# BUILDING SERVICES IN FACILITY MANAGEMENT

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# BUILDING SERVICES IN FACILITY MANAGEMENT

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Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

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# ABSTRAK

Pengurusan Kemudahan (FM) biasanya sukar dan rumit. Kakitangan kemudahan biasanya menggunakan kertas atau sistem maklumat untuk merekodkan kerja penyelenggaraan kemudahan. Walau bagaimanapun, tidak mudah bagi kakitangan kemudahan untuk merujuk ilustrasi maklumat tradisional berasaskan CAD 2D dalam penyelenggaraan kemudahan. Selain itu, maklumat penyelenggaraan kemudahan yang sama perlu mengulang rekod dan menyebabkan ketidaknyamanan bagi kakitangan kemudahan. Untuk mengatasi masalah ini, pendekatan pemodelan maklumat bangunan (BIM) digunakan dan dibangunkan sebagai model maklumat 3D untuk mengurus dan mengekalkan kemudahan dalam kajian. Dengan penyepaduan model BIM dengan maklumat berkaitan penyelenggaraan kemudahan, kakitangan kemudahan dapat meningkatkan kecekapan penyelenggaraan dan pengurusan fasilitas. Kajian ini mencadangkan pengurusan kemudahan (FM) berdasarkan sistem pemodelan maklumat bangunan untuk pengurus dan kakitangan kemudahan. Sistem ini kemudiannya digunakan dalam kajian kes terpilih Kolej Kediaman 4 (KK4) untuk mengesahkan metodologi yang dicadangkan dan menunjukkan keberkesanan pengesanan dan pengurusan maklumat penyelenggaraan berkaitan dalam persekitaran 3D. Akhirnya, kajian ini akan membentangkan manfaat, batasan dan kesimpulan aplikasi BIM dalam pengurusan kemudahan, dan juga memberi cadangan untuk penyelidikan masa depan.

## ABSTRACT

Facilities management (FM) usually is difficult and complicated work. The facility staffs usually use paper or information system to record the facilities maintenance work. However, it is not easy for facility staffs to refer the traditional 2D CAD-based information illustration in the facility maintenance. Moreover, the information of same facilities maintenance needs to repeat the record and cause inconvenience for facility staffs. To overcome these problems, the building information modelling (BIM) approach is applied and developed as 3D information models for managing and maintaining facilities in the study. With the integration of BIM model with related information of facilities maintenance, the facility staffs may improve the efficiency of maintenance and management work of facilities. This study proposes a facility management (FM) based on building information modelling system for facility managers and staffs. The system is then applied in selected case study of a Kolej Kediaman 4 (KK4) to verify our proposed methodology and demonstrate the effectiveness of tracking and managing the related maintenance information in the 3D environment. Finally, this study will present the benefits, limitations and conclusions of BIM application in facilities management, and also provide suggestions for future research.

## TABLE OF CONTENT

**DECLARATION**

**TITLE PAGE**

**ACKNOWLEDGEMENTS** ii

**ABSTRAK** iii

**ABSTRACT** iv

**TABLE OF CONTENT** v

**LIST OF TABLES** ix

**LIST OF ABBREVIATIONS** x

**CHAPTER 1 INTRODUCTION** 1

1.1 Introduction 1

1.2 Background of Study 2

1.3 Problem Statement 3

1.4 Aim and Objective of Study 4

1.5 Scope of Study 4

1.6 Significant of Study 5

**CHAPTER 2 LITERATURE REVIEW** 6

2.1 Introduction 6

2.2 Definition of Building Information Modelling 6

2.3 Building Services in Facility Management 8

2.3.1 What is Facility Management 9

2.3.2 Important of Facility Management in Building Services 10

2.4 BIM for FM 11

2.4.1 BIM as FM Tools 12

**CHAPTER 3 METHODOLOGY 14**

3.1 Introduction 14

3.2 Model Information 14

3.3 Research Methodology 14

3.4 Data Collection 15

3.5 Analysis Data 15

3.5.1 Drawing of Architecture 16

3.5.2 Work Order 16

3.6 REVIT 2017 18

3.6.1 3D Modelling 19

**CHAPTER 4 RESULTS AND DISCUSSION 21**

4.1 Introduction 21

4.2 Schedule of Facility Management 21

4.3 Discussion 26

**CHAPTER 5 CONCLUSION 28**

5.1 Introduction 28

5.2 Conclusion 28

5.2.1 Objective 1 29

5.2.2 Objective 2 29

5.2.3 Objective 3 29

5.3 Recommendation 29

**REFERENCES 30**

**APPENDIX A SAMPLE APPENDIX 1** **33**

**APPENDIX B SAMPLE APPENDIX 2** **36**

## LIST OF FIGURES


| | | |
|---|---|---|
| Figure 2.1 | BIM implementation through building lifecycle | 7 |
| Figure 2.2 | Facility management – combining place, people and process | 10 |
| Figure 2.3 | Various FM Task Supported By BIM | 13 |
| Figure 3.1 | Methodology Process | 15 |
| Figure 3.2 | As-Built Drawing Plan | 16 |
| Figure 3.3 | Workflow Process | 17 |
| Figure 3.4 | Work Order Data | 18 |
| Figure 3.5 | 3D Modelling | 19 |
| Figure 3.6 | First Floor Plan | 20 |
| Figure 3.7 | Front Elevation | 20 |
| Figure 4.1 | Schedule Properties | 21 |
| Figure 4.2 | Schedule For Facility Management | 22 |
| Figure 4.3 | Export of Schedule in Autodesk Revit Architecture | 23 |
| Figure 4.4 | Txt file exported from Autodesk Revit Architecture | 23 |
| Figure 4.5 | Change Format From txt to xls File | 24 |

## LIST OF TABLES


| | | |
|---|---|---|
| Table 4.1 | Schedule for Facility Assets | 24 |
| Table 4.2 | CAD and BIM Attributes | 26 |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| FM | Facility Management |
| BIM | Building Information Modelling |
| 3D | Three Dimension |
| 2D | Two Dimension |
| 4D | Four Dimension |
| IT | Information Technology |
| CAD | Computer Aided Design |
| KK4 | Kolej Kediaman 4 |
| UMP | Universiti Malaysia Pahang |
| UMPH | Universiti Malaysia Pahang Holdings |
| AEC | Architecture Engineering and Construction |
| WO | Work Order |
| CAFM | Computer-Aided Facility Management |
| O&M | Oil and Maintainance |

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

The concept of Facility management (FM) is expanding and has become an important part of the construction and maintenance industries worldwide as globalization's impact on business and on the growth of related professionals and organizations increases. Today Facility management as a profession is much more accepted and recognized than in 1999 (David G. Cotts, Kathy O. Roper, and Richard P. Payant, 2010).

Facility management, defined as a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process, and technology, allows stakeholders to secure an important part of the design, construction and maintenance process due to various advantages like cost savings, increasing the life and quality of a facilities and simplifying methods of maintaining facilities (David G. Cotts, Kathy O. Roper, and Richard P. Payant, 2010).

Facilities management (FM) represents one of the fastest growing sectors in real estate and construction. To benefit most, organizations need to understand that they must be informed clients in managing their facilities and properties. However, tracking and managing facility effectively are extremely difficult owing to the various facilities. Real time monitoring and control for maintenance management may be necessary and helpful to control and manage effectively the maintenance work in the building facilities.

To enhance maintenance management performance, the building information modeling (BIM) approach is applied and developed as 3D information models for

managing and maintaining facilities in the study. With the integration of BIM model with related information of facilities maintenance work, the facility maintainers may improve the efficiency of maintenance and management work of facilities. With the assistance of the BIM approach, facility-based maintenance management information enables information dissemination and information sharing in the 3D environment.

This study addresses application of facility management in the maintenance phase and proposes a BIM based on Facility Management system for facility managers and staffs. The BIM based on FM is then applied for building of a Kolej Kediaman 4(KK4) to verify our proposed methodology and demonstrate the effectiveness of tracking and managing the related maintenance information in the 3D environment. By developing FM system, facility managers can track and manage the related maintenance record in the 3D environment.

## 1.2 Background of Study

Building Information Modelling (BIM) is the process of data generation and management of an asset during the stages of design, construction, facility and operation management, and demolition with the intention of maximizing efficiency and reducing costs in the AEC field (Lee et al., 2005). In this study, the BIM is interpreted as an information model in the BIM. The primary purpose of this study is to extend BIM into the maintenance phase and to create a single repository of facility data for facilities maintenance.

The application of utilizing BIMs to capture and store information of facilities thought to 3D BIM model including facing problem description of facilities, facilities maintenance information, and attaching documents in the BIM.

Generally, facility managers and staffs require access to the facility location to handle inspection and maintenance work at any facility locations. Facility staffs generally use sheets of paper and/or field notes. Facility staffs generally handle various types of information, including 2D drawings information for inspection and maintenance.

However, it is not easy for facility staffs to refer the traditional 2D CAD-based information illustration in the facility maintenance.

Information technology (IT) is important in successfully controlling and managing construction projects, particularly in enhancing communication and coordination among participants. Communication and coordination must be maintained to support resource and competency sharing among the involved participants. This paper proposes a new and practical methodology to capture and represent facility management information by using Building Information Modeling (BIM) approach.

Building Information Modeling (BIM) is a new technology in the field of CAD, which contains not only geometric data, but can accommodate great amount of engineering data over the lifecycle of a building (Xudong and Jie 2007). According to Khemlani (2010), BIM is a revolutionary technology that goes well beyond the design phase to impact construction and lifecycle management of the project. BIM can be used in the preconstruction phase in cost and quantity estimates, and in integration and coordination among building components and their scheduling data. It can also be used as a life cycle information management process for safety planning (Sulankivi et al. 2010). Elbeltagi and Dawood (2011) developed a time control model for repetitive construction projects based on BIM technology.

## 1.3 Problem Statement

BIM is interpreted as an information model in the FM. The primary purpose of this study is to extend BIM into the maintenance phase and to create a single repository of facility data for facilities maintenance. Furthermore, the application of utilizing BIMs to capture and store information of facilities thought to 3D BIM model including facing problem description of facilities, facilities maintenance information, and attaching documents.

This case is applied in the Kolej Kediaman 4 maintenance work. The facility department hopes to enhance maintenance management performance using full

advantage 3D CAD-based environment, and let facility staffs handle maintenance easily and effectively. Furthermore, the facility department hopes to develop the 3D CAD-based FM system to support facility-related information sharing among facility managers and staffs. Therefore, the contractor announced that all engineers would be encouraged to begin to use the BIM in FM system integrated with BIM approach to apply maintenance management to manage facility-related data and information effectively in the 3D visual environment.

## 1.4 Aim and Objective of Study

The aim of this research is to determine with using BIM model-based to track and manage facility assets that can be help the facility managers and staffs to enhance facility information tracking and sharing efficiency. In order to achieve the above aim, the following objectives of study have to be carried out:

I. To create parameter based on actual data information
II. To track and manage facilities assets in BIM.
III. To produce the schedule of facility management from the actual data.

## 1.5 Scope of Study

The research is based on case study. The study is focusing on a project that has been completed and has a complete data including drawings and costing. The selected building is a block A from undisclosed location. The scope of study for this research are:

i. Get the 2D CAD drawing from undisclosed client.
ii. Data collection is based on architecture drawing for building architecture building components from the BIM model using Revit Suite Software
iii. Develop the schedules of materials take of using Revit Suite Software and convert to Microsoft Office Excel.
iv. Breakdown total work into subtasks.

v. Calculating quantities of material and estimating material costing based on Revit Organization Schedules

## 1.6 Significant of Study

The research is based on case study. The study is focusing on a project that has been completed and has a complete data including drawings and costing. The selected building is a block A from undisclosed location. The scope of study for this research are:

vi. Get the 2D CAD drawing from undisclosed client.

vii. Data collection is based on architecture drawing for building architecture building components from the BIM model using Revit Suite Software

viii. Develop the schedules of materials take of using Revit Suite Software and convert to Microsoft Office Excel.

ix. Breakdown total work into subtasks.

x. Calculating quantities of material and estimating material costing based on Revit Organization Schedules

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews facilities management in building of Kolej Kediaman 4. The literature review presented to explore the information and facts that used in this research. This chapter will explain the background of the study and related theories about facilities management in building information modelling. The building information modelling (BIM) is described in the first section based on the uses of software Autodesk in facilities management. Then, it discusses about the building services in facilities management and important of facilities management. Other than that, this chapter presents the implementation of building information modelling in facilities management.

## 2.2 Definition of Building Information Modelling

Building Information Modelling is the process of data generation and management of an asset during the stages of design, construction, facility and operation management, and demolition with the intention of maximizing efficiency and reducing costs in the AEC field (Lee et al., 2005).

Consequently, various definitions have been given to its term in order to show the importance of BIM. Some consider BIM is an extension of the Computer Aided Design (CAD) while others think it is a series of models with different elements of a project (Azhar, 2011). BIM is not just a technology, but it also encompasses the process by using product of the right kind of software (Azhar, 2011). BIM application connects all parties such as architects, contractors, surveyors, designers and owners to work together on a

common information system (Eastman, 2009). Thus, this allows all parties to share the information with each other and increasing the confidence and consistency among them.

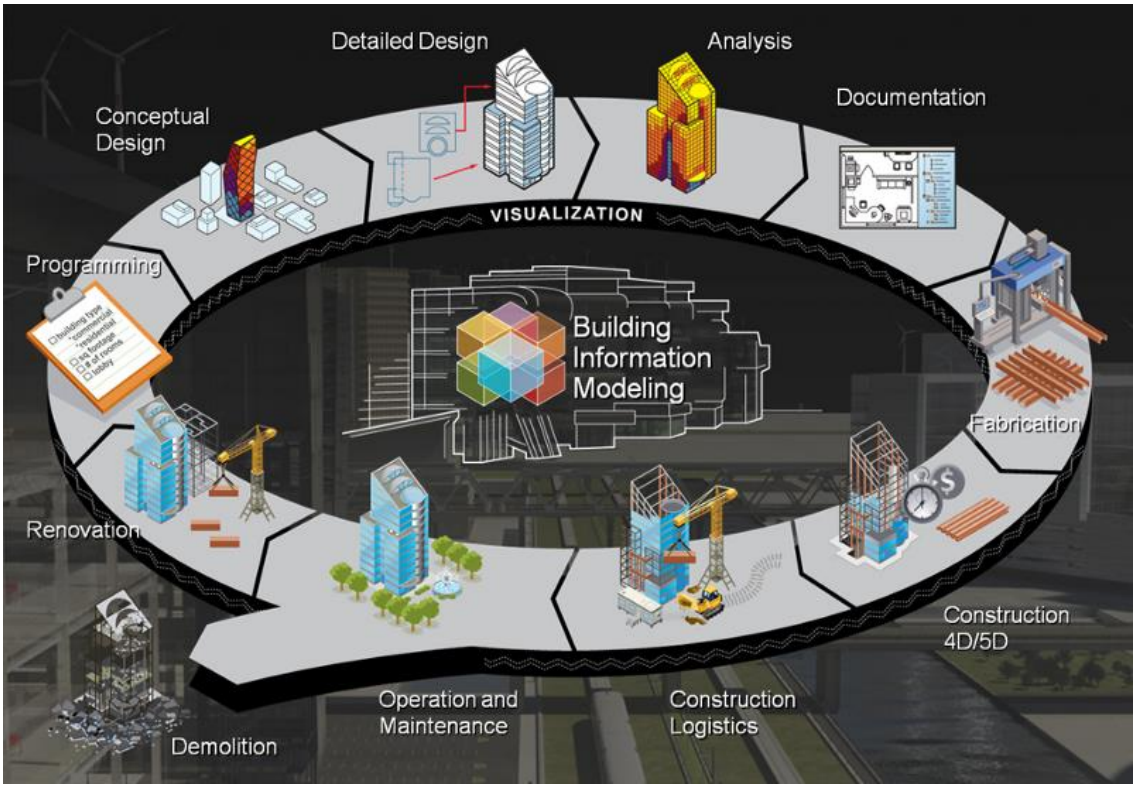


Figure 2.1 BIM implementation through building lifecycle

An ideal BIM implementation process happens when the accumulation of information about an asset starts at an early design stage and evolves until the asset's final demolition. There is information that accompanies the building during its entire life. Nevertheless, most of it changes throughout the different stages.

At the beginning, the information about a building is very inaccurate and is used for price estimation and to inform the asset's owner and planners. As time passes and more accurate information for construction is needed, data related to the building becomes larger and more specific. In this stage, all stakeholders involved in the project contribute by adding their respective information into a common source for the planning and execution of the construction.

At the end of the planning stage, enough information is gathered to start the construction schedule. The construction schedule can be linked to the 3D model, which is also called 4D BIM, a 3-dimensional model with an extra dimension of time. The additional dimension provides information about processes during construction and helps solve problems at an early stage, before construction, to avoid future complications on site. Changes, made during the construction phase, are recorded to keep all information about the project updated. All information gathered during the construction phase should be delivered as requested at the time of the handover. During the operation and maintenance stages, all data collected from previous steps is used and kept up-to-date as necessary. During the renovation or demolition of the asset updated information can be used for cost estimation and more. The idea of all the process analysis of each BIM stage is to minimize the loss of information, which will be needed in the future for further stages.

## 2.3 Building Services in Facility Management

Facilities management supports operation and maintenance of a building and its services. Facilities management is multi-faceted complex task often challenged by lack of updated information. The implementation of BIM has improvised facilities management tasks by providing relevant information throughout the building lifespan. The goals of integrating the design of building services, performance simulation, and coordination of these with all other industry sectors are yet to be realized; however, exchange between disciplines is becoming more possible due to improvements in software interoperability.

Facilities Management (FM) is a general term covering a broad spectrum of services from real estate management, building maintenance, financial systems, health and safety, and contract management, facility maintenance, and domestic services (Atkin & Brooks, 2000; Amaratunga, Baldry & Sarshar, 2000). Hamer, (1988) refers to Facility Management as a tailored platform for the planning, implementation, maintenance of space within a building with a value adding focus. Kamaruzzaman and Zawawi (2010) suggest Facility Management has strategic positioning while balancing business and technical management processes and services. With Facility Management services service solutions covering a variety of areas such as knowledge transfer, encountering,

productivity, mobility, hospitality, accessibility, safety, representation, distinction and sustainability. (Kok, Mobach, & Omta p. 259, 2011).

### 2.3.1 What is Facility Management

Facility Management is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology. This is how the International Facility Management Association describes facility management. (International Facility Management Association, 2010.).FM is the coordination of multiple disciplines involving an asset to ensure it is the functionality (Micromain, 2016). The term of Facility Management (FM) started in the United States of America in the early 1970's (EuroFM, 1999). It was not until the late 1980s that it started to become more popular, being acknowledged as a discipline and profession (Nor et al., 2014).

FM represents the interface between the physical world (asset), the virtual world (processes) and the mental world (people) (EuroFM, 1999). The idea of FM is to manage an asset by controlling the tasks of different groups of specialists required for the operation of the building. Facility management is divided into specialized subject groups such as commercial asset management, communication, technical asset management, general services and area management. These groups are nowadays supported by IT equipment such as management systems, building control systems, CAD and networks. Facility management is related to the asset management and not administration. FM's purpose is to rapidly have access to necessary information to efficiently perform tasks, or for communication purposes.

Data that comes from the building information systems is used for targeted controlling to ensure smart decisions, reduce costs and generate profit. Information management starts at the creation and construction stage of an asset and ends at its demolition. The FM must incorporate all tasks related to an asset. Meaning that information from many different fields must be stored under one roof. It is essential for facility managers, that all gathered information is in a centralized source. Information

stored must be managed and analyzed in a structured and systematic way for smart decision-making.


Figure 2.2 Facility management – combining place, people and process

### 2.3.2 Important of Facility Management in Building Services

The role of Facility Management can be defined as a key function in managing facility resources, support services and the working environment and supporting the core business of organisations (Tay & Ooi, 2001; Chotipanich, 2004). Facility Management within the service sector accounts for 30-40 percent of an organisation's annual budget and can add value to an organisation by improving delivery of service, resource control and supply chain (Amaratunga & Baldry, 2002).

Building Information Modelling is the next step in the development of computer-aided design. In practice, instead of several specialized documentations containing architecture design, landscape design, construction and installation designs as well as bills of quantities and cost estimates, we have one 3D model with a database containing all above information. Parametric modelling is the essence of the full application of BIM in practice. It allows quick implementation of changes in 3D model when it is necessary during the interdisciplinary coordination process. Other benefits of using BIM can be distinguished. They are shortly described in the following sections.

## 2.4 BIM for FM

Regards to a vast area of FM services, using new technologies like BIM within FM sector is complicated and could be performed at different levels. Since BIM provide beneficial information about physical assets, FM sector follows AEC sector in adopting BIM. Of course, BIM model is not replaced with a whole range of information which is used by FM organization, but it will facilitate using this information especially information of building. Since the FM organization and its practitioners are not as complete as AEC practitioners familiar with building drawings and specifications, BIM could provide a better understanding of people who involved in FM sector. BIM could be used for energy analysis and sustainability during the life cycle of the building. It can help FM organization in terms of managing inventories, furniture, and equipment, and to improve the energy efficiency of the building as well as the security management.

FM organization could gain profit from using BIM for space planning. Since BIM provide accurate geometry of spaces and the objects in them, it is very useful tool for measuring the spaces and checking rules requirements. Recently some real-time data analysis software are realized which are a further step in building automation.33 During the last decades, serious efforts have been made to adopt BIM within FM sector, however, there are still some challenges in using BIM in FM.

The current BIM software developed to be used for design and mostly have been divided into Architectural, Structural, and MEP disciplines. Based on the different characteristics and requirements of FM sectors, neither current BIM software provides full support to FM sector, nor developing separate BIM software for using in FM makes sense based on economic and interoperability issues. Integrating BIM within FM companies requires a comprehensive well-defined strategy. Most of the FM companies have their own sources of information in forms of drawings, specifications, daily reports, etc. which need planned process to convert to BIM model.

According to the marketing matters, it is impossible to downgrade the BIM models to the earlier version, which will be resulted to needs to buying the new version. Software providers also do not provide support services for products more than 5 years for the same reason. Regards to the longer duration of operation and maintenance phases

which are main phases that FM sector involves, the cost of BIM software and upgrade them are considerable and could affect the trend of adopting BIM within FM sector.

Currently, there are plenty of FM applications which each of them contain a huge amount of information. Large scale FM companies need to use more than of them since because of the wide range of their activities and services there is no one comprehensive software which could cover all of their requirements.

### 2.4.1 BIM as FM Tools

Facilities managers consider BIM as a facilitator for achieving their service goals. The integration of FM tools such as Computer-Aided Facility Management (CAFM) with BIM would accelerate the FM purpose as BIM deals with energy management and sustainability issues along with building management systems. Nevertheless, the major concern of BIM is the implementation cost and training. The ability of BIM to serve as FM tools through the programming, record modelling, preventative maintenance scheduling, building systems analysis, asset management, space management and tracking and disaster planning and response (Brinda & Prasanna, 2014).

Similarly (Arayici et al, 2012) has summarized the capability of BIM as FM tool in comparison to the conventional tools using a case study in terms of:

- Space planning – BIM was proved to be more efficient. The difference lies in the need of BIM model for constantly upgraded dataset libraries. The benefits of BIM depend on the quality of model maintenance. Virtual reality can work in synergy with BIM database to produce a single all-in-one tool. This can benefit FM with regards to visual space planning and data storage for O&M.

- Addressing both hard and soft tasks: BIM addresses both hard and soft tasks associated with FM, to cater relocation and building life cycle FM.

Therefore, the BIM has the capability of acting as FM tool. The reduction of information lose in the process of exporting information can be checked. Figur3 3 shows the schematic diagram of the various FM tasks supported by BIM.

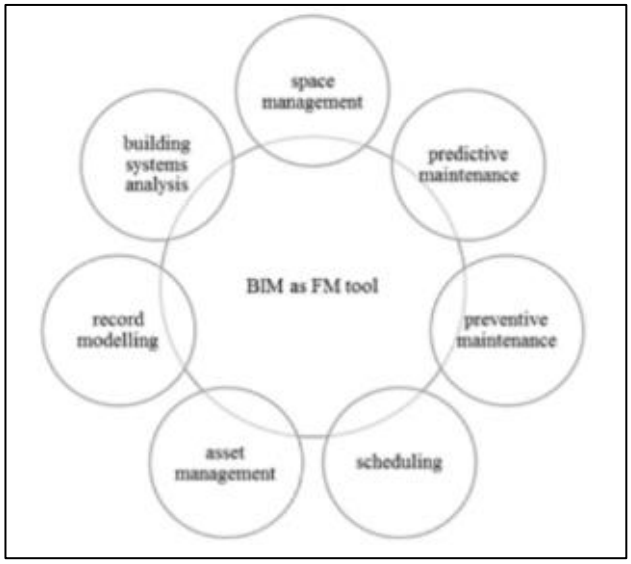


Figure 2.3 Various FM Task Supported By BIM

Since its inception BIM has developed from information management strategy to construction management method while the focus has changed to create an integrated environment of up-to-date distributed building information, which is flexible for accumulate new information (U. Isikdag, 2015). Therefore, BIM has the ability to track the changes and update the same in the form of accurate information for FM purposes. As a result, BIM can address the information deficiency inherently tagged to FM profession, or in other words, emergence of BIM as FM tools would reduce information loss by standardizing the data format. However, to manage information throughout the lifespan requires considerable large library directories for different building components, equipment based on the type of services.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

Research methodology is important and it is refer as the procedure to develop the research. This statement had been explained by Fellows & Liu (2007), "research methodology refers to the principles and procedures of logical thought process which are applied to a scientific investigation". The chapter is to discuss all the process flow of research and this study is conducted based on computer aid design software which is Revit Suite Software. The procedure of the project had been explored before the research start to ensure that the research achieved their goal.

## 3.2 Model Information

All the data use in this research is based on the true building construction. This building is Kolej Kediaman 4 (KK4), Universiti Malaysia Pahang Gambang which consists of eight floor excluding ground floor and roof top floor. Commencement date of this building is April 2014 and construction completion date on December 2015. This model is an architecture model which generated from architecture construction drawing. All defect is based on work order from facilities in that building and get from staff Universiti Malaysia Pahang Holdings (UMPH).

## 3.3 Research Methodology

Figure 3.1 illustrates that the methodology flow of this study for conducting building services in facility management (FM) based on BIM model.


Figure 3.1 Methodology Process

### 3.4 Data Collection

The study process would commence in data collection, where architectural plans for this study would be solicited. Through the preliminary study of the collected architectural plans, the viability of conducting this pilot study would be examined. With the viability of conducting the pilot study ensured, a building information model is confirmed to be used in this study for the facility management.

### 3.5 Analysis Data

The 3D parametric data, which would emphasize on reviewing the feasibility of using original BIM's information to improve the efficiency of maintenance and management work of facilities. Analysis would be made on the proficiency of automated measurement by BIM software, Autodesk Revit Architecture. By using BIM software which is Autodesk Revit where it help to managing and tracking work of facilities and produce the schedule by work order.

### 3.5.1 Drawing of Architecture

The drawing building of Kolej Kediaman 4 in 2D CAD drawing get from Cik Marni which is the staff of UMPH that in charged. The drawing will be check to ensure all information and drawing received such as plan of floor, construction architect, floor finishes schedule, ceiling finishes schedule, door schedule and window schedule are completed. After the drawing completed checked, rearrange and coordinate all the drawing to start the 3D modelling. The example of as-built drawing for ground floor plan, 1st floor plan until 7th floor plan as shown in figure 3.2:

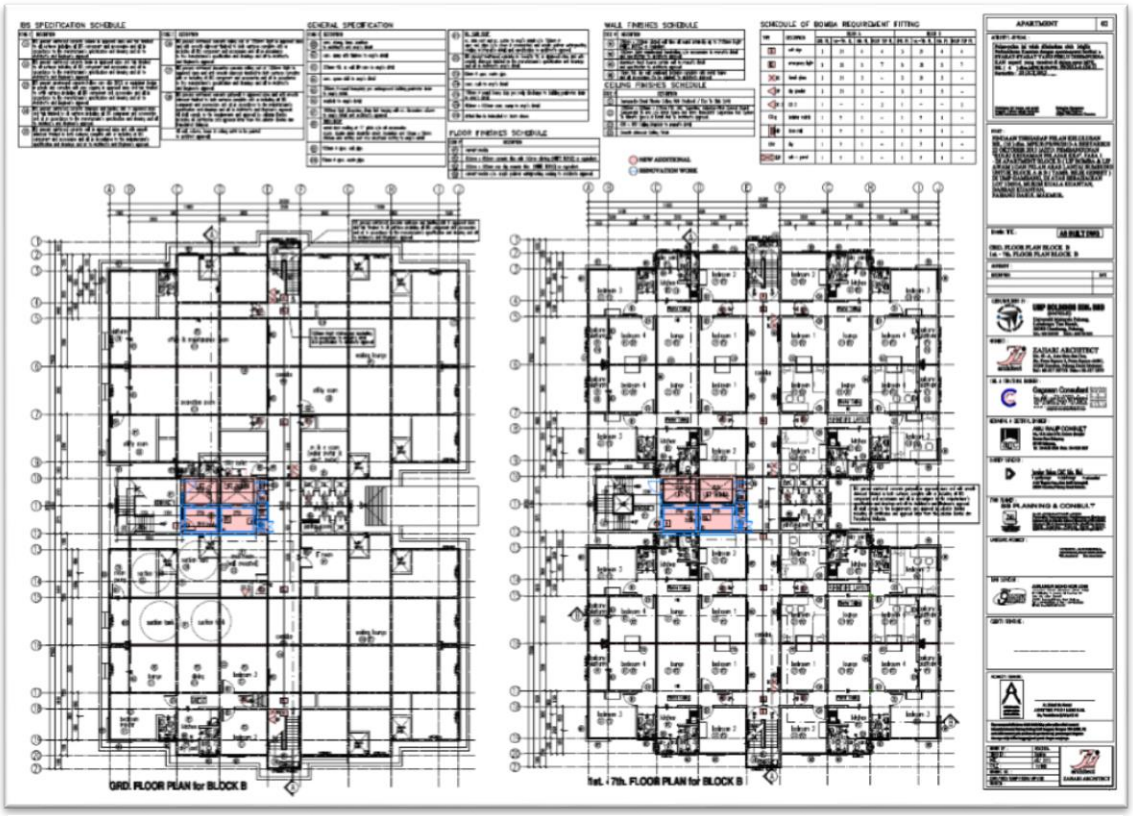

Figure 3.2 As-Built Drawing Plan

### 3.5.2 Work Order

A work order (WO) is an authorization of maintenance, repair or operations work to be completed. Work orders can be manually generated through a work request submitted by a staff member, client, tenant, or automatically generated through a work order management software. The process of work flow of WO as shown in figure 3.3:

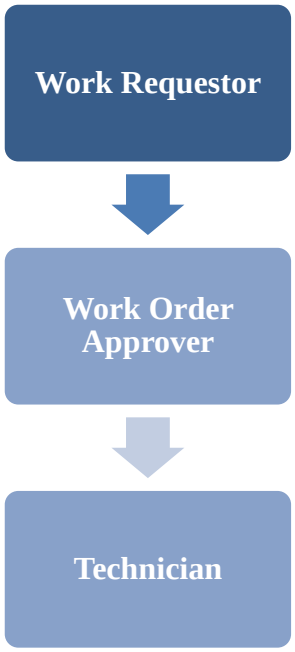


Figure 3.3 Workflow Process

The requestor creates work requests to report and complaint an issues on equipment or assets that have problem. For corrective work or customer appeals, work order requests are submitted. So that, the approver can approves request to the staff in charged to assigns work to repair and fixed the problem. The technician will performs work and closed work order. Besides that, Maintenance managers can tailor workflow processes for request submission, approval, rejection, and completion to the specific needs of their organization. The example of WO as shown in figure 3.4:

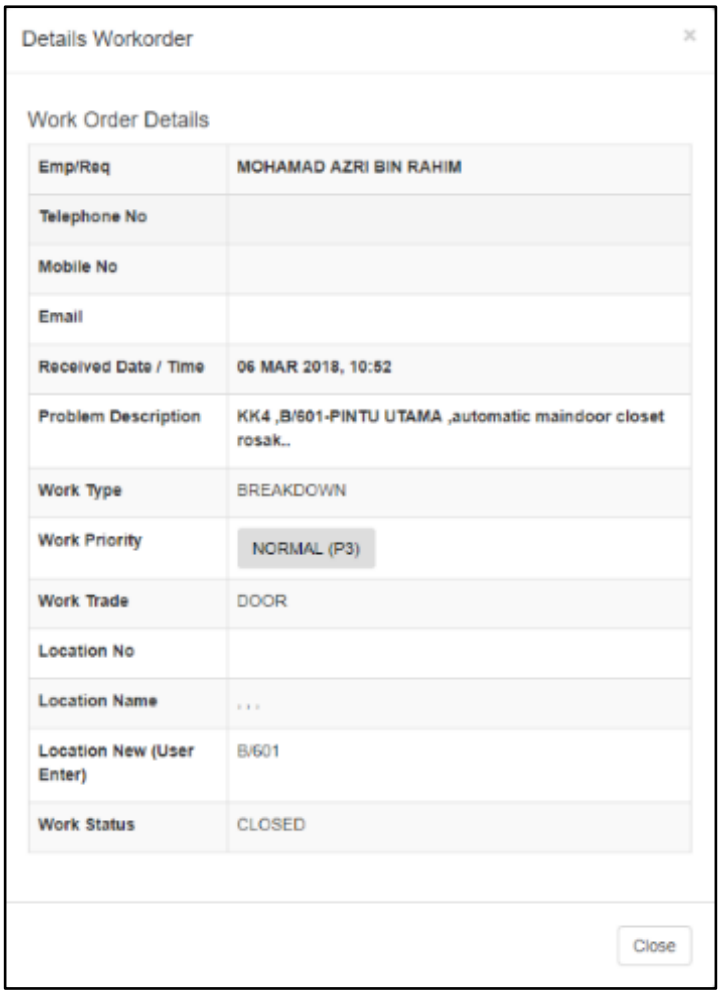


Figure 3.4 Work Order Data

## 3.6 REVIT 2017

After introducing the most popular BIM software and Autodesk as the company that develops Revit, the spotlight will move now to Revit itself. (ReonidRaiz and Irwin Jungreis, 1997) founded the company Charles River Software, which started building Revit. Their main goal was to include parametric modeling to the existing idea of CAD, and to allow the user to determine the parametric components graphically, instead of having to use a programming language.

Autodesk Revit 2017 is building information modeling software for architects, landscape architects, structural engineers, MEP engineers, designers and contractors developed by Autodesk. In this thesis, Autodesk Revit 2017 used to extract all the

information from the CAD data of the building. Autodesk Revit is a software complex Building Information Modeling (BIM). It provides users the ability to design, parametric 3D modeling and 2D drawing elements, makes it possible to organize joint work on a project from concept to production of working drawings and specifications. Building information modeling is a system of computer-aided design (CAD), which uses intelligent 3D objects to represent real physical building components such as walls and doors. In addition, the Revit database may contain information about the project at various stages of the life cycle of buildings, from concept to construction and decommissioning.

### 3.6.1 3D Modelling

The creation of a 3D model using the Revit 2017 showed the powerful features of BIM. The creation of an element on a view such as floor plan translated correctly to a different view such as elevation view. This saved a lot of time in comparison to if the design were drawn in traditional 2D view. Furthermore, the parametric modelling detected the conflicts of elements. The use of this feature eliminated duplication or overlapping of elements.

REVIT 2017 is one of tool of BIM software that used to create the 3D modelling of Kolej Kediaman 4. All the information from 2D drawing are extract to the model for example floor, wall, window, door and roof. The 3D model of architecture is shown as shown.

Figure 3.5 3D Modelling

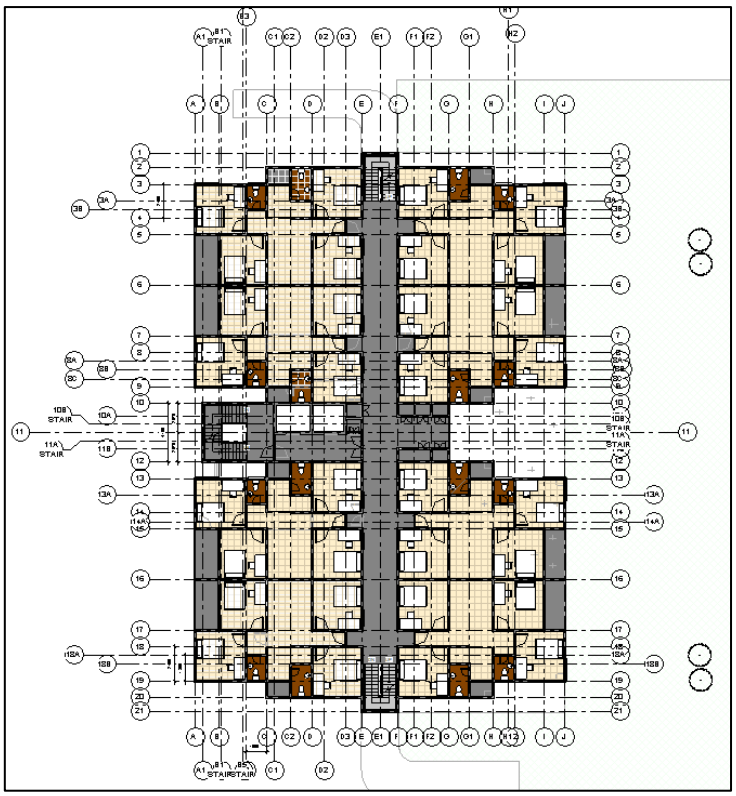

Figure 3.6 First Floor Plan

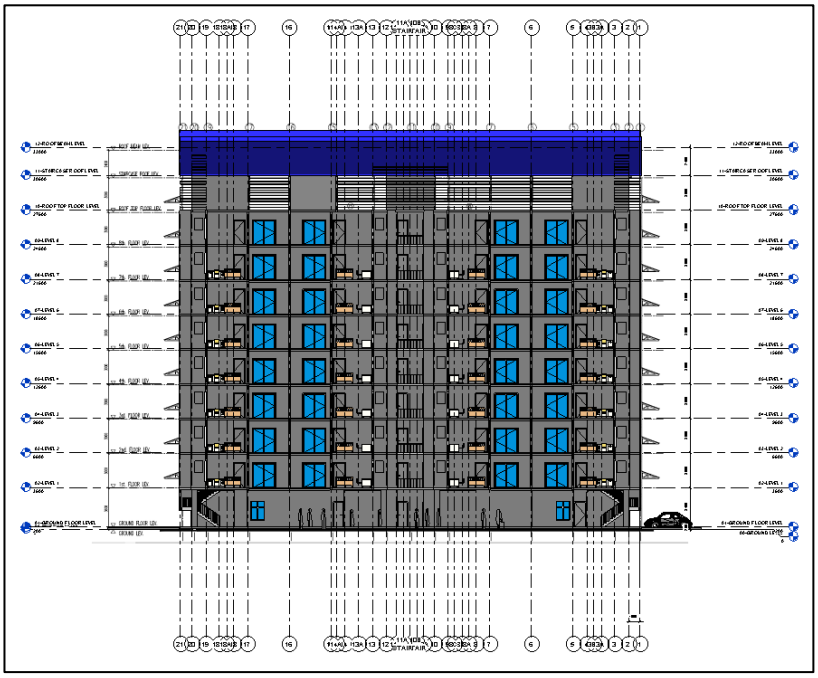

Figure 3.7 Front Elevation

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

In this chapter will be discusses the case studies finding for achievement of the research objective. Facilities management will be conducted based on the BIM 3D parametric model of building construction. After all the schedule is produced in Revit, it will convert to xls format for input of Microsoft Office Excel.

## 4.2 Schedule of Facility Management

After all the data and information be key in the parameter in the 3D modelling. The schedule can be track or sorting by location, work trade, number of room or work type. The figure 4.1 as shown.

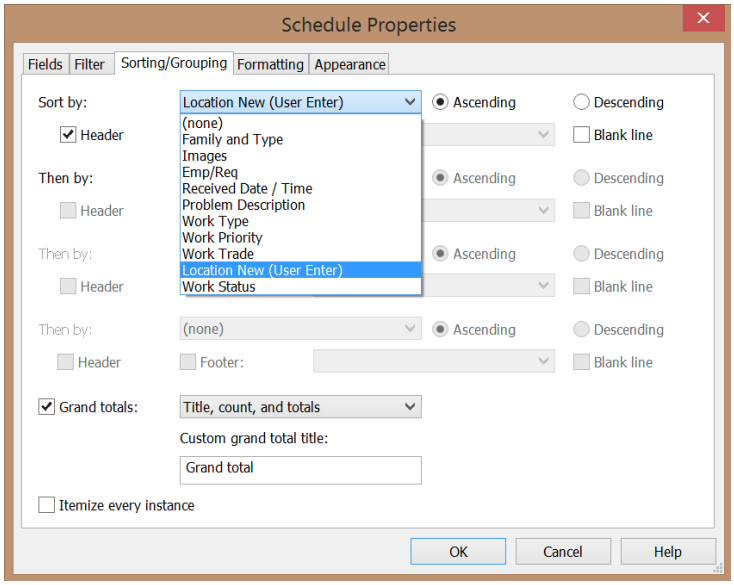


Figure 4.1 Schedule Properties

The appropriate information is provided in the schedule by selecting the appropriate fields to be inserted in the schedule. An example of the facilities management schedule showing the images, requestor, received date and time, problem description, work priority and location materials can be found in Figure 4.2:

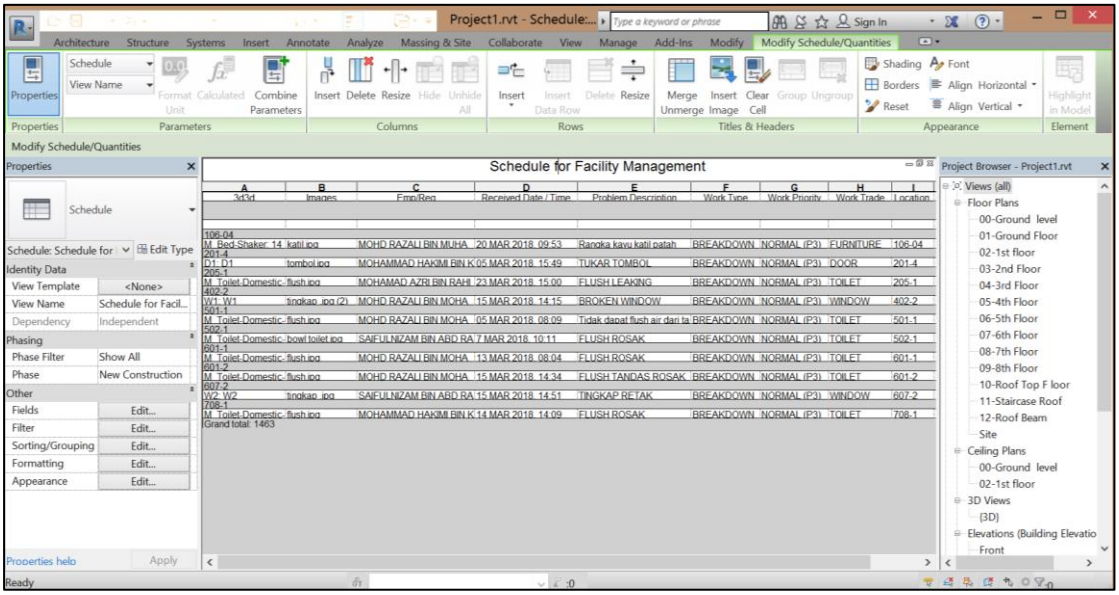


Figure 4.2 Schedule For Facility Management

All the schedules is used by facility staff to review the problem that had been happen for the past month. The important information generated from the schedules is geometric data, building information and information of assets and defect. After all materials schedules are generated, all schedules than exported to Microsoft Office Excel for the data input so that output data about the facility management can be obtained and review. Below is the procedure how to export facility assets schedule from rvt format generated by Revit Suite Software to xls format for Microsoft Office Excel.

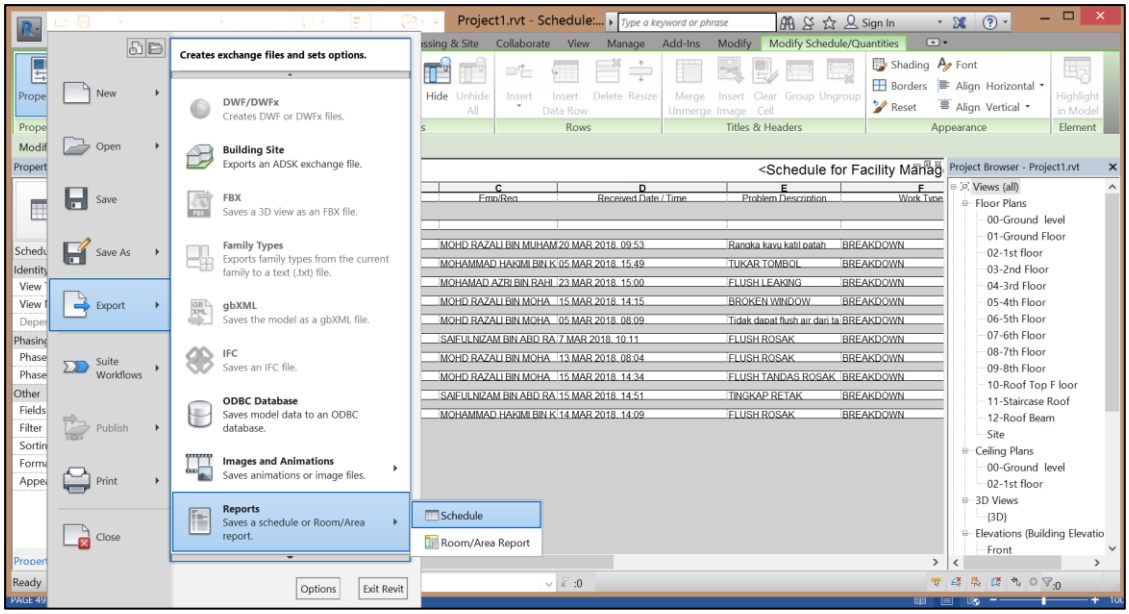


Figure 4.3 Export of Schedule in Autodesk Revit Architecture

After the schedule been exported, it will be save as txt format. Researcher need to convert the txt format to xls format so that the data can be review into Microsoft Office Excel. The step to convert the format is, open folder search option and choose view. Then untick hide extensions for known file type. The file format will be appear like shown in Figure 4.4 and the format will be change from txt to xls format so that the input data can be review by using Microsoft Office Excel.

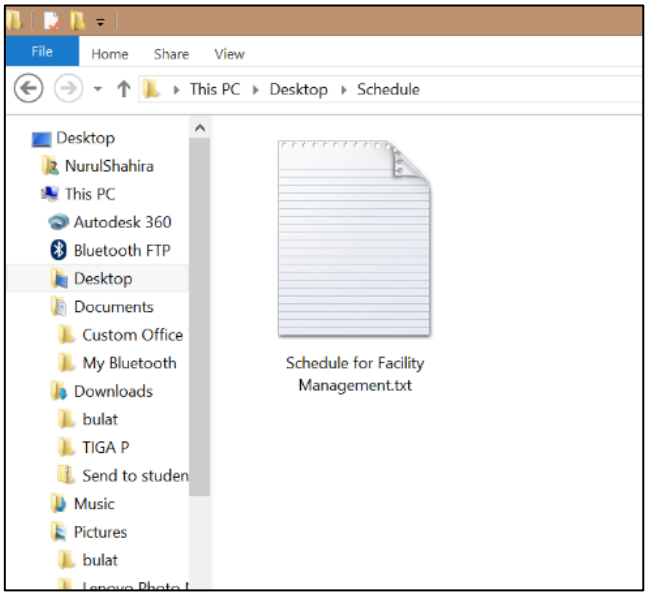


Figure 4.4 Txt file exported from Autodesk Revit Architecture

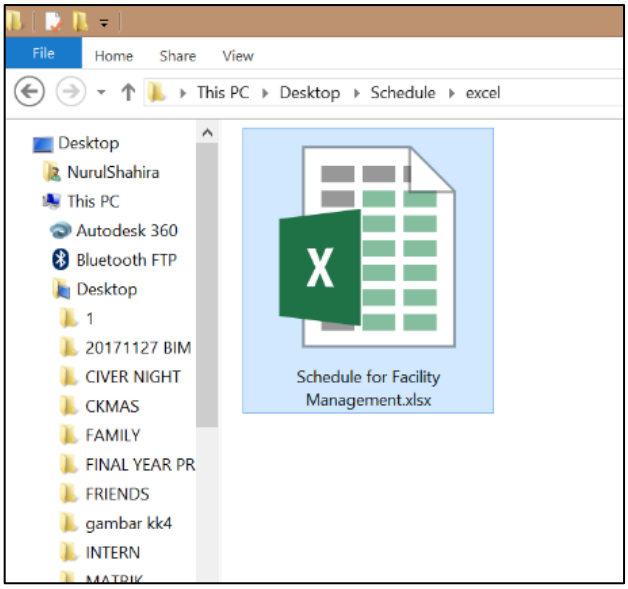


Figure 4.5 Change Format From txt to xls File

Table 4.1 Schedule for Facility Assets

| 3d3d | Images | Emp/Req | Received Date / Time | Problem Description | Work Type | Work Priority | Work Trade | Location New (User Enter) | Work Status |
|---|---|---|---|---|---|---|---|---|---|
| 106-04 | | | | | | | | | |
| M_Bed-Shaker: 1422 x 1981mm - Double |  | MOHD RAZALI BIN MUHAMMAD | 20 MAR 2018, 09:53 | Rangka kayu katil patah | BREAK DOWN | NORMAL (P3) | FURNITURE | 106-04 | CLOSED |
| 201-4 | | | | | | | | | |
| D1: D1 |  | MOHAMMAD HAKIMI BIN KAMARUDIN | 05 MAR 2018. 15:49 | TUKAR TOMBOL | BREAK DOWN | NORMAL (P3) | DOOR | 201-4 | CLOSED |
| 205-1 | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| M_Toilet-Domestic-3D: M_Toilet-Domestic-3D |  | MOHAMAD AZRI BIN RAHIM | 23 MAR 2018, 15:00 | FLUSH LEAKING | BREAK DOWN | NORMAL (P3) | TOILET | 205-1 | CLOSED |
| 402-2 | | | | | | | | | |
| W1: W1 |  | MOHD RAZALI BIN MOHAMMAD | 15 MAR 2018, 14:15 | BROKEN WINDOW | BREAK DOWN | NORMAL (P3) | WINDOW | 402-2 | CLOSED |
| 501-1 | | | | | | | | | |
| M_Toilet-Domestic-3D: M_Toilet-Domestic-3D |  | MOHD RAZALI BIN MOHAMMAD | 05 MAR 2018, 08:09 | Tidak dapat flush air dari tangki air tandas | BREAK DOWN | NORMAL (P3) | TOILET | 501-1 | CLOSED |
| 502-1 | | | | | | | | | |
| M_Toilet-Domestic-3D: M_Toilet-Domestic-3D |  | SAIFULNIZAM BIN ABD RAZAK | 7 MAR 2018, 10:11 | FLUSH ROSAK | BREAK DOWN | NORMAL (P3) | TOILET | 502-1 | CLOSED |

The table for facility assets can be produced as shown above in Table 4.1 after the file from Autodesk Revit converted into xls format in Microsoft Office Excel. The table be tracking by sorting with location.

So, all the problem for the assets at all the location in Kolej Kediaman 4's building can be track. The building information modelling (BIM) approach will be produce the 3D illustration and mapping of facility assets. The BIM approach retains facility information in a digital format, and facilitates easy updating and transfer of facility information in the 3D CAD environment. By using the 3D facility asset, project

participants can obtain an overview of previous and current facility asset in a given facility and manage facilities. Furthermore, facility staffs can track and access the most recent information for any basic information, conditions, or maintenance during the maintenance phase. Maintenance information can be updated rapidly and made available via the web-based 3D CAD environment.

## 4.3 Discussion

The 3D visualization model assists the user to easily and quickly find the location of facility and increases work efficiency, and storing maintenance information using BIM model to improve the inconvenience of traditional approach such as carrying and looking up a lot of paper documents. Besides that, the 3D model more immediately finds the assets compare with traditional approach.

Table 4.2 CAD and BIM Attributes

| **CAD** | **BIM** |
|---|---|
| • Drawing Production.<br>• Requirements for subscription types and designs of these fonts, use of colour, layering, scale, symbols and title blocks.<br>• Drawing format (DWG,PDF)<br>• Process interpreting and restore.<br>• Group design “four layers”.<br>• Consume: Executing contractors, subcontractors and suppliers.<br>• Archive: Drawing files constructor. | • Modelling.<br>• Required information for content of objects, attributes and relationship.<br>• Model format (RVT).<br>• Process reuse.<br>• Project group “one product”.<br>• Consumer: Architect, civil engineer, MEP engineer, developer project management, construction management and BIM coordinator.<br>• Archive: Simulation model file on BIM server. |

Table 4.2 shown the CAD and BIM attributes in the facilities management where it give the benefits to all the participant involve.

Using BIM model to store the planning of facilities management can assist facility managers understanding the schedule of tasks, task time and maintenance staffs of task. The BIM approach not only enhanced efficiency and convenience of facilities management, but also reduced lacks of schedule management that are caused by human factors.

Using the BIM approach, the facility staffs can quickly find the location of facilities, monitor the state of facilities maintenance, and examine the related files of facility. Therefore, the BIM approach can be more helpful to facility managers when they need to make an appropriate action or decision compared with traditional approach.

# CHAPTER 5

# CONCLUSION

## 5.1 Introduction

This chapter aims at providing the conclusions and recommendations for the industry and research, and suggests future research as a result of the findings, encapsulated in the research that was carried out and detailed in this thesis. In order to realize these aims, the overview will be provided by revisiting the research objectives, process and main findings, and these will be discussed critically to evaluate the extent to which the research objectives were met. In addition, the discussion of the main findings will provide some ideas about interesting aspects of research questions for the future. The study of this research has established the facility management link with Building Information Modelling (BIM). The aim of this research is to determine whether using BIM model based on facilities management are efficiency in manage the assets.

## 5.2 Conclusion

This study implements the facility management in building information modelling system for all facility staffs as a facility management platform. The system provides insight into factors impacting FM activities, which in turn assists facility staffs in managing interface events to improve facility management performance. The system allows facility staffs and managers to track and manage the most recent maintenance-related information, events, problem descriptions, and solutions in the 3D CAD-based models. The 3D CAD-based models illustrate facility events, problem descriptions, and solutions in 3D representations. Notably, BIM is a highly promising means of enhancing FM and identifying facility information relevant to both basic information and maintenance

### 5.2.1 Objective 1

*To create parameter based on information of work order*

By using the Revit software, the data and information based on parameter have been created to easy the staff key in the information. To enhance maintenance management performance, the building information modelling (BIM) approach is applied and developed as 3D information models for managing and maintaining facilities in the study.

### 5.2.2 Objective 2

*To track and manage facilities assets in BIM*

By using the Revit, the staff or manager be able to track and manage facilities management with efficiency. With the integration of BIM model with related information of facilities maintenance, the facility staffs may improve the efficiency of maintenance and management work of facilities

### 5.2.3 Objective 3

*To produce the schedule of facility management from the actual data*

With Revit where can produce the schedule of facility management quickly. From the schedule, the staff be know the defect by sorting with location, work trade or location. It easier for the staff to review back the problem that have be done

## 5.3 Recommendation

There are several limitations that have been facing by researcher during this research. The recommendation for these studies is more engineering data regard to building components for obtaining more information of drawing and data of work order for better workstation for conducting more quickly data interpretation in Revit Software

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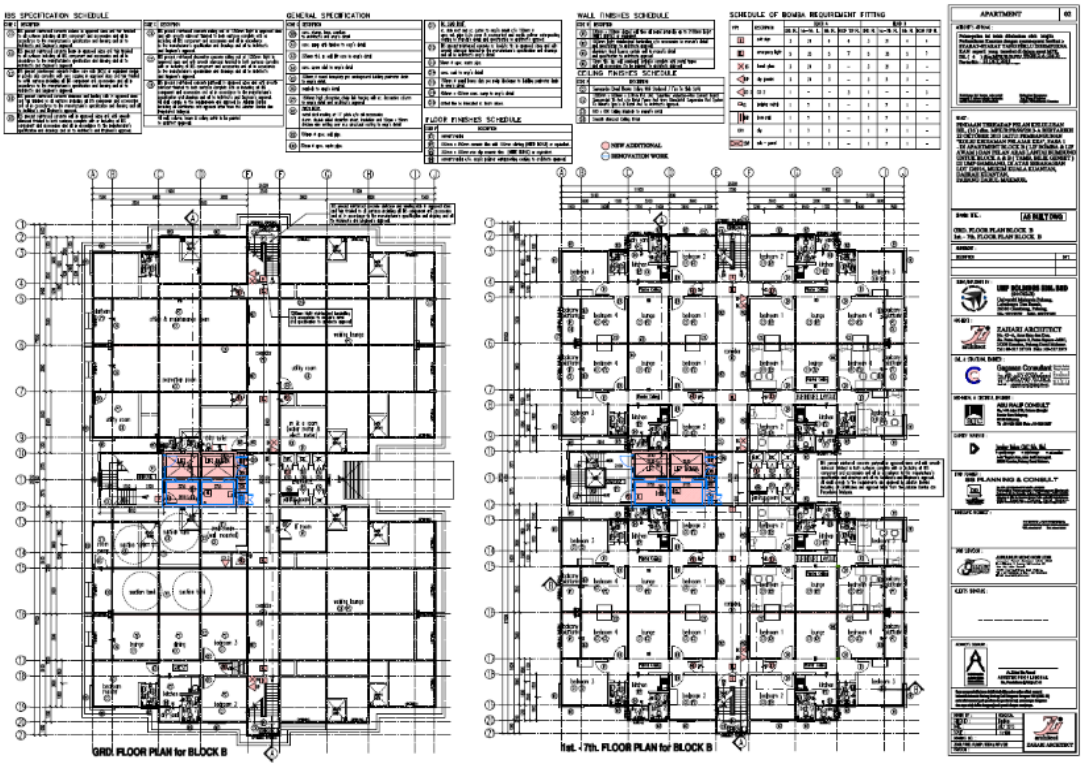
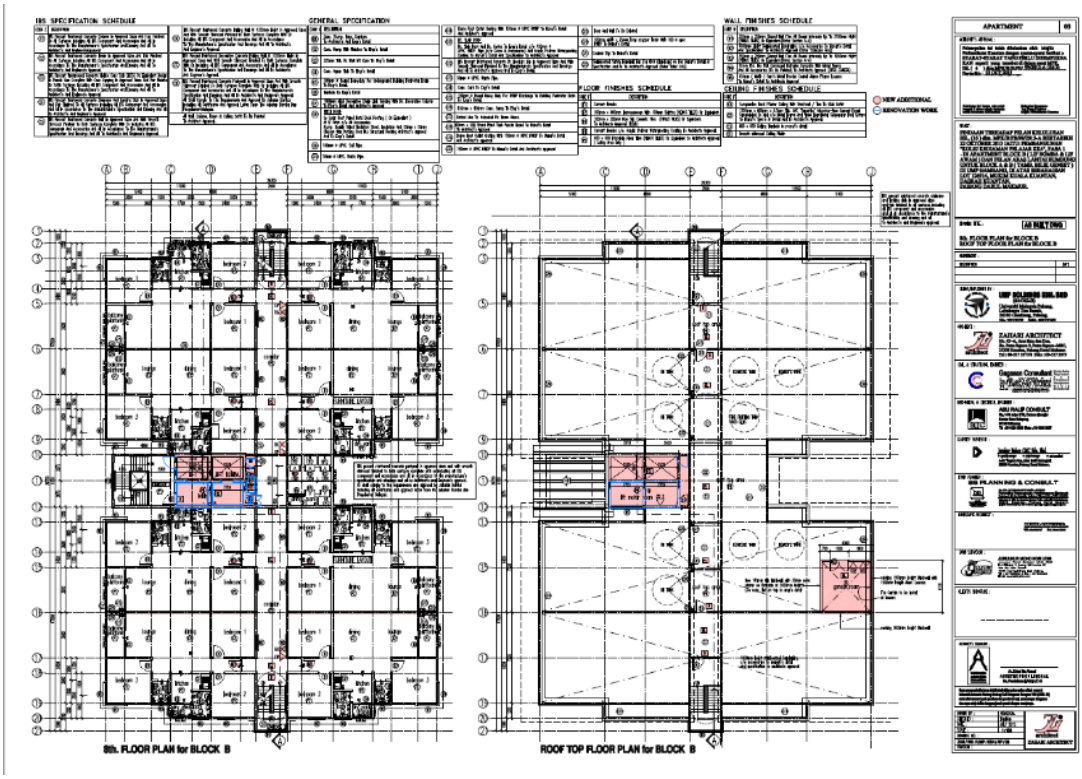
# APPENDIX A
# SAMPLE APPENDIX 1

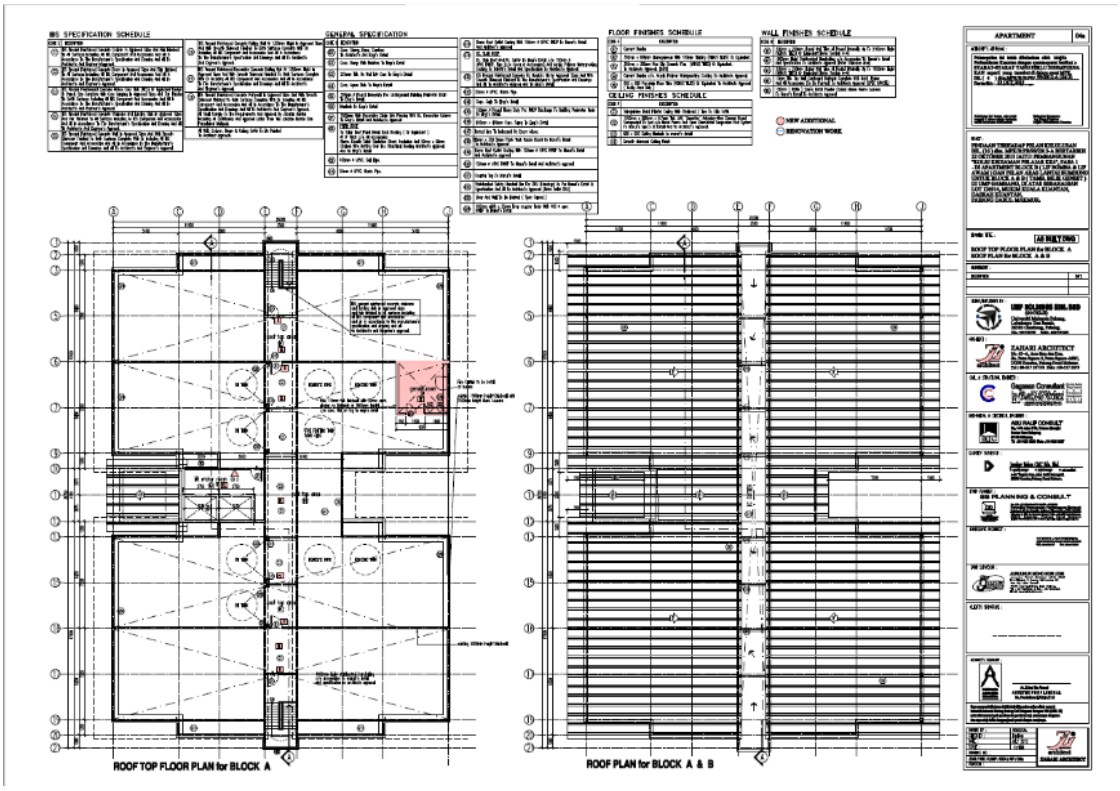
GROUND FLOOR PLAN AND 1TH – 7 TH PLAN



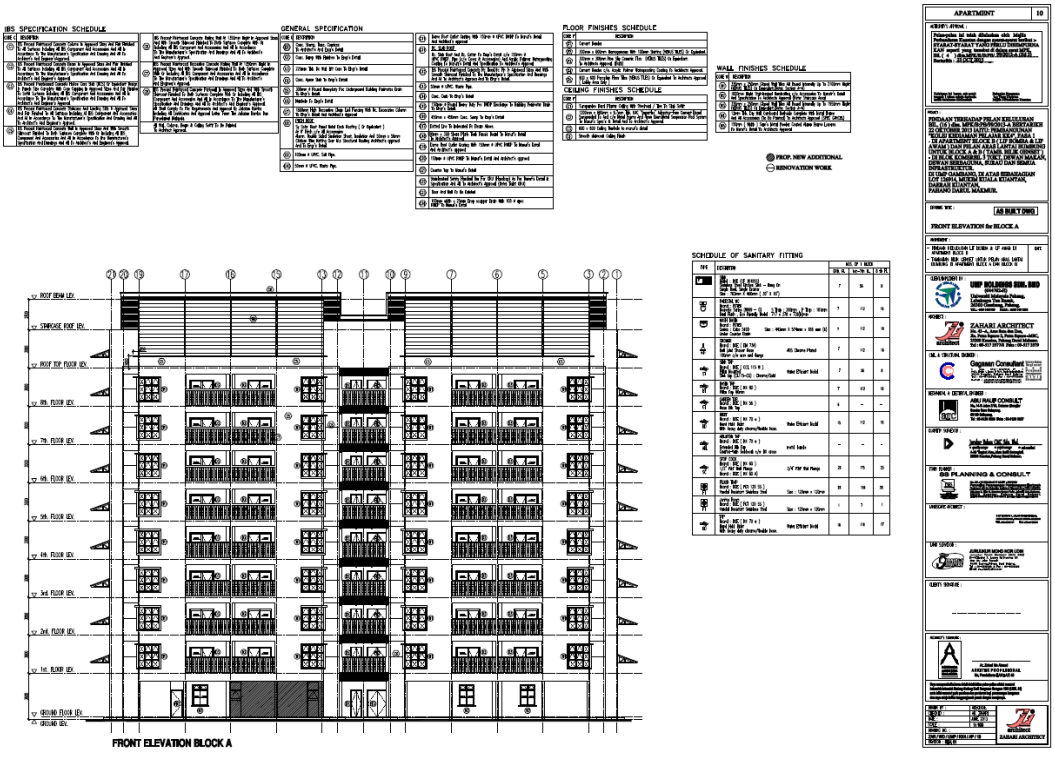

8TH FLOOR PLAN AND ROOF TOP FLOOR PLAN



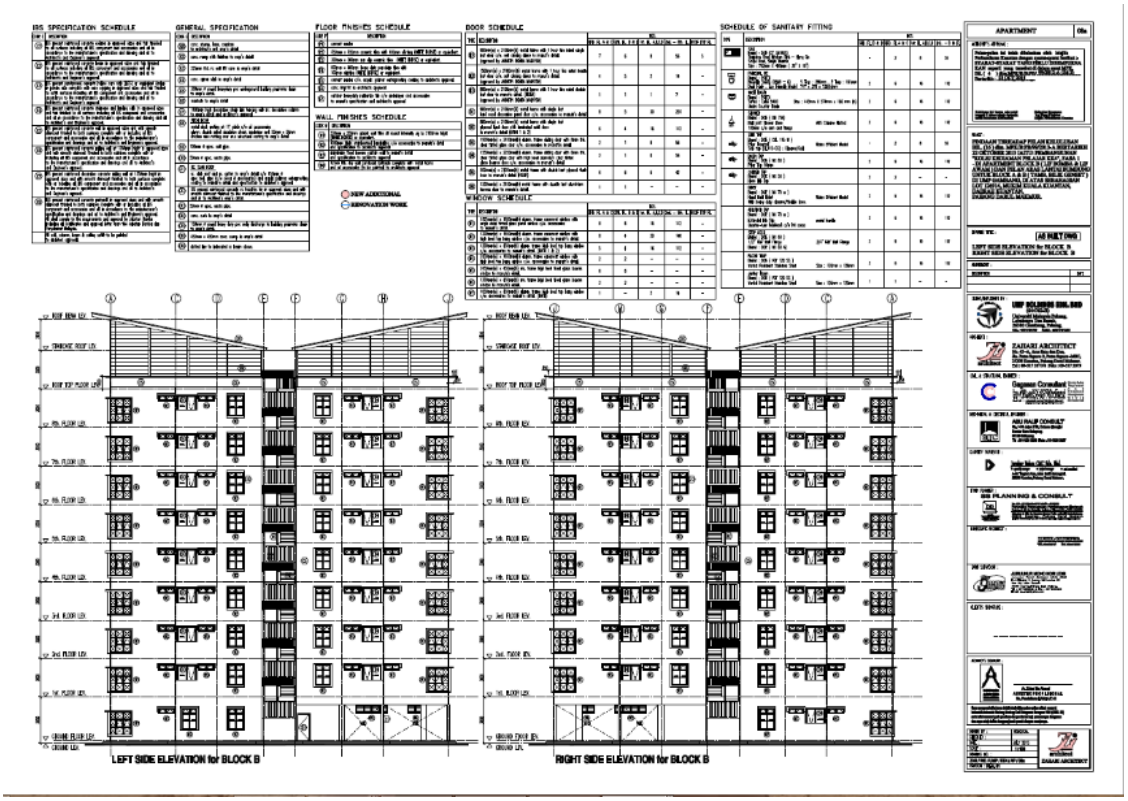
ROOF TOP FLOOR PLAN AND ROOF PLAN



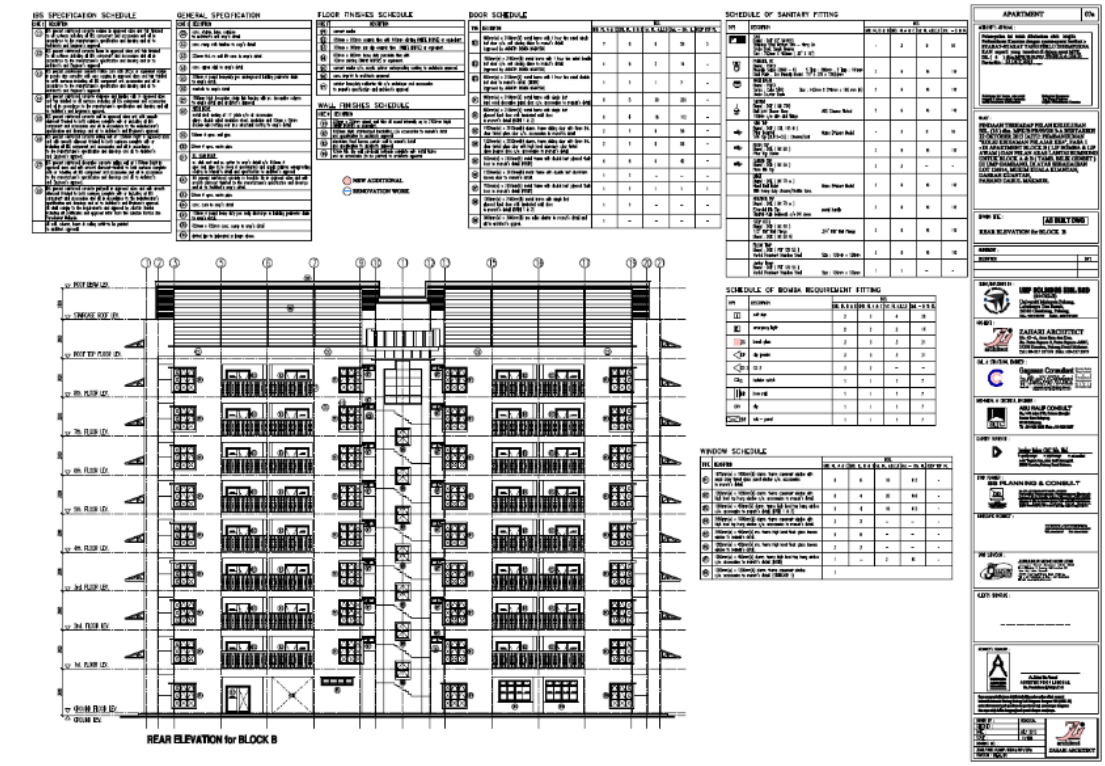

FRONT ELEVATION



## LEFT AND RIGHT ELEVATION

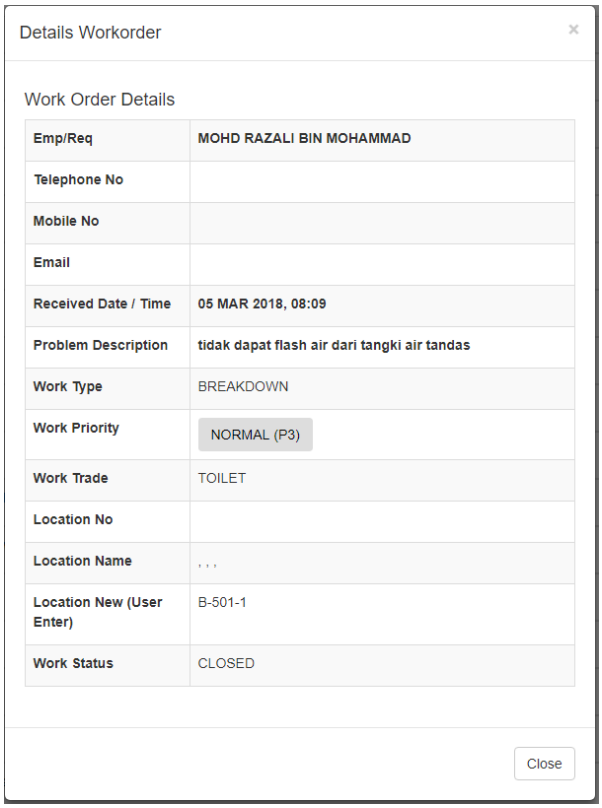



## REAR ELEVATION



# APPENDIX B
# SAMPLE APPENDIX 2

DATA WORK ORDER

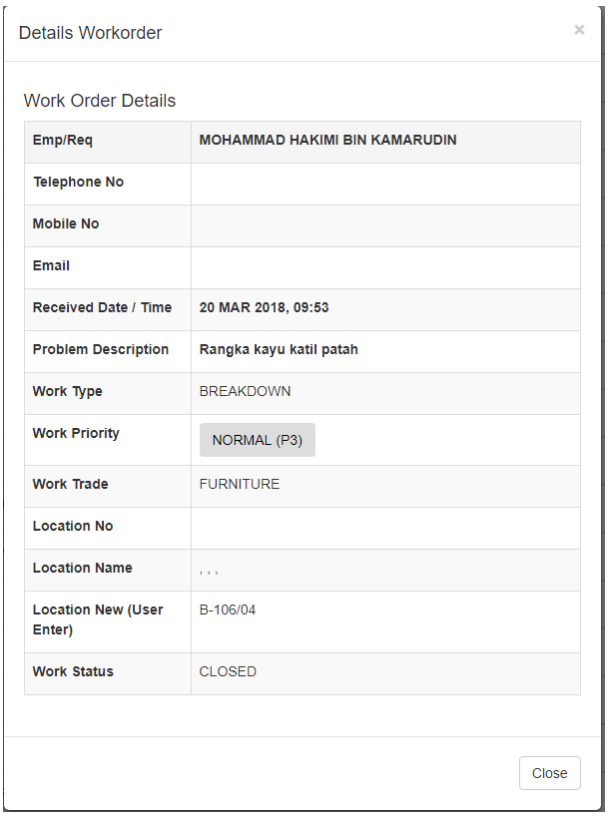


Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHD RAZALI BIN MOHAMMAD** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **05 MAR 2018, 08:09** |
| **Problem Description** | **tidak dapat flash air dari tangki air tandas** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | TOILET |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | B-501-1 |
| **Work Status** | CLOSED |

Close



Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHAMMAD HAKIMI BIN KAMARUDIN** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **20 MAR 2018, 09:53** |
| **Problem Description** | **Rangka kayu katil patah** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | FURNITURE |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | B-106/04 |
| **Work Status** | CLOSED |

Close

DATA WORK ORDER

Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHAMMAD HAKIMI BIN KAMARUDIN** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **05 MAR 2018, 15:49** |
| **Problem Description** | **TUKAR TOMBOL** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | DOOR |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | A201-4 |
| **Work Status** | CLOSED |

Close

Details Workorder

Work Order Details

| | |
|---|---|
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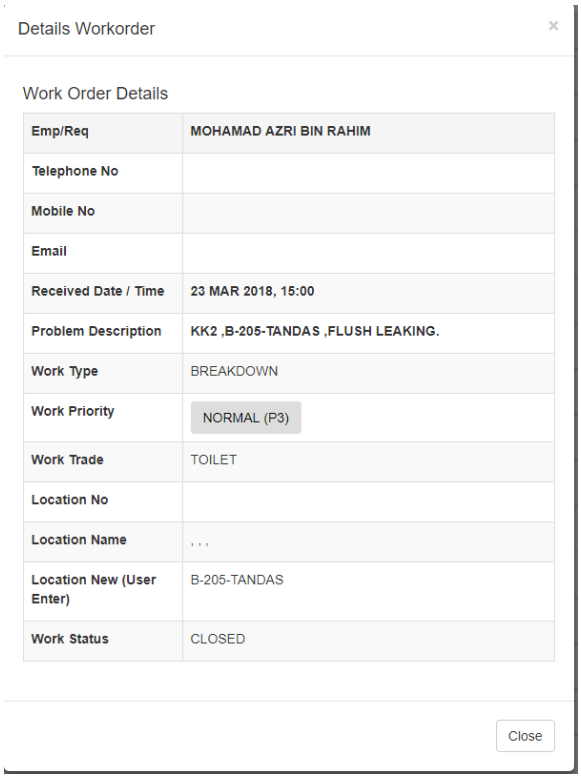
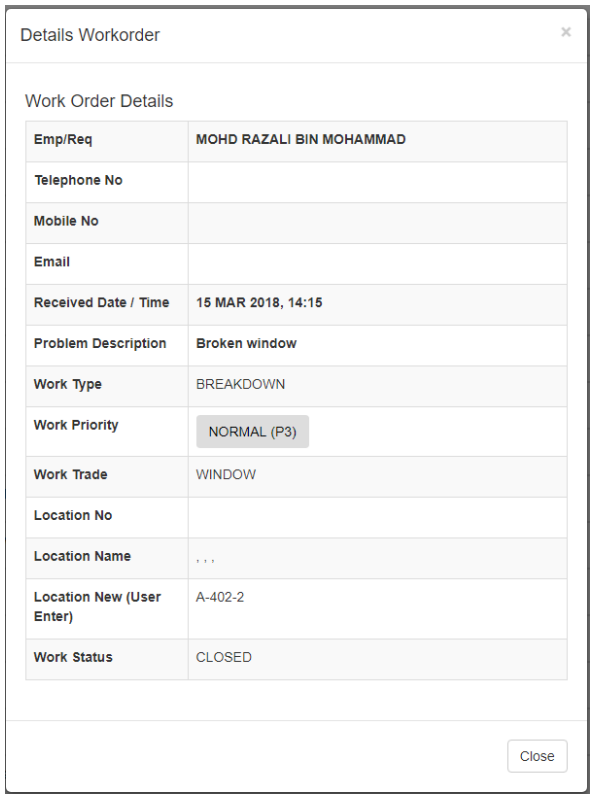
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **15 MAR 2018, 14:31** |
| **Problem Description** | **tingkap retak** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | WINDOW |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | A607/2 |
| **Work Status** | CLOSED |

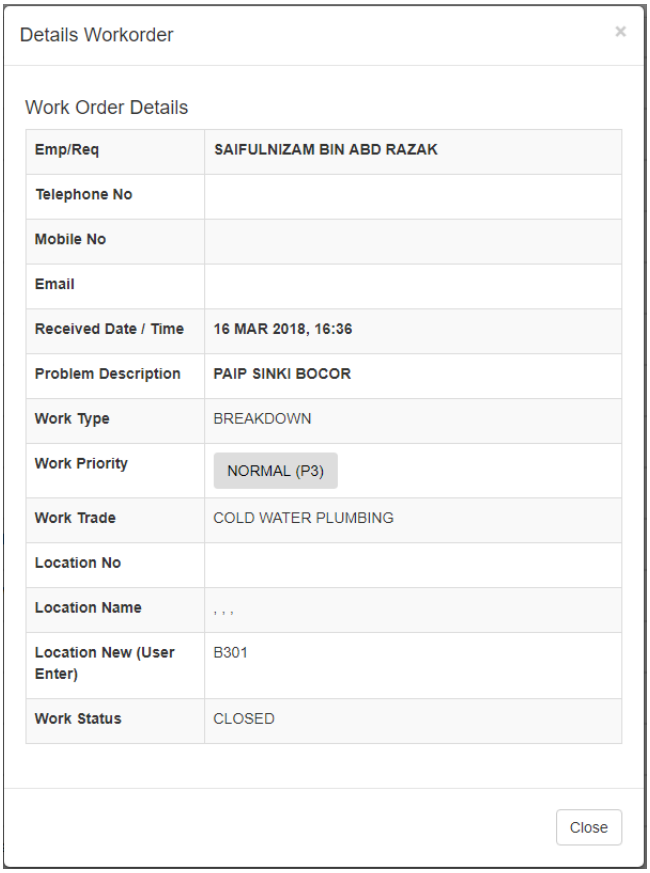
Close

DATA WORK ORDER



DATA WORK ORDER

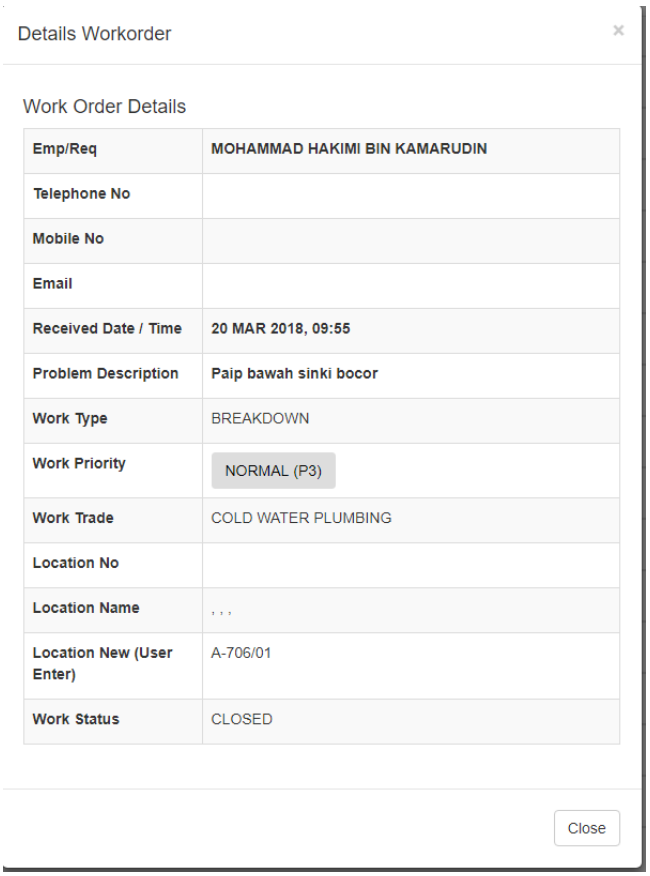


Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **SAIFULNIZAM BIN ABD RAZAK** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **16 MAR 2018, 16:36** |
| **Problem Description** | **PAIP SINKI BOCOR** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | COLD WATER PLUMBING |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | B301 |
| **Work Status** | CLOSED |

Close



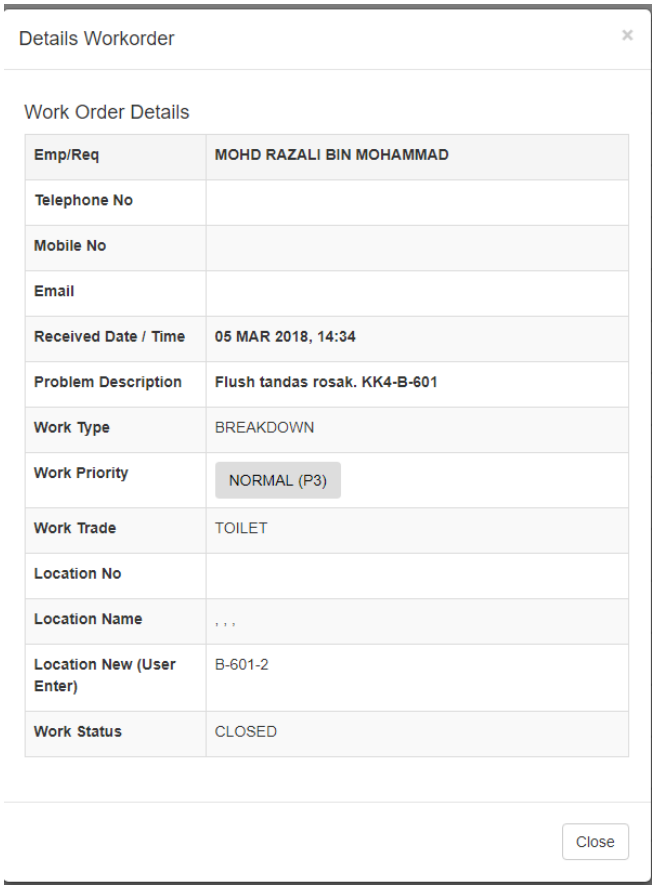
Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHAMMAD HAKIMI BIN KAMARUDIN** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **20 MAR 2018, 09:55** |
| **Problem Description** | **Paip bawah sinki bocor** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | COLD WATER PLUMBING |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | A-706/01 |
| **Work Status** | CLOSED |

Close

DATA OF WORK ORDER

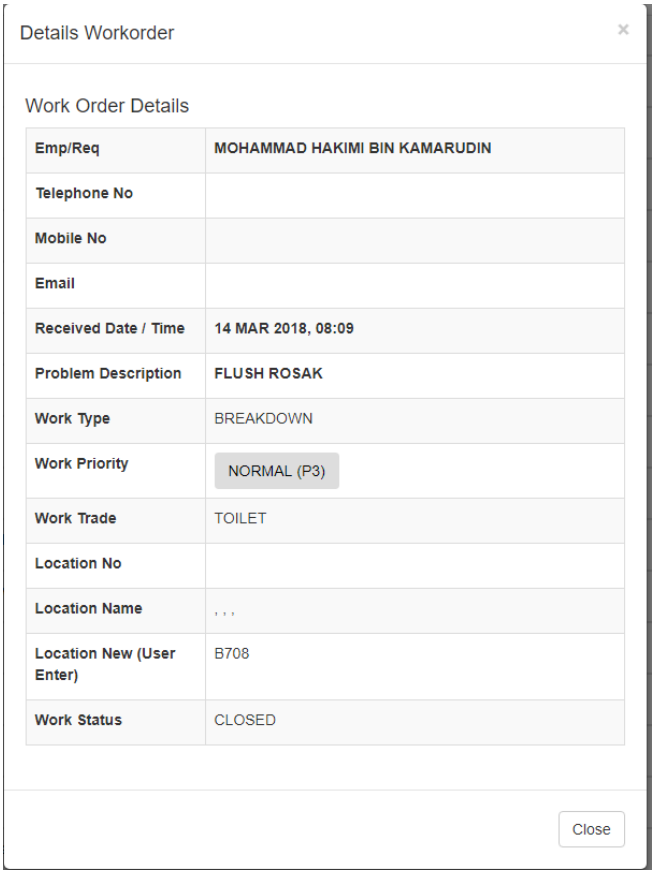


Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHD RAZALI BIN MOHAMMAD** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **05 MAR 2018, 14:34** |
| **Problem Description** | **Flush tandas rosak. KK4-B-601** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | TOILET |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | B-601-2 |
| **Work Status** | CLOSED |

Close



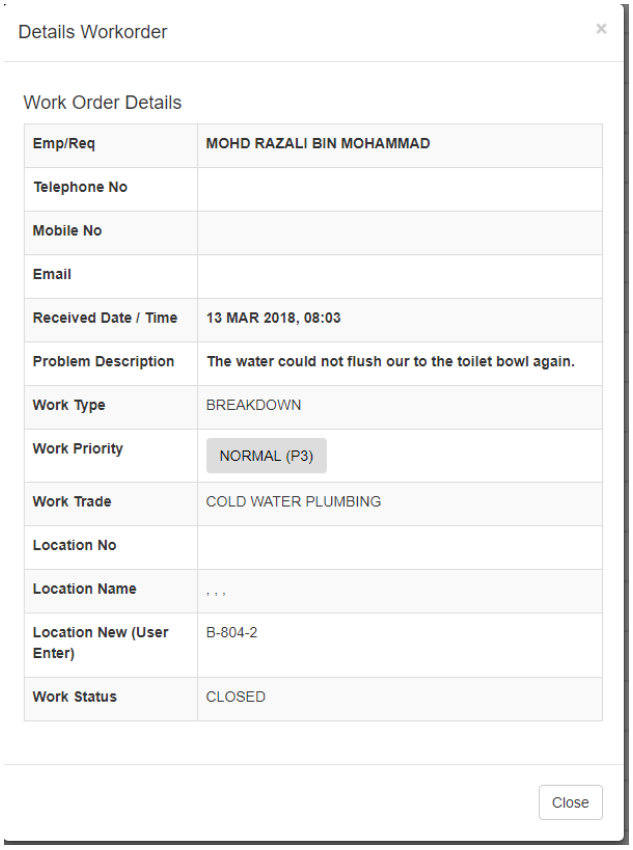
Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHAMMAD HAKIMI BIN KAMARUDIN** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **14 MAR 2018, 08:09** |
| **Problem Description** | **FLUSH ROSAK** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | TOILET |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | B708 |
| **Work Status** | CLOSED |

Close

DATA WORK ORDER

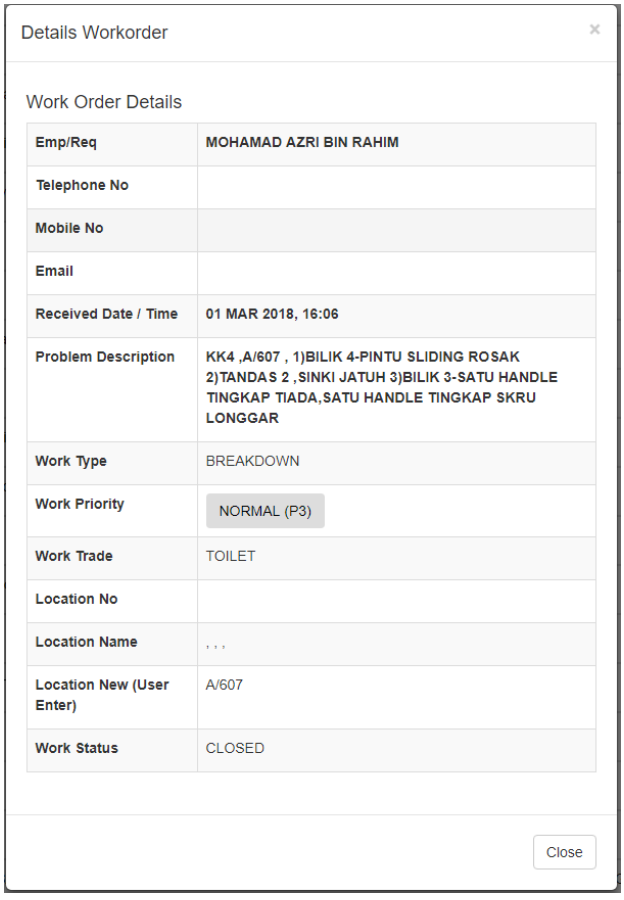


Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHD RAZALI BIN MOHAMMAD** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **13 MAR 2018, 08:03** |
| **Problem Description** | **The water could not flush our to the toilet bowl again.** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | COLD WATER PLUMBING |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | B-804-2 |
| **Work Status** | CLOSED |

Close



Details Workorder

Work Order Details

| | |
|---|---|
| **Emp/Req** | **MOHAMAD AZRI BIN RAHIM** |
| **Telephone No** | |
| **Mobile No** | |
| **Email** | |
| **Received Date / Time** | **01 MAR 2018, 16:06** |
| **Problem Description** | **KK4 ,A/607 , 1)BILIK 4-PINTU SLIDING ROSAK 2)TANDAS 2 ,SINKI JATUH 3)BILIK 3-SATU HANDLE TINGKAP TIADA,SATU HANDLE TINGKAP SKRU LONGGAR** |
| **Work Type** | BREAKDOWN |
| **Work Priority** | NORMAL (P3) |
| **Work Trade** | TOILET |
| **Location No** | |
| **Location Name** | , , , |
| **Location New (User Enter)** | A/607 |
| **Work Status** | CLOSED |

Close