 31/8/2020

Interview Questions:

No.	Questions	Feedback
1	Do you aware on IoT evolvement in Facilities Management? (Yes/No)	Yes
2	Do you know what is IoT? (Yes/No)	Yes
3	Do you understand how IoT works? (Yes/No)	Yes
4	What system you used to run the services in your building? (Building Automation System (BAS)/ Building Management System (BMS)/ Conventional Building System etc)	Building Automation System (BAS)
5	What types of services provided in the building and what informations they need from the services?	ACMV - to schedule, monitor operational and temperature. (Air Handling unit, Variable Refrigerent flow & etc)
		Digital clock system - centralize time control.
		Fire Fighting System - Automatic system monitoring (Pump system, alarm trigger & etc)
		Queue Management System
		Customer care management system
		CAMS- Card Access Management System
		CCTV
6	What type of connectivity platform provided in the building? Is it wire network or wireless interfaces?	Both. Wire network and wireless interfaces.
7	Does the building services has a server to store all the information?	Yes.
8	How does the facilities services in the building works? (HVAC, Automatic Door System and Fire Fighting System)	HVAC - Control from Building Control Room for time scheduling and monitor operational (chiller,

Interview Questions:

No.	Questions	Feedback
		Cooling tower, pump system, AHU & etc) Automatic Door System - Automatic motion sensor . Fire Fighting System - Fire/smoke insiden - device trigger alarm - module signal to MFAP (Control Room) - CMS link Bomba
9	Does all services are automation and have their own sensors embedded? Where the sensors embedded?	All automation and have own sensors.
10	Let says, if the services can be linked to another services, what would be the services in your mind so that can ease FM job? What types of information you need to ensure the services provided well done?	Purchasing system and Human Resources Management I have no idea.
11	How the informations will be collected, where the informations will be stored and when the informations will reused ?	Not sure. No data storage for the information and we just repair once we receive the report
12	Where the overall control systems of the building's services located?	Building control room
13	Who can have the access and control the systems of the buildings?	Facilities Team and BCS technician.
14	In overall, what are the functions of the control room?	Routine maintenance to oversee all system inc FFS, BCS, CCTV, Lift, PA syst and etc
15	Does the services provided connected to another services at the same time or solely works? How many times the maintenance works of each services been planned? Does it progress accordingly?	No Monthly planning for the maintenance works. But the progress not well progress all the time.
16	When the maintenance works of the services will be notified and who notify to Manager?	Daily routine technician and engineer notify to Manager
17	Does the standby team or any relevant parties will be notified at the same time?	Yes. Via whatsapp or phone call
18	Are there any predictive maintenances for the services?	Yes.
19	What services are frequently non-predictive maintenance have to take over by the management team as at to date?	Lift system and fire fighting system

Interview Questions:

No.	Questions	Feedback
20	How long it takes the team to resolve the issues?	2 to 4 hours and some times more than that depends on the situation
21	What difficulties the team have to face during the maintenances works, especially when handling the non-predictive maintenance?	The related and relevents parties involve take more time to respon due to late to be informed.
22	In any emergency cases in the building, how the team response to it? Example: Passenger stuck in lift	Communicate with intercom, call service provider to release entrapment (get details numbers and ID passengers), check lift system and make sure back to operational, submit incident report and service sheet to the client.
23	Does the process of action to response on the emergency case takes short time, long hours or at reasonable time?	Less than 30 minutes base on KPI
24	What consequences that can be identified if the process of action needed to be taken in any emergency cases take too long or delay? How does Manager resolve the issue? Is there any contingency planning?	24 hour BCS staff in control room.
25	Does the cost of operations increasing or decreasing from the past 3 to 5 years? If increasing or decreasing why does it happen?	Increasing. GST, O&G, demand and etc
26	Usually, how they control the budget of the yearly or monthly operations? Is there any cut off cost in operations take over?	Baseline profit from total contract'. No cut costs in operations to deliver the best services in 3 years
27	How the maintenance team will strategize the contingencies planning?	Follow Key Performance Index and guideline from JKR
28	Does the owner of the building willing or has intention to upgrade the building equipment to implement IoT application of IoT in the facilities management of the building parallel to IR 4.0?	Yes but depends on the budget and necessity.
29	In your opinion, what the building owner can do to upgrade their building from Intelligent Building to Building of Internet of Things (BIoT) by implement IoT in application in the building facilities and services?	I think, for the long term evolution the owner of the building should invest some of the budget to upgrade the building facilities by try to apply IoT in the building instead of using conventional building system and BAS. At first, it might costly because it is normal at initial stage we need to put some money to buy good things

Interview Questions:

No.	Questions	Feedback
		to upgrade existing things. But, to me in the long term it can pay off because IoT seems can help to saves the maintenance and repair works because it helps to ease the management by providing the real-time information of the lifespan for each facilities accurately and there will be no need for contingency plan but we can focus on preductive maintenance which is based on accurate information with the help of IoT.
30	As Manager and you know about IoT and your building well, in your opinion what the equipments should be install to enable your building with IoT?	Since we have control room and server, I think firstly we need an equipment which can help to connect all the services and facilities to our server to store all the data and information. Second, I think we need secure connection to cloud computing to share and store our data there. We need equipment to connect our server with the cloud. Third, a platform for us to easily get the information and control our assets and facilities.

Appendix B The list of information gathered to enable IoT in FM

	Codes	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E
Objective 2 Information should be prioritized to enable IoT application for facility management	1) Building System	Conventional Building System	Conventional Building System	Building Automation System (BAS)	Building Automation System (BAS)	Conventional Building System
	2) Services sensor devices	No	No	Yes	Yes	Partially
	3) Services interconnection	Services works individually and not connected each other	Services works individually and not connected each other	Services works individually and not connected each other	No	No
	4) Prioritized services interconnection	Current stand-alone system are very minimal, not crucial to integrated overall systems	N/A	HVAC and lighting	Purchasing system and human resource management	Lighting and occupants
	5) Information Needed	Not at the moment. We are still in 24 month DLP	True information and quick access to data.	Accurate and real-time data so that the maintenance can be arrange and schedule accordingly without any overbudget and at the same time can saves the cost of operations.	I have no idea.	Accurate and real-time data

	Codes	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E
	6) Maintenance works planning	Annual preventive maintenance scheduled inclusive monthly maintenance will be established every year to ease the breakdown on each services, apparently breakdown still happened with minimal downtime	Monthly service and daily checking still required to ensure all utilities are in good condition	Monthly planning for the maintenance works. But the progress not well progress all the time.	Monthly planning for the maintenance works. But the progress not accordingly all the time.	Monthly planning for the maintenance works. Yes, progress accordingly.
	7) Maintenance works notification	All issues or breakdown will be notified to respective managers via Whatsapp or mobile phones by building executive.	The subordinate at site will get the Manager be informed via Whatsapp or phone call after received the complaints from the residents/occupants.	When the problem happens or any issues arising at that time. The subordinate at site will get the Manager be informed via Whatsapp or phone call after received the complaints from the residents/occupants.	Daily routine technician and engineer notify to Manager	The co-worker will notify to Manager when there is issue arising.
	8) Predictive maintenance	Lift ,Auto barrier gate system & water pump system	Yes. For fires fighting system	Yes. For fires fighting system	Yes	Yes. For fires fighting system and lift

	Codes	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E
	9) Non-predictive maintenance	Not applicable. In 24 months DLP	Lift system, pump system and fires fighting system	Lift system and fires fighting system	Lift system and fires fighting system	Lift system and fires fighting system
	10) Total hours (repair works/ emergency case)	Not applicable. In 24 months DLP	2 to 4 hours and sometimes more, depends on the situation.	1 to 3 hours and more	less than 30 minutes based on KPI	More than 1 hours and depends on the situation.
	11) Problem in non- predictive maintenance	Not applicable. In 24 months DLP	The related parties involved take more time to respond if late to be informed	Take more time to respond if the late to be informed	Take more time to respond.	Take more time to respond.
	12) Contingency planning	Weekly management meeting to discuss any issue arising and keep the team up to date	Weekly management meeting to discuss any issue arising and keep inform the team, works progress, assigning tasks etc.	We will have management meeting every week to discuss any issues arising, update information, the progress of works and etc.	Follow Key Performance Index and guideline from JKR	Meeting with the management team
	13) Cost of operation (from past 3 to 5 years)	Not applicable. In 24 months DLP	Increasing. The repair works are costly. Especially for the lift. Always problem due to vandalism.	Increasing. The repair works for the equipment are expensive.	Increasing due to GST, O & G, demand etc.	Increasing. The repair works are expensive. For example, the renewal service contract increases due to current market value.

Appendix C The requirements need to be followed for implementation plan or best practices in sequence to apply IoT to improve FM

	Codes	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E
Objective 2 Information should be prioritized to enable IoT application for facility management	1) Building System	Conventional Building System	Conventional Building System	Building Automation System (BAS)	Building Automation System (BAS)	Conventional Building System
	2) Services sensor devices	No	No	Yes	Yes	Partially
	3) Services interconnection	Services works individually and not connected each other	Services works individually and not connected each other	Services works individually and not connected each other	No	No
	4) Prioritized services interconnection	Current stand-alone system are very minimal, not crucial to integrated overall systems	N/A	HVAC and lighting	Purchasing system and human resource management	Lighting and occupants
	5) Information Needed	Not at the moment. We are still in 24 month DLP	True information and quick access to data.	Accurate and real-time data so that the maintenance can be arrange and schedule accordingly without any overbudget and at the same time can saves the cost of operations.	I have no idea.	Accurate and real-time data

	Codes	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E
	6) Maintenance works planning	Annual preventive maintenance scheduled inclusive monthly maintenance will be established every year to ease the breakdown on each services, apparently breakdown still happened with minimal downtime	Monthly service and daily checking still required to ensure all utilities are in good condition	Monthly planning for the maintenance works. But the progress not well progress all the time.	Monthly planning for the maintenance works. But the progress not accordingly all the time.	Monthly planning for the maintenance works. Yes, progress accordingly.
	7) Maintenance works notification	All issues or breakdown will be notified to respective managers via Whatsapp or mobile phones by building executive.	The subordinate at site will get the Manager be informed via Whatsapp or phone call after received the complaints from the residents/occupants.	When the problem happens or any issues arising at that time. The subordinate at site will get the Manager be informed via Whatsapp or phone call after received the complaints from the residents/ occupants.	Daily routine technician and engineer notify to Manager	The co-worker will notify to Manager when there is issue arising.
	8) Predictive maintenance	Lift ,Auto barrier gate system & water pump system	Yes. For fires fighting system	Yes. For fires fighting system	Yes	Yes. For fires fighting system and lift

	Codes	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E
	9) Non-predictive maintenance	Not applicable. In 24 months DLP	Lift system, pump system and fires fighting system	Lift system and fires fighting system	Lift system and fires fighting system	Lift system and fires fighting system
	10) Total hours (repair works/ emergency case)	Not applicable. In 24 months DLP	2 to 4 hours and sometimes more, depends on the situation.	1 to 3 hours and more	less than 30 minutes based on KPI	More than 1 hours and depends on the situation.
	11) Problem in non- predictive maintenance	Not applicable. In 24 months DLP	The related parties involved take more time to respond if late to be informed	Take more time to respond if the late to be informed	Take more time to respond.	Take more time to respond.
	12) Contingency planning	Weekly management meeting to discuss any issue arising and keep the team up to date	Weekly management meeting to discuss any issue arising and keep inform the team, works progress, assigning tasks etc.	We will have management meeting every week to discuss any issues arising, update information, the progress of works and etc.	Follow Key Performance Index and guideline from JKR	Meeting with the management team
	13) Cost of operation (from past 3 to 5 years)	Not applicable. In 24 months DLP	Increasing. The repair works are costly. Especially for the lift. Always problem due to vandalism.	Increasing. The repair works for the equipment are expensive.	Increasing due to GST, O & G, demand etc.	Increasing. The repair works are expensive. For example, the renewal service contract increases due to current market value.