BUILDING OPERATION AND MAINTENANCE IN BUILDING INFORMATION MODELLING (BIM)

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ABSTRAK

Pengurusan maklumat sepanjang kitaran bangunan bangunan menjadi semakin penting dan ‘Building Information Modelling’ (BIM) sering digunakan untuk memastikan kesinambungan data. Bagaimanapun, maklumat kemudahan yang berdasarkan BIM dari fasa pembinaan sukar diperoleh dan digunakan semasa fasa operasi dan penyelenggaraan. Ini berlaku kerana maklumat BIM tidak digunakan dengan baik dalam pengurusan kemudahan (PK). Dalam kajian ini, kami mencadangkan satu pendekatan untuk menguruskan maklumat PK berasaskan BIM secara berkesan dengan menghubungkan unsur-unsur bangunan berasaskan BIM dan maklumat kerja PK dalam pangkalan data sistem PK. Kami membentangkan sistem maklumat PK data yang menghubungkan data BIM secara semantik ke rekod kerja sejarah yang relevan. Cadangan ontologi telah dinilai menggunakan dataset sampel rekod kerja penyelenggaraan seni bina bangunan pejabat. Dengan menggunakan pendekatan yang dicadangkan, pengurus kemudahan akan dapat meningkatkan kecekapan mereka dalam mencari rekod kerja yang berkaitan yang mempertimbangkan objek BIM yang dikongsi dengan meningkatkan keupayaan operasi dan akses data PK.

ABSTRACT

The management of information throughout a building's lifecycle is becoming increasingly important and building information modelling (BIM) is often used to ensure the interoperability of data. However, BIM based facility information from the construction phase is difficult to access and use during the operation and maintenance phase. This occurs because the BIM information is not utilized well in facility management (FM). In this research, we propose an approach to effectively manage BIM based FM information by linking the BIM based building elements and FM work information in an FM system database. We present the data FM information system that semantically links BIM data to relevant historical work records. The proposed ontology was evaluated using a sample dataset of the architectural maintenance work records of an office building. Using the proposed approach, facility managers will be able to increase their efficiency in searching related work records that consider shared BIM objects by enhancing the interoperability and accessibility of FM data.

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LIST OF ABBREVIATIONS

BIM	Building Information Modelling
FM	Facility Management
OM	Operation and Maintenance
CAD	Computer Aided Design
3D	3 Dimensional
2D	2 Dimensional

CHAPTER 1

INTRODUCTION

1.1 Introduction

Building Information Modeling (BIM) is one of the most promising developments in the architecture, engineering and construction (AEC) industries. With BIM technology, one or more accurate virtual models of a building are constructed digitally. They support design through its phases, allowing better analysis and control than manual processes. When completed, these computer generated models contain precise geometry and data needed to support the construction, fabrication and procurement activities through which the building is realized.

BIM also accommodates many of the functions needed to model the lifecycle of a building, providing the basis for new design and construction capabilities and changes in the roles and relationships among a project team. When adopted well, BIM facilitates a more integrated design and construction process that results in better quality buildings at lower cost and reduced project duration.

BIM has been widely adopted by the construction sector, though Facility Management (FM) is still based on a variety of disparate FM systems. The operational phase requires comprehensive set of well-structured information regarding the building asset. Therefore, a BIM model filled with the multifarious information from the pre-use phase to be exploited through its integration with existing FM systems.

This paper aims to appreciate the contribution of BIM in optimizing the processes conducted conventionally within the FM practice. The importance of sustained information flow for the efficient operational stage is a pre-requisite of the further discussion. The exploration of FM application areas for BIM enabled processes is aimed to depict the potential of the BIM for FM concept. By elaborating on the existing challenges concerning the shift from traditional FM processes to new BIM based approach the outstanding problems are realized.

The study focuses mainly on new investments, where information management must be sustained from the project inception until the current operational stage. The paper proves the potential of BIM for the optimization of FM practices, presenting a wide range of application areas followed by tangible benefits for the building performance across its life-cycle.

Identified barriers are assumed to be mitigated by diligent implementation of provided recommendations. It is concluded that BIM based FM processes have the potential to shed a new light not only on the FM sector itself but on the perception of the whole industry being based on the collaborative approach towards delivery of the intelligent facilities.

1.2 Background of study

The current FM industry cultural approach to adopting new processes and technologies is considered as a key challenge. The FM industry is quite rigid in its approach to new technology, and unless BIM for FM benefits are clearly proven, its uptake in the FM industry will continue to be low (Becerik-Gerber, 2012).

Indeed, there is a lack of demand by clients for BIM models for FM (Architects, 2010) which is exacerbated by a general lack of collaboration between project stakeholders for modelling and model utilisation (Becerik-Gerber, 2012). The shortage of BIM skills and understanding in the FM industry hinders the adoption of BIM. This is especially prominent because a BIM model for FM uses is considered an individual building asset, which requires continuous maintenance to remain valuable to the building itself and its owners.

The proper identification of the information necessary and beneficial to improve the operational performance of a building is key to the creation of any BIM in Operations model. There is no limit to the types of information that can be incorporated into a model.

However much of the information typically included in models is unnecessary for day to day operations.

Similarly, given the level of effort required to populate a BIM model with operational data, the strategic identification of operational information is critical. This data will vary enormously from project to project based on specific user systems, organizational structure and scope of the model but will be related to one of three rough areas: space planning, maintenance activities, and front-of-house (occupant comfort, sustainability

The improvement of handover processes is the among the main drivers for using BIM in FM (Gu, Singh et al. 2008). Despite current interoperability challenges, BIM data and information collected during the building lifecycle will reduce the cost and time required to collect and build FM systems (Teicholz 2013).

For example, data regarding spaces, systems, finishes, etc. can be captured in digital format BIM models and do not require to be re-entered in downstream FM systems (Eastman et al. 2011). More importantly, the quality and reliability of data will improve, and in turn will result in increased workforce efficiencies (Teicholz 2013).

According to Eastman et al. (2011) the utilisation of improved data quality is likely to improve further as more people become accustomed to working in a BIM environment. These benefits are summarised in a statement by the BIM Task Group (2013).

Once the previously illustrated scenarios have demonstrated the value of BIM in FM, discussions with the FM estates department have shifted to understand the challenges associated with migrating from current FM processes to BIM based processes. Several key challenges were revealed and are related to the implementation. There is a need to communicate and understand the benefits of BIM for FM such as the examples previously mentioned.

However, the FM team should have the skills to be in position of maintaining and controlling the BIM for FM models. A concise BIM for FM specification must be developed to define the information required to suit the particular requirements of the business and FM function. It was also acknowledged that there are still industry-wide challenges related to technologies and processes. FM teams wishing to implement BIM for FM in the immediate future should be willing to adapt to such challenges.

The management of information throughout a building's lifecycle is becoming increasingly important and building information modelling (BIM) is often used to ensure the interoperability of data. However, BIM based facility information from the construction phase is difficult to access and use during the operation and maintenance phase. This occurs because the BIM information is not utilized well in facility management (FM).

In this research, we propose an approach to effectively manage BIM based FM information by linking the BIM based building elements and FM work information in an FM system database. We create the parameter based on FM information that semantically links BIM data to relevant historical work records.

The proposed ontology was evaluated using a sample dataset of the architectural maintenance work records of Kolej Kediaman 4. Using the proposed approach, facility managers will be able to increase their efficiency in searching related work records that consider shared BIM objects by enhancing the accessibility of FM data through the parameter that have been create.

1.3 Problem statement

The purpose of facilities management practices is to provide the facility management profession with a leading reference on facilities management activities and standards. Most of FM industry players were unaware about the importance to implement the practices which should follow the standard, to ensure it will be successfully delivered to the user. Therefore, it is important by the FM industry player to overlook at the current state of practice before developing robust strategies in order to manage facilities efficiently and effectively, within the context of the organization's strategic business plan. Besides, it also to improve the quality and performance of maintenance of a building by using BIM so that they can overcome lack of coordination and information during the maintenance process. Easy for client to track down the relevant data to facilities management system. This research aims to introduce the accessibility of FM data through the parameter that have been create into the model for better monitoring.

1.4 Aim and objective

The aim of this research is to identify the significant areas in improving quality facility management in BIM project using the actual data.

i. To identify relevant actual data to the system of facility management.
ii. To demonstrate how BIM contributes to operations and maintenance (O&M) of the facilities.
iii. To identify how the BIM model can contribute to time planning during the operations and maintenance (O&M) process.

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. The selected building is a block B of Kolej Kediaman 4. The scope of study for this research area:

i. Get 2D CAD drawing from the client.
ii. Data collection is based on architecture drawing for building architecture building components from the BIM model using Revit Software.
iii. Focus on facility management since they are still using the traditional way.
iv. Creating the parameter into the Revit Software based on data of work order.
v. Develop the schedules of facility management of using Revit Software and convert to Microsoft Office Excel.

1.6 Significant of study

The findings from the research represented in this thesis are expected to be significant in further contribution to the construction industry especially for users to manipulate the building elements to reduce construction time during early design stage while remaining the gross area of the project. The study of the implication of BIM in building quantification will enrich the literature with a contemporary viewpoint on robust research. It is anticipated that the findings of this study could offer a sensible way for users to strategize facility management during early design stage for their future project. A further benefit of the search is to offer the chance for a paradigm shift forward for users to improve their facility management system for clients through their early involvement in the project using BIM, specifically in the Malaysian context.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

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 building operation and maintenance in building information modelling. Although the literature review covers a wide variety of theories, this review will focus on operation and maintenance, the application BIM for conducting facility management and BIM approaches in construction industries. The main focus on this literature review is application of BIM model based on operation and maintenance for FM.

2.2 Operation and Maintenance

The operation and maintenance (O&M) phase of buildings is the longest phase within the lifecycle. It always involves advanced interactions among various stakeholders, facilities, professionals and management activities as well as some various works, such as scheduling, space planning, repairing, and emergency managing. From daily activities, huge amounts of disordered data are generated. In order to manage these data, introducing building information modelling (BIM) technology in building O&M is currently in practice. BIM provides a parametric and detailed model with the related components of buildings, as well as integrated model views that enable constant synchronization of any changes (Cerovsek, 2011), within a unified information repository, supporting the requirements of information integration (Schultmann, 2014) for collaboration among different stakeholders. In addition, BIM enables better information exchange from the design and construction phases towards the O&M phase.

On the other hand, makes it possible to store mass information generated during the O&M phase. Therefore, BIM can perform as the data layer in applications (Underwood, 2008). However, when the data in BIM increase to a certain volume, some features of the large data emerge. It is believed that huge data have the potential to find latent patterns as well as to help prediction (Oyedele, 2016), but the problems in the information requirement within data arise in at least two aspects which are:

i. The increasing volume of data in BIM is now challenging the outdated method of data usage and experience based on decision making (Qadir, 2016). The heterogeneity in information, the complexity in storage and the specialized functions of users lead to more and more non-intuitive data. Current BIM standards usually represent building elements and their relationships by complex structures. Besides, only managers with enough professional knowledge can access information via BIM. The ways to extract useful information from BIM data and represent those patterns in an understandable form are worth exploring.

ii. Inaccurate data may impact management activities. Manual input, which is an error disposed procedure, still plays an important role in data input and management in current practice. Besides, wrong input can lower the data quality and lead to negative implications for management activities. For example, if an improper repair instruction is attached to a pump, workers may incorrectly perform repair tasks. However, manual checks are almost impossible, because handling so much data will be feel bored and costly (Juneja, 2014). Those inaccurate records may also confuse the data analysis process (Kamber, 2011).

2.2.1 Application of BIM based data in Operation and Maintenance

With a strong ability to manipulate data, BIM supports the information requirements in O&M applications. As a result, an increasing amount of data from various sources are accumulating routinely in BIM, forming data. These data are mainly gathered from the following channels. When establishing BIM, basic information is input manually or derived from standard component libraries. Records generated in daily management are integrated by methods into existing models, such as schedule and work package information (Al-Hussein, 2015). The accumulation of big visual data, such as pictures, videos, point cloud, etc., is discussed as well (Han, 2017).

Many entities are transformed by algorithms from outside the BIM environment via some building management tools. For example, a framework was developed to store and distribute knowledge in the management process (Deshpande, 2014). This approach could acquire lessons from previous projects and then map to the corresponding elements in BIM. A semantic material matching system (Kim, 2013) transformed the names of materials in BIM according to standard libraries. This mainly addressed the semantic conflicts among stakeholders and brought rich information of components properties as well.

Documents were delivered from the design or construction phase to O&M models. More documents were gradually attached to building components during daily management, such as checking lists and operation history. Then, the indoor or outdoor collect huge amounts of samples and send them back to the data repository (Guerrero, 2016). Location or orientation via BIM (Li, 2011) technology was used as data sources. They usually send various data in BIM when executing the tasks. In addition, cloud technology enables workers to establish dynamic data in BIM (Chang, 2016).

2.2.2 Practices of data mining in building industry

Strategies in DM were reviewed, as DM is utilized to analyse large data sets generated in the O&M phase. Some innovative research has been reported recently. As reviewed, clustering, regression, and pattern analysis were the most commonly used in projects. The factors of steam load were mined as a regression model to predict in every month (Kusiak, 2010). Pattern analysis was executed on facility operational data and found rules to save energy (Yu, 2012). A recent trend shows that researchers prefer multiple methods rather than an individual method in their works. For instance, clustering was used to discover basic operations of doors and windows, and then five abnormal patterns were discovered through pattern analysis for ventilation design (D'Oca, 2014).

These studies indicate that several data mining methods may work in a sequence to dig deeper information step by step. In addition, this data is analysed by means, showing their power in practice. Many successful cases were reported regarding data mining towards building management.

2.3 Benefit BIM towards FM

The benefits facility managers can take advantage of by using building information modelling (BIM), as a tool for facility management. Firstly, its comes from integrating a BIM model with a facility's maintenance management system. If a preventive maintenance program isn't already automated, BIM can do that. And if it is, BIM can connect to the existing software package to supplement the data and information that already exists, ensure an even more robust maintenance program. Essentially, the BIM model becomes an electronic owner’s manual, and can also be a valuable tool if facility managers undertake a recommissioning process.

Next, BIM can improve space management. BIM can show quickly and visually where space could be used more efficiently and help make it. Besides, BIM can help with building analysis, especially in regards to sustainability initiatives. The BIM model can be a continuously updatable repository for all the data collected and programs developed in conjunction with green goals. BIM can help streamline change management. Facility managers can use the BIM model to scenario plan and configure space more efficiently. BIM can also help identify conflicts when space requirements or purposes change.

Lastly, new software packages are being created and put out on the market that allow a BIM model to connect with a facility's building automation system. This has numerous benefits in terms of information management and system efficiency. After all, nothing is more expensive than information cannot trust, as the common saying goes.

2.4 Challenges of BIM in FM applications

The lack of processes for updating the designed model with as built information is considered among the top challenges for BIM in FM applications (Gu, 2010). Roles and responsibilities for providing the data and maintaining the model are not well defined (Becerik-Gerber, 2012). Facility managers have traditionally been included in the building lifecycle in a very limited way and at the late phase of facility handover to clients (Azhar, 2011). Additionally, design decisions are not usually challenged for their impact on operational cost or maintenance (Management, 2012).

As a result of these challenges, BIM data for FM is either lacking or inadequate. The FM field relies heavily on getting usable data from a BIM to do anything meaningful with it. All too often, this data is not really there or is inaccurate, as the model has not been updated with any design changes made after the design phase and is therefore not an accurate model of the facility as it is built (Lee, 2012). The traditional procurement of FM contractors, in which FM contractors are appointed for a contracted period of time, generally three to five years, is also considered as an obstacle for BIM for FM applications. This change of contracts with FM contractors often entails notoriously poor handed-over data between the contractors, leading to additional survey costs being added to the fee.

Capture as built conditions and the owner will have to pay over and over once for the construction contractor to complete the documents at the end of construction and again for the maintenance contractor survey and the start of every contract. This process is inherently ineffective as it leads to a duplication of information. It could be suggested that there needs to be improvement made to the workflow of handover data and the maintenance of that data through the life of the building

2.5 Value of BIM in FM applications

Today most contracts require the handover of paper documents containing equipment lists, product data sheets, warranties, spare part lists, preventive maintenance schedules, etc. This information is essential to support the management of the facilities by the owner and facilities managers. The current process of information handover to FM phase is generally done manually. Information handed over is often incomplete and inaccurate (Lucas, 2013). The improvement of handover processes is the among the main drivers for using BIM in FM (Gu N. , 2008). Despite current interoperability challenges, BIM data and information collected during the building lifecycle will reduce the cost and time required to collect and build FM systems (Teicholz, 2013) For example, data regarding spaces, systems, finishes, etc., can be captured in digital format within a BIM and do not require to be re-created in downstream FM systems (Eastman et al., 2011).

The ability to capture manufacturers information within 3D parametric objects reduces the need of duplicating asset information (Shen et al., 2012). BIM is considered as an enabler of improved data quality and reliability which will in turn result in increased workforce efficiencies (Teicholz, 2013). According to (Eastman, 2011) the quality of data will improve as more people become accustomed to working in a BIM environment. The ability of extracting and analysing views from BIM, specific to various need sand users, will provide information to make decisions and improve the delivery of facilities (Azhar, 2011). For example, 3D visualisation can help FM technicians to better utilise their cognitive and perceptual reasoning for problem solving (Motamedi, 2014).

BIM visualisation provides accurate geometrical data that has never been possible before and can support the analysis of building proposal sand the simulation and benchmark of performance (Atkin, 2009). For example, intelligent algorithms could be created to automate decision making for FM applications that has never been possible before the addition of digital data (Golabchi, 2013). Scenarios showing the benefits of BIM to FM interventions such as troubleshooting broken equipment and improving ergonomic and comfort conditions are described by (Becerik-Gerber, 2012). Other important BIM in FM applications outlined literature are in space management, emergency management, energy control and monitoring and personnel training and development (Motamedi, 2014). There are also suggestions that adopting BIM in FM will facilitate the future involvement of facility managers at a much earlier design stage, in order to convey their input and influence on the design and construction of a building (Azhar, 2011). The adoption of BIM in FM is also expected to provide ways for managing knowledge about building operation which can be utilised in future designs (BIM, 2013)

For refurbishment projects, BIM and associated technologies such as laser scanning are expected to reduce the cost of producing as built information and the accuracy and reliability of FM information (Huber, 2011). Researchers are already exploring ways for integrating the scan to BIM and the enhanced data capture of existing buildings with non-destructive testing techniques to analyse materials and existing properties, as these will not be captured in a scan (Volk, 2014).

2.6 Project delivery in BIM for construction industry

Construction Management at Risk, Build and Integrated Project Delivery (IPD) methods are the most common project delivery approaches that the industry currently practices. No matter which delivery approach is chosen, the general contractor or the construction manager can use BIM. Construction managers or general contractors can use BIM to extract quantities of work to prepare cost estimates. Furthermore, they can provide powerful 3D renderings. Moreover, schedule integrated BIM known as 4D BIM can be used for animations, safety analysis, and to prepare site logistic plans. Construction managers can use BIM to coordinate work with subcontractors. They can also update schedule and costs with BIM. Lastly, they can turn over an as-built building information model to the owner’s maintenance team.

The construction manager job is officially started in a project as soon as is awarded. The project award timeline to the construction manager and the organizational structure of the project are dependent upon the construction delivery approach. These two factors impact the involvement of the construction managers in the Building Information Modelling process. In the traditional approach, the design, bid, and build phases follow each other. The architect, typically the lead designer in building projects and construction manager works directly for the owner. The engineering consultants are part of the designer’s team. The engineer and the architect first design the building. Upon, the completion of the design phase, the construction managers also known as general contractors in the traditional approach bid for the job. Once the bid is awarded, then the construction starts. It is not a fast track project delivery method. In other words, the approach does not involve early participation of the construction team during design. If the designers generated a 3D parametric model for the project, the BIM will lack the knowledge of the contractors during the design phase. Overall, eliminates the benefits of having the construction input during design phase when the ability to influence the cost is the highest as depicted in Figure 2.1. The architects and the engineers may not want to share their models due to risks, liability concerns, unauthorized reuse of intellectual properties and misinterpretation of the information included in the model.

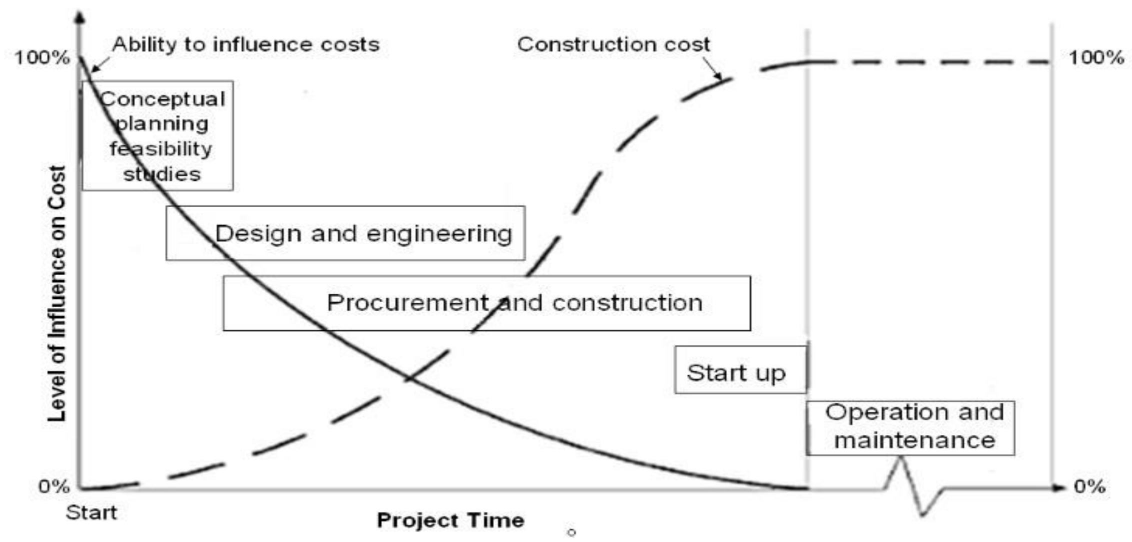


Figure 2.1 Project Life Cycle

In Construction Management at Risk delivery method, both the designer and the construction manager work directly for the owner. They can collaborate and complement each other’s work and report to the owner. When BIM is used, this approach carries the risk like the traditional method that the architects and the engineers may not want to share their models due to risks such as liability concerns, and unauthorized reuse of intellectual properties. Also, Construction Management at Risk approach usually entails the preconstruction services.

This enables the input of the construction team to the Building Information Model early on during the design phase. It can be used for private and public fast track projects. Construction Management at Risk is the approach that the research will be based upon. Build delivery approach requires a single entity to take over the responsibilities of the designer and the builder for the owner. Selection of design and build professionals is usually based on a combination of cost and professional qualifications. Since the designer and the general contractor work together, quality control assurance is limited. In other words, cost could become a priority over quality. On the other hand, Building Information Model can be used freely right from beginning of the project.

The intimate collaboration of the designer and the builder can yield to using the Building Information Modelling as a strong and effective process. Finally, a new method known as integrated project delivery (IPD) contractually requires designers, construction manager, subcontractors and owners to share the project risks. If the project stays within budget, then all the project participants receive their share of profits. Otherwise, they all lose their fee. This incentive promotes all the participants to work together towards a common goal. They share all the Building Information Model, share decision making, and share the responsibility. This joint project management approach results in pure collaboration and no litigation. Overall, Building Information Modelling makes IPD achievable. (Handler, 2010) The Building Information Modelling is a process of virtual design and construction of the project. The traditional approach will not be the best approach to promote the benefits of BIM since the construction manager or the general contractor will not be involved in the process until after the design phase of the project is complete.

Therefore, Construction Management at Risk, Design, and Integrated Project Deliveries (IPD) are better project deliveries to collaborate and to maximize the use of BIM. This would enable the construction managers to provide input by collaborating through BIM during the design phase when the ability to influence the cost and schedule is maximized.

Despite the delivery method, BIM Addendum created by Consensus can be integrated as an additional rider to each project participant’s contract. BIM Addendum does not impact the contractual relationships of the project participants. However, it requires the participants to communicate, collaborate and exchange information via using BIM tools.

Information technology responsibilities are assigned to an Information Manager whose tasks consists of account maintenance, back up and security. BIM requires the implementation of BIM Execution Plan which identifies the BIM needs of the project. It consists of checklist of issues including but not limited to the type of Models to be created, required level of detail, purpose of each model, responsible party for creation of each model, schedule for delivery of Model, file formatting, file naming, object naming, interoperability of BIM tools, coordination and clash detection, and BIM website utilization, etc (Lowe 2009).

In the BIM addendum, Design Model and Construction Model are identified. Design Model developed by engineers and architect is expected to be completed at level of detail of two-dimensional construction documents. Construction model developed by the contractor and subcontractor is equivalent to modelling of shop drawings and related information.

Developer of each distinct model can work and update his or her own files and are responsible for dimensional accuracy of model. Distinct models can be linked to each other to form a federated model. The federated model can be used for many purposes including clash detection, marketing and facility maintenance purposes (Lowe 2009).

As part of BIM Addendum, parties waive claims against each other. BIM Addendum addresses the risk of the potential intellectual property infringement claims. Each party allows the use of their models for the benefit of the project. If a software malfunction is found to impact the project, the owner is mainly taking the risk and the schedule extension for the project is allowed (Lowe 2009).

2.7 Use of BIM in Construction Management

There are many uses of Building Information Modelling for each project participant. Figure 2.2 depicts these uses for the planning, design (preconstruction), construction and operation (post construction) phases:

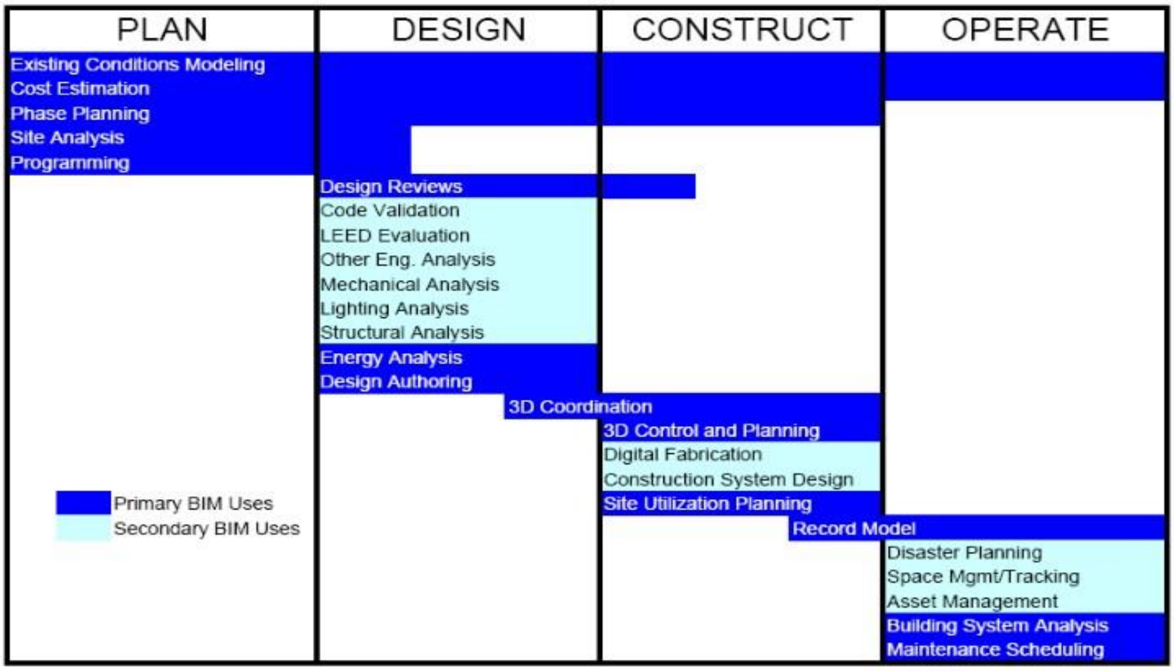


Figure 2.2 BIM Uses throughout a Building Lifecycle

During the design phase, the use of BIM can maximize its impact on a project since the ability to influence cost is the highest. The team can creatively come up with ideas and provide solutions to issues before problems become high cost impacts to the project.

This can be realized through the cooperation and coordination of the entire project staff. Therefore, it is extremely important to have a good collaboration. The use of BIM especially enhances the collaborative efforts of the team.

The architect and engineer can test their design ideas including energy analysis. The construction manager can provide constructability, sequencing, value and engineering reports. They can also start 3D coordination between subcontractors and vendors during early stages of design. The owner can visually notice if the design is what he is looking for.

Overall, the BIM promotes the collaboration of all of the projection participants. There are beneficial uses of BIM during the construction phase. However, the ability to impact the cost in a project reduces as depicted in figure 3 as the construction progresses. Several uses include sequencing, cost estimation, fabrication and onsite BIM. These uses are later discussed in detail.

During the post construction phase, maintenance scheduling, building system analysis, asset management, and space management and tracking, disaster planning, and record modelling can a record model can help to maintain the building throughout its lifecycle.

Ideally, the building automation system which controls and monitors the use of mechanical and electrical equipment can be linked to the record model to provide a successful location based maintenance program. Furthermore, building system analysis including energy, lighting, and mechanical can be used to measure building’s performance. Moreover, upgrades may be initiated to various equipment and components of the building.

CHAPTER 3

METHODOLOGY

3.1 Introduction

A methodology consists of phases and sub phases. All the phases and sub phases are the guideline to researchers for conducting, plan, manage, control, analyse and interpret their research. 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 and Microsoft Office Excel.

Besides that, researcher also had contacted the staff to obtain all information about facility management. Methodology elaboration is focused more toward on develops knowledge data process, quantification and preparation to facility management based model to achieve the aim and objectives of the study.

3.2 Model Information

All the data use in this research is based on the true building construction. This building consists of double storey building which are ground floor, first floor and roof top. Commencement date of this building is October 2015.

This model is an architecture model which generated from architecture construction drawing. All facility management is generated from the building elements which are door, window, furniture and plumbing fixtures.

3.3 Research Methodology

Figure 3.1 illustrates that the methodology flow of this study for conducting facility management based on BIM model.

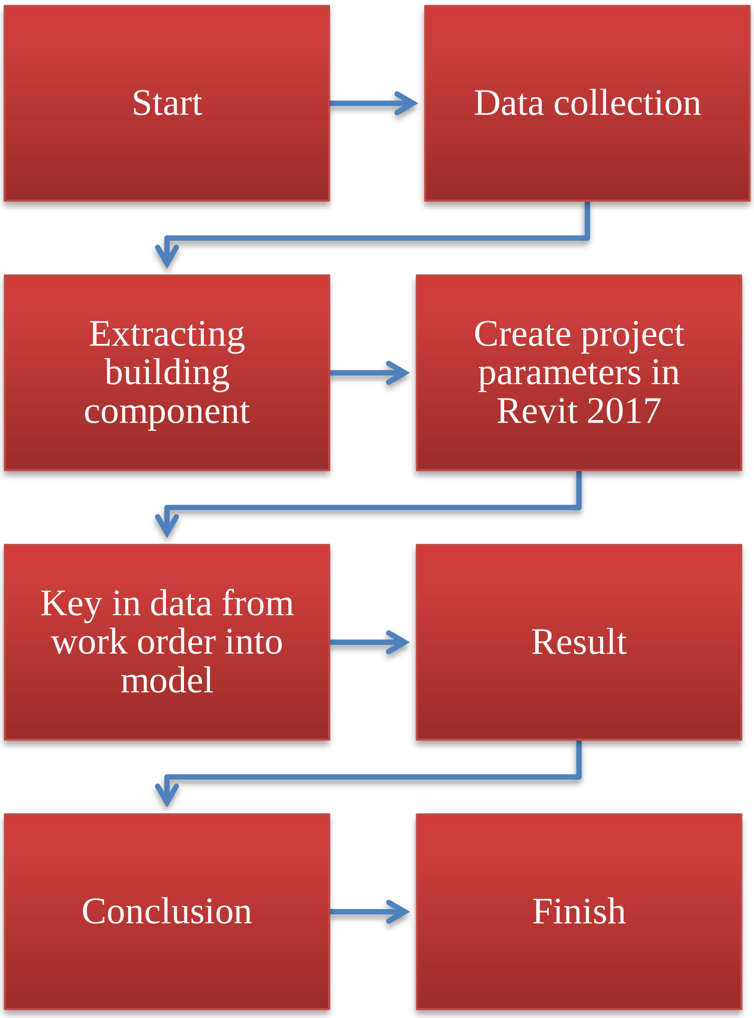


Figure 3.1 Methodology flow chart

3.4 Data Collection

The study process would start with 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. Data collection from the work order will be created after the 3D model is completed. All the information in the work order will be inserted into the 3D model. Besides, with the viability of conducting the pilot study ensured, a building information model is confirmed to be used in this study for the facilities management production.

3.5 Analysis Data

The 3D parametric data, which would emphasize on reviewing the feasibility of using original BIM's information to produce the facilities management on architectural elements, would be made. Analysis would be made on the proficiency of automated measurement by BIM software, Autodesk Revit Architecture. For facilities management measurement using Autodesk Revit Architecture, it can be further divided into measurement directly from BIM automatic. Data from work order measurement directly from BIM automatic refers to measurement using schedules automatically generated in Autodesk Revit Architecture whereas facilities management measurement by abstracting work trade and information from BIM.

3.6 BIM Modelling

Building Information Modelling (BIM) is an important knowledge in the industry of AECO (Succar, 2009). 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. A BIM model contains a representation of the actual parts used in the construction process to build a building, in which case it contains the geometry, spatial relationships, geographical information, the number and nature of the building components, cost estimating, project schedule and material inventory (Bazjanac, 2006). The life cycle of a building can also be simulated by using BIM from the beginning of construction of the system up to operating facilities (Sabol, 2008).

i. Concept of Building Information Modelling (BIM) According to Eastman (201I), these types of digital models are not categorized as BIM:

ii. The model contains 3D data only and no object attributes. iii. A model with no support of behaviour.

iii. The model allows changes to the dimensions in one view only that are not automatically reflected in other views.

iv. The model consists and composed of a variety of 2D CAD reference files that need to be combined to determine the building.

The main difference in the application of BIM technology with conventional 3D CAD is that a 3D CAD depicts a building with free 3D looking like a plan, section and elevation alone (CRC Construction Innovation, 2007). Editing one of the 3D visual perceptions requires the involvement of another visual standpoint to be checked and updated. Errors often occur at this stage which also acts as a major cause in the production of 3D CAD poor documentation. Furthermore, the data available in 3D CAD drawings are only graphical entities, such as lines, curves and circles (Azhar and Richter, 2009). These situations are different if it is seen from the intelligent contextual semantics of BIM model, where the objects in the system are defined in terms of building elements and systems such as space, walls, beams and column. Data on a building will be incorporated into the BIM model and thus allow the objects in the system 'knows' how to communicate with each other as well as to the design of the building model, (Azhar and Richter, 2009).

During this research building virtual model is generated by architects using Revit. Revit is built specifically for Building Information Modelling (BIM), empowering design and construction professionals to bring ideas from concept to construction with coordinated and consistent model-based approach (Autodesk).

3.7 Revit 2017

In this thesis, Autodesk Revit 2016 used to extract all the information from the CAD data of the building. Autodesk Revit is a software complex Building Information Modelling (BIM). It provides users the ability to design, parametric 3D modelling 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 modelling 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.

This is sometimes called 4D CAD, where time is the fourth dimension. This software provides structural engineers and designers with the tools to more accurately design and build efficient building structures. Built to support Building Information Modelling (BIM), Revit helps to use intelligent models to gain project insight through simulation and analysis and predict performance prior to construction. The document designs more accurately using coordinated and consistent information inherent in the intelligent models.

All this construction information is obtained from party organization in construction which is client, architect, MEP engineers, Structural Engineers, Quantity Surveyor and suppliers. All this information will be combined and completed parametric 3D model will be generated.

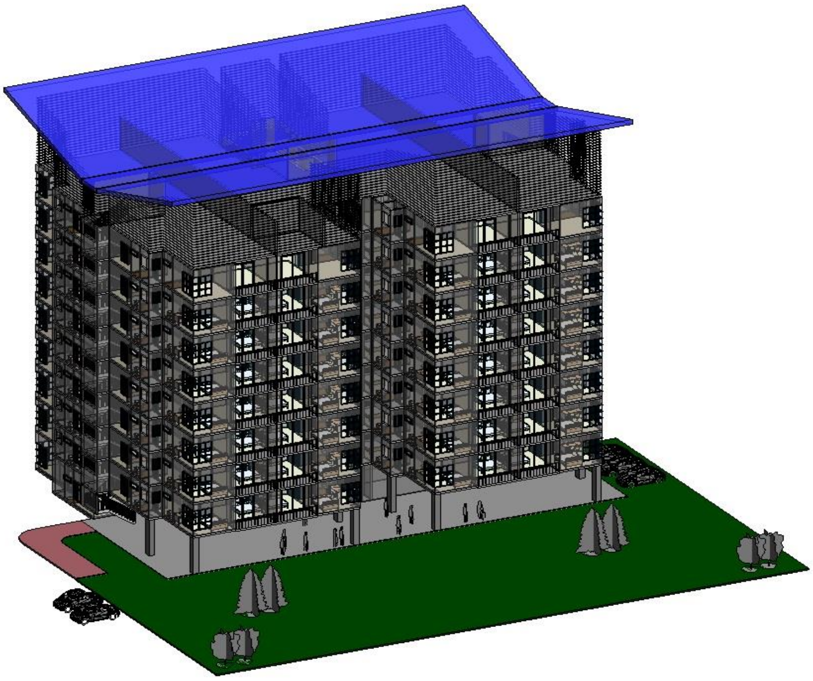


Figure 3.2 3D view of Kolej Kediaman 4 using Revit Software

3.7.1 Creating project parameters using Revit 2017 based on 3D model

In this chapter, emphasis would be put on the ways creating project parameters and data maintenance using Autodesk Revit Architecture. Some common trades, including door, window, furniture and plumbing fixtures would be involved in the creating project parameters. It is believed that BIM can benefit the quantity surveying industry by its automatic measurement. To review facilities management measurement directly from BIM automatic quantities, analysis would be made on the feasibility of using original BIM's information in facilities management measurement on architectural elements.

After all the building components are being extracted, staffs and facility manager need to review all the information about geometric design and information of facilities management that have been used for this 3D parametric model. Besides that, staffs and facility manager need to identify all building component so that easy to be conducted. From Revit, they can obtain accurate area of only by clicking the building component like in Figure 3.3.

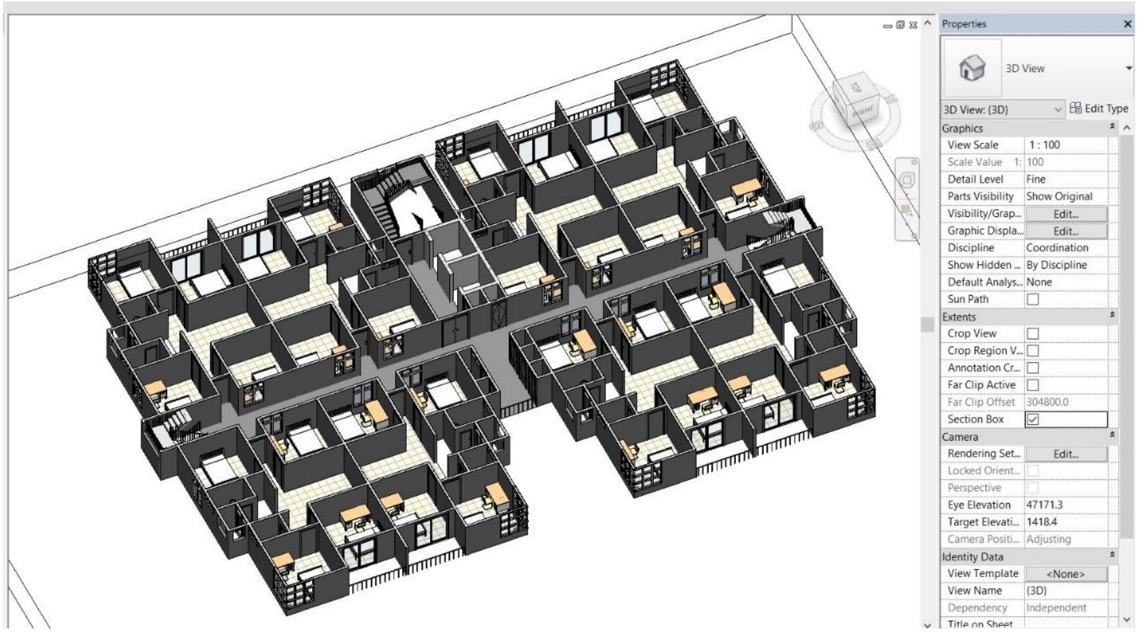
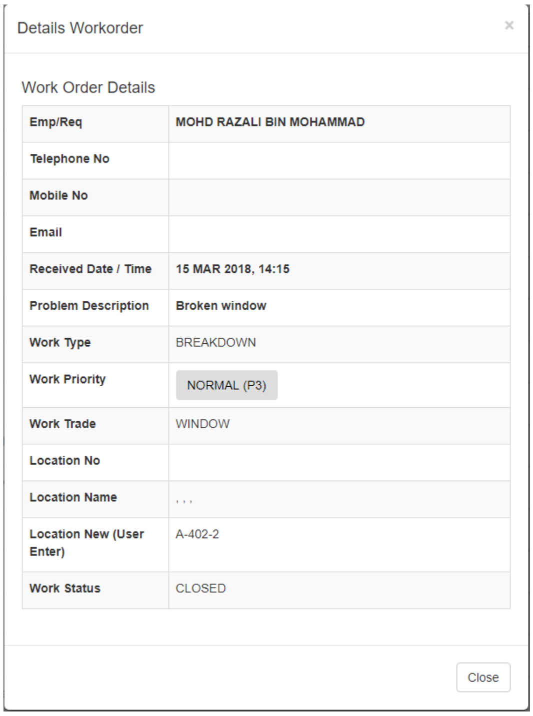


Figure 3.3 Building component information

The studied model is fit for visualization purpose as all the basic building elements in the design are incorporated in the building information model. For creating project parameters, project parameters are specific to a single project file. They are added to elements door, window, furniture and plumbing fixtures by assigning them to multiple categories of elements, sheets or view. Furthermore, information stored in project parameters cannot be shared with other projects. Thus, project parameters are used for scheduling, sorting and filtering in a project. For example, a project parameter can be used to categorize views within a project. Thus, creating parameters is one of the important keys in completing this project. to create the parameters, the most important thing is the data.

In this project, work order has been used as data as shown in Figure 3.4. A work order 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 or automatically generated through a work order management. in the work order, covering all details of the damage that has occurred in Kolej Kediaman 4. The damage that often occurs there are elements of door, window, furniture and plumbing fixtures. With the implementation of BIM towards this case, it will reduce the time for staffs and facility managers to identify the damage occurring in Kolej Kediaman 4.


Details Workorder

×

Work Order Details

Emp/Req	MOHD RAZALI BIN MOHAMMAD
Telephone No	
Mobile No	
Email	
Received Date / Time	15 MAR 2018, 14:15
Problem Description	Broken window
Work Type	BREAKDOWN
Work Priority	NORMAL (P3)
Work Trade	WINDOW
Location No	
Location Name	, , ,
Location New (User Enter)	A-402-2
Work Status	CLOSED

Close

Figure 3.4 Example of work order

For the information in feed by the Revit 2017, user shall press the project parameters in manage of the toolbar which is circled in red in Figure 3.5. Parameter properties will be appeared and there is some input that user need to insert in it. Besides, there are two type of parameter which are project parameter and shared parameter. For this project, project parameter has been used for all elements as shown in Figure 3.6. All the information data from work order need to insert in under parameter data. Parameter data consists of name, discipline, type of parameter, group parameter and tooltip description which are all the data from work order need to insert follow by the list of requirements in parameter data.

Furthermore, parameter data consist of two type which are type parameter and instance parameter. Type parameter enables user to modify parameter value which applies to all elements of the family type and instance parameter enables user to modify the parameter value separately for every instance. Hence, for this project type parameter has been used as shown in Figure 3.7. The elements of architecture have been shorting by the four elements which are door, window, furniture and plumbing fixtures in the categories of parameter properties. User may click the mini box that written hide un-checked categories so that user may know the correct element that selected which is just four elements only as shown in Figure 3.8. The Figure 3.9 and Figure 3.10 shown the progress before and after key in the data from work order into the project parameter in Revit 2017.

After completing insert the data, the project parameters will appear in the properties of Revit. For example, when user click the element of window, all the information about the damage of window will be appear in the properties of Revit.

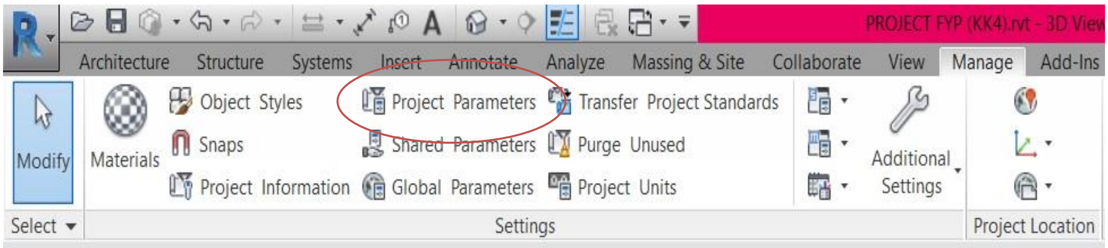


Figure 3.5 Project parameters at toolbar

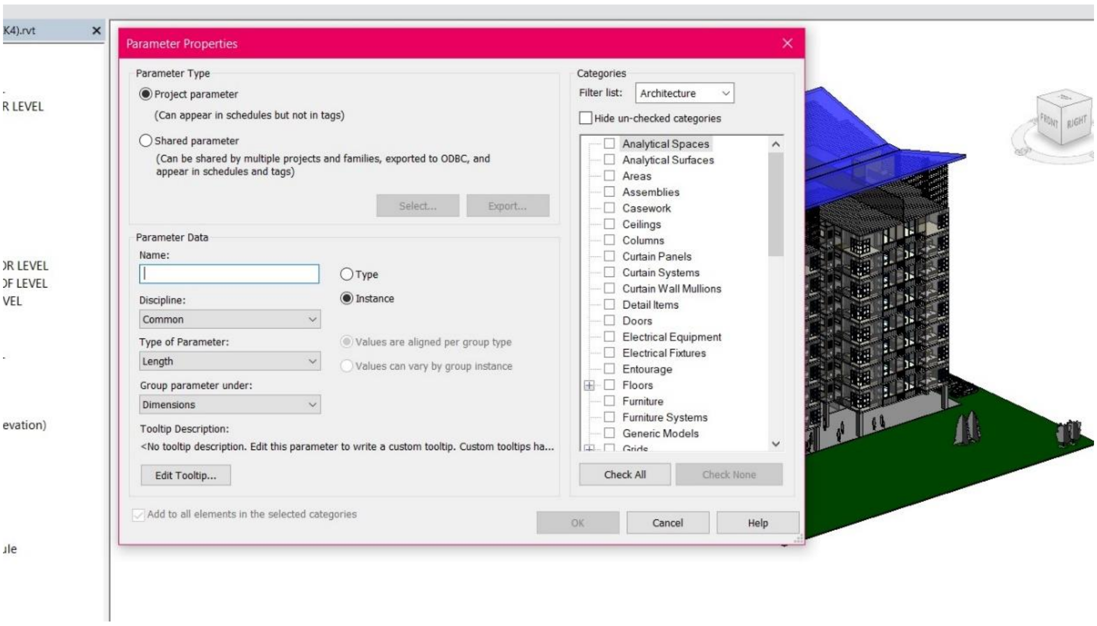


Figure 3.6 Create parameter into Revit Software

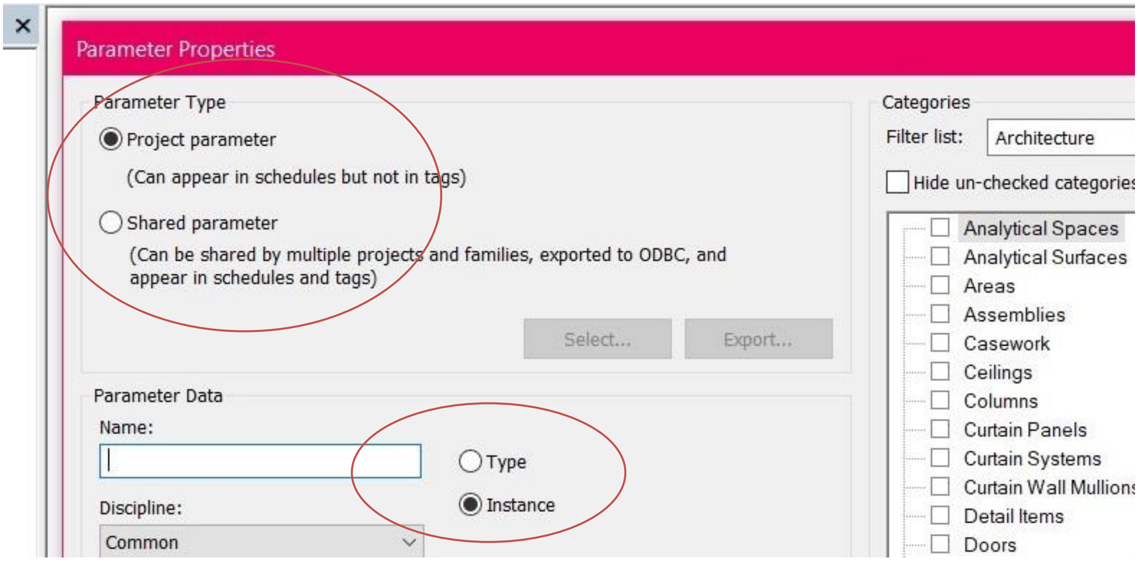


Figure 3.7 Use of project parameter and type parameter

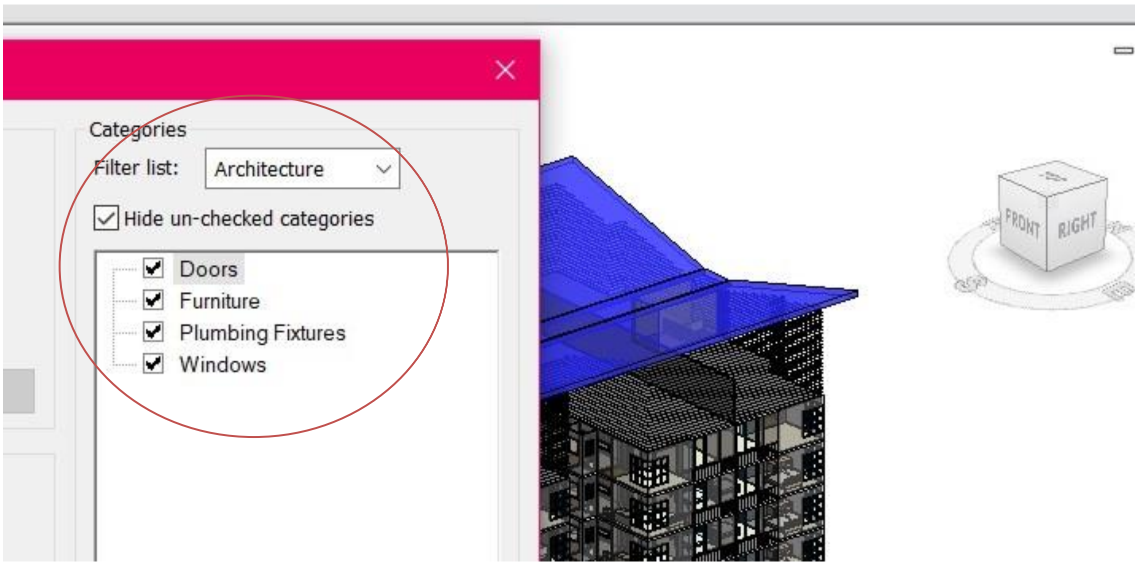


Figure 3.8 Sorting by elements of Architecture

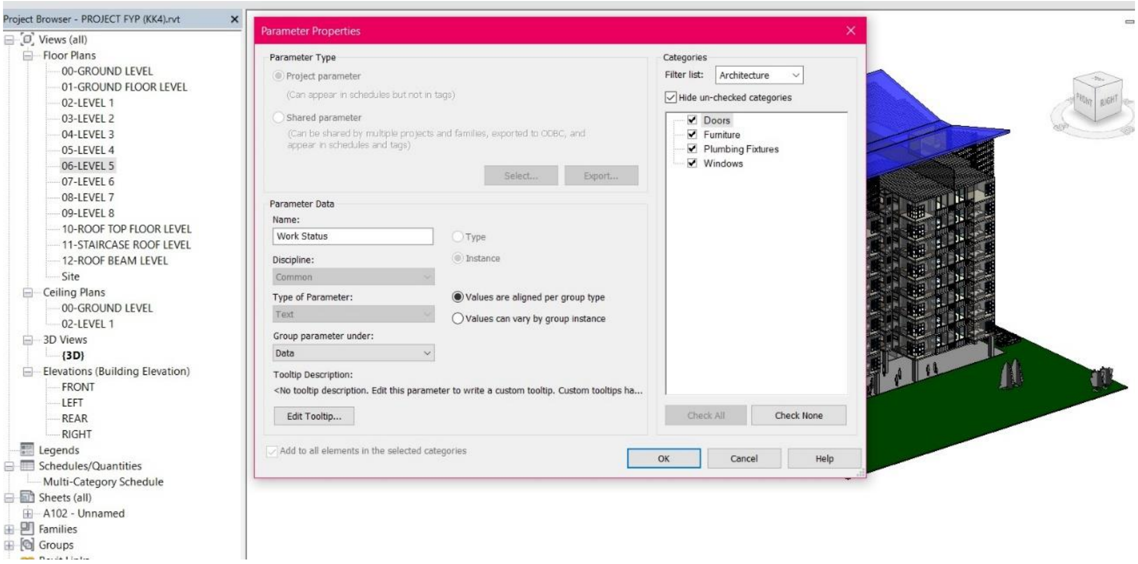


Figure 3.9 Completing insert the data into parameter

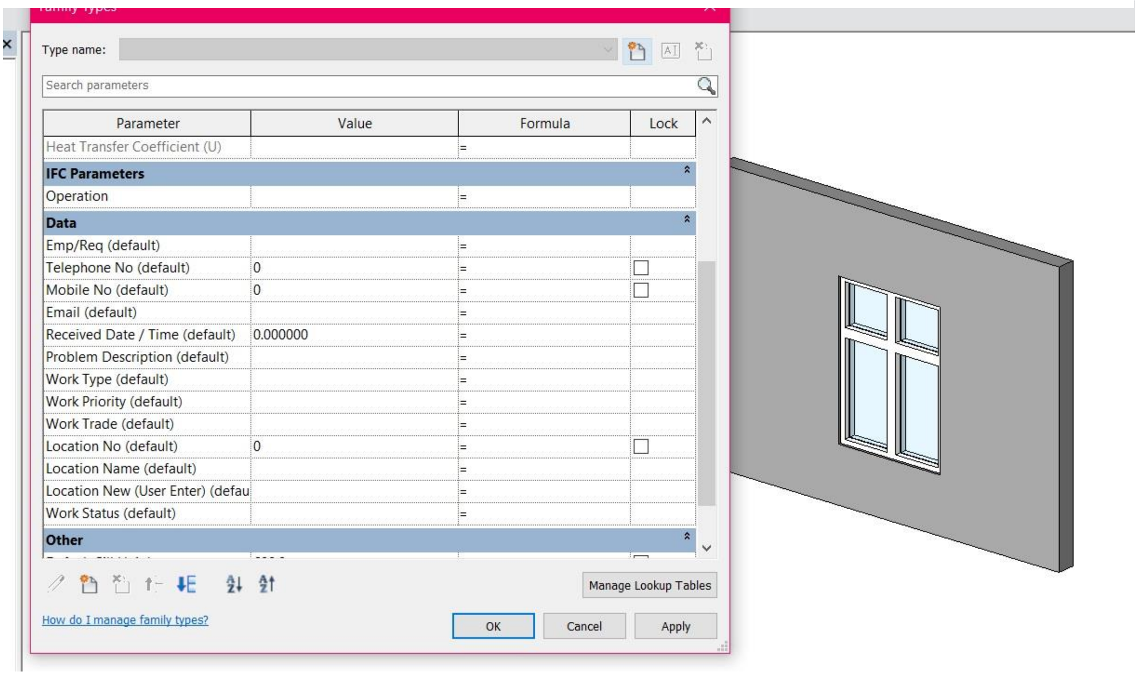


Figure 3.10 Data from work order insert into parameter

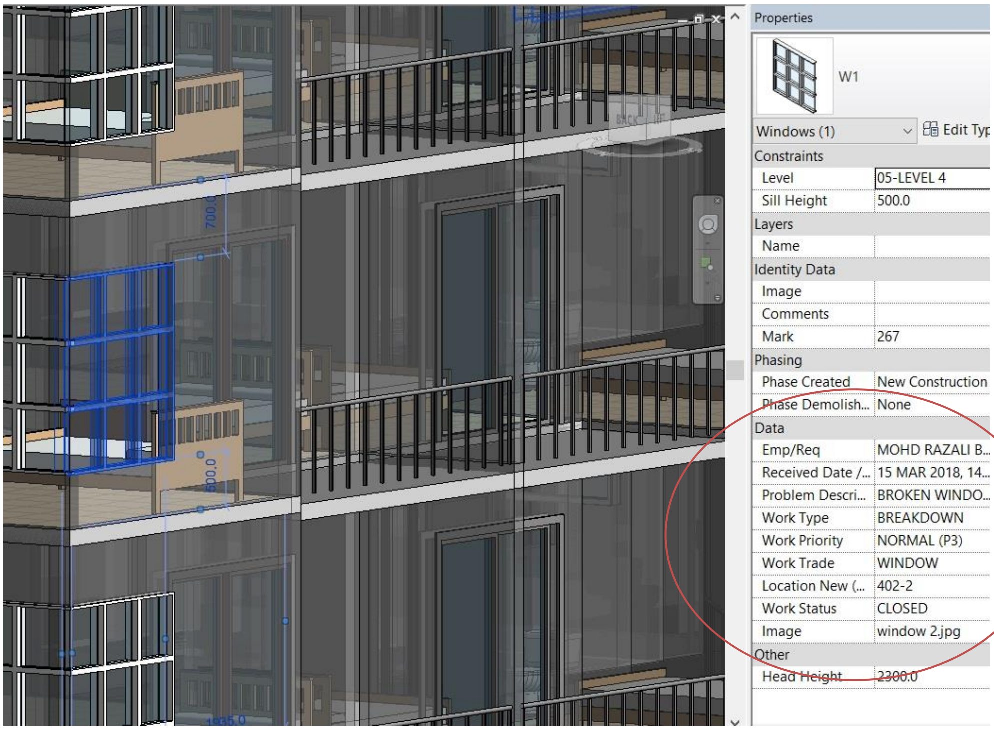


Figure 3.11 The data has been recorder into the element

Figure 3.12 Cut section view of first floor with facilities management

3.8 Project parameter vs Shared parameter

Table 3.1 Project parameter vs Shared parameter

Project parameter	Shared parameter
Project parameters are specific to a single project file. They are added to elements by assigning them to multiple categories of elements, sheets, or views. Information stored in project parameters cannot be shared with other projects. Project parameters are used for scheduling, sorting and filtering in a project. A project parameter can be used to categorize views within a project.	Shared parameters are parameter definitions that can be used in multiple families or projects. After add a shared parameter definition to a family or project, user can use it as a family or project parameter. Because the definition of a shared parameter is stored in a separate file not in the project or family, it is protected from change. For this reason, shared parameters can be tagged and scheduled.

3.9 Work order

Work orders are crucial in maintenance because modern infrastructure is just too complex for any one person to deal with. And as work orders evolve from pen and paper to software-based systems. It becoming easier to share relevant information with key players in our facility. Besides, work orders vary slightly in form and function from industry to industry but generally speaking they are written requests for work that needs to be done. They can be referred to as job orders, work requests, or purchase orders when used externally.

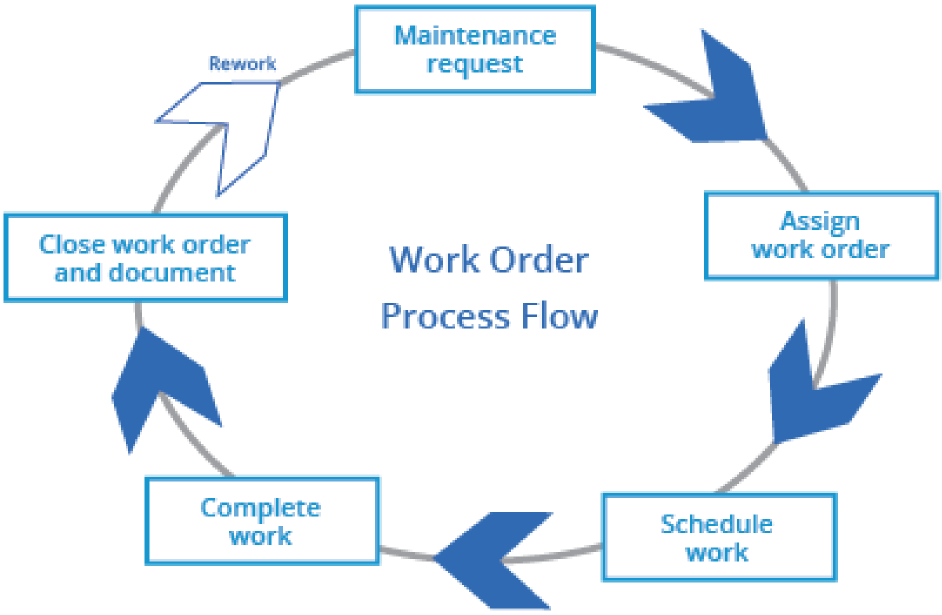


Figure 3.13 Work order process flow

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter discusses the case studies finding for achievement of the research objective. Facility management will be conducted based on the BIM 3D parametric model of building construction. After all the building components are extracted from building, it will convert to xls format for input of Microsoft Office Excel.

Revit organization and all information in the tabulated table converted from rvt format in Revit 2017 software will be used and excel data sheet is developed for facility management. Major focus on this research only on architecture works. Researcher need to measure quantity of the materials used for bungalow construction for preparation of variation order.

The understanding in Building Information Modelling (BIM) based on facility management is highly useful for guide the researcher to cross analyse, discuss and theoretically validate facility management based on 3D parametric model generated by BIM computer aid design (CAD) software.

4.2 Schedule of facility management

After measurement of the architectural elements, the quantities shall be transferred into the facility management schedule. In the following, the process of transferring quantities into the items using Autodesk Revit architecture would be illustrated. However, for facility management measurements directly generated from BIM automatic quantities, the transfer of quantities into bill items would be different and would be illustrated in the following. With the model developed suitable for quantity preparation, schedules are generated.

The appropriate information is provided in the schedule by selecting the appropriate fields to be inserted in the schedule. An example of the facility management schedule showing request, location, problem description, work priority, work trade and date as shown in Figure 4.1:

<Schedule of Facility Management>

A	B	C	D	E	F	G
Emp/Req	Location Ne	Problem Description	Work Priority	Work Trad	Received Date / Time	Work Status
106-04						
MOHAMMAD HAKIMI BIN K	106-04	RANGKA KAYU KATIL PATAH	NORMAL (P3	FURNITU	20 MAR 2018, 09:53	CLOSED
201-4						
MOHAMMAD HAKIMI BIN K	201-4	TUKAR TOMBOL	NORMAL (P3	DOOR	05 MAR 2018, 15:49	NEW
205-1						
MOHAMAD AZRI BIN RAHIM	205-1	FLUSH LEAKING	NORMAL (P3	TOILET	23 MAR 2018, 15:00	NEW
402-2						
MOHD RAZALI BIN MOHAM	402-2	BROKEN WINDOW	NORMAL (P3	WINDOW	15 MAR 2018, 14:15	CLOSED
402-4						
MOHD RAZALI BIN MOHAM	402-4	KAKI KATIL SENGET	NORMAL (P3	FURNITU	26 MAR 2018, 08:52	NEW
501-1						
MOHD RAZALI BIN MOHAM	501-1	TIDAK DAPAT FLASH AIR DARI T	NORMAL (P3	TOILET	05 MAR 2018, 08:09	CLOSED
601-1						
MOHD RAZALI BIN MOHAM	601-1	FLUSH ROSAK	NORMAL (P3	TOILET	13 MAR 2018, 08:04	CLOSED
601-2						
MOHD RAZALI BIN MOHAM	601-2	FLUSH TANDAS ROSAK	NORMAL (P3	TOILET	05 MAR 2018, 14:34	PENDING
607-2						
SAIFULNIZAM BIN ABD RAZ	607-2	TINGKAP RETAK	NORMAL (P3	WINDOW	15 MAR 2018, 14:31	PENDING
708-1						
MOHAMMAD HAKIMI BIN K	708-1	FLUSH ROSAK	NORMAL (P3	TOILET	14 MAR 2018, 08:09	CLOSED
Grand total: 2655						

Figure 4.1 Facility management schedule

4.2.1 Converting schedule into Microsoft Office Excel

The important information generated from the schedules is geometric data, building information and quantification value generated from the schedules. After all facility management schedules are generated, all schedules than exported to Microsoft Office Excel for the data input so that output data about the elements can be calculated and obtained. Figure 4.2 and Figure 4.3 is the procedure how to export facility management schedule from rvt format generated by Revit Suite Software to xls format for Microsoft Office Excel.

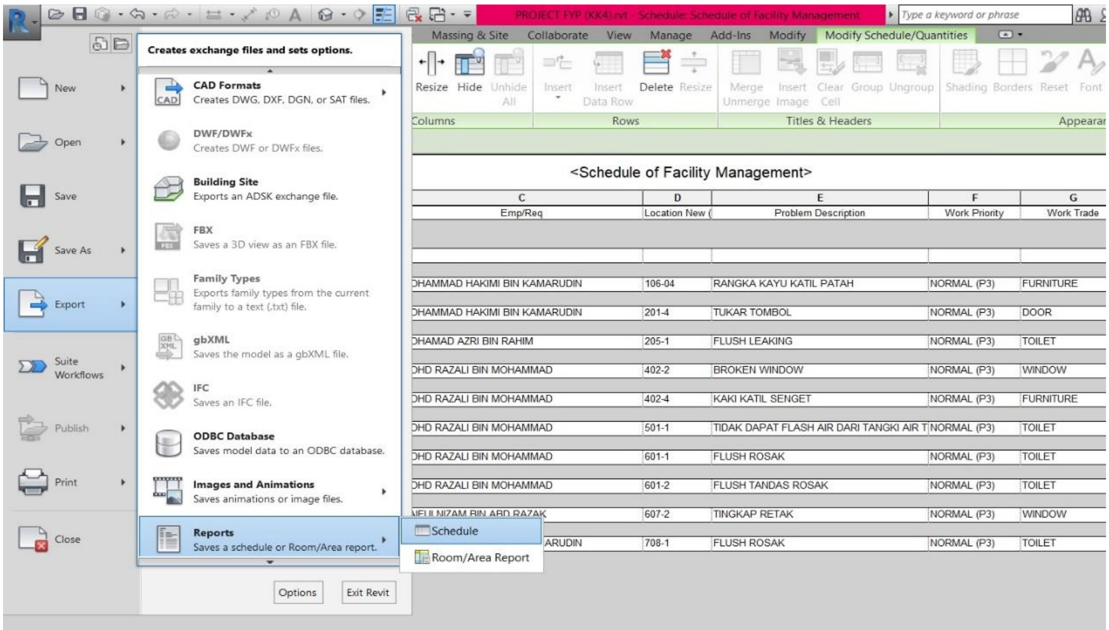


Figure 4.2 Export of schedule in Autodesk Revit

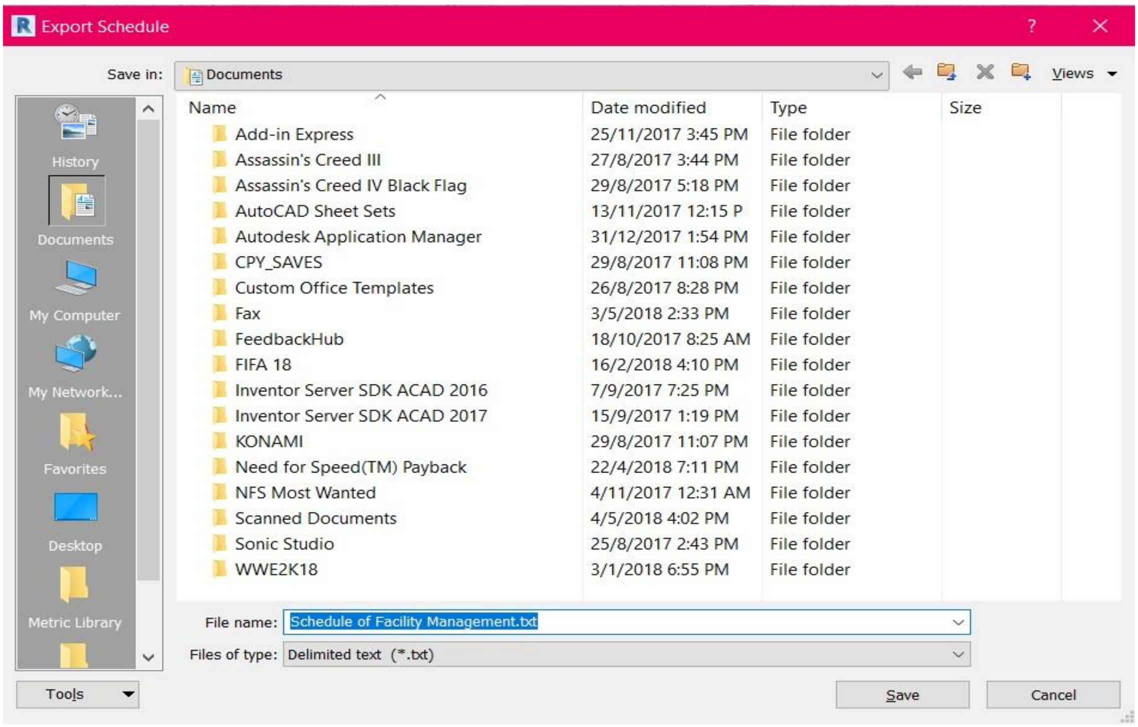


Figure 4.3 Save facility management

After the facility management schedule been exported, it will be save as txt format. This process may make easier for the user to analyse the data through Microsoft Office Excel. Besides, it will reduce the time for the user when doing the inspection. 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 appeared 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.

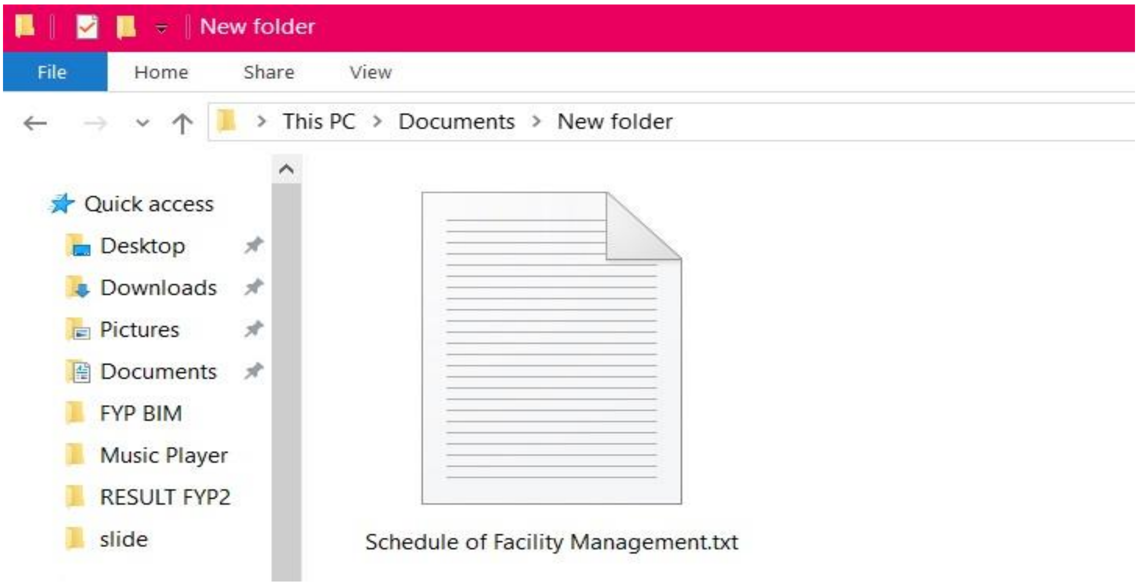


Figure 4.4 Txt file exported from Autodesk Revit architecture

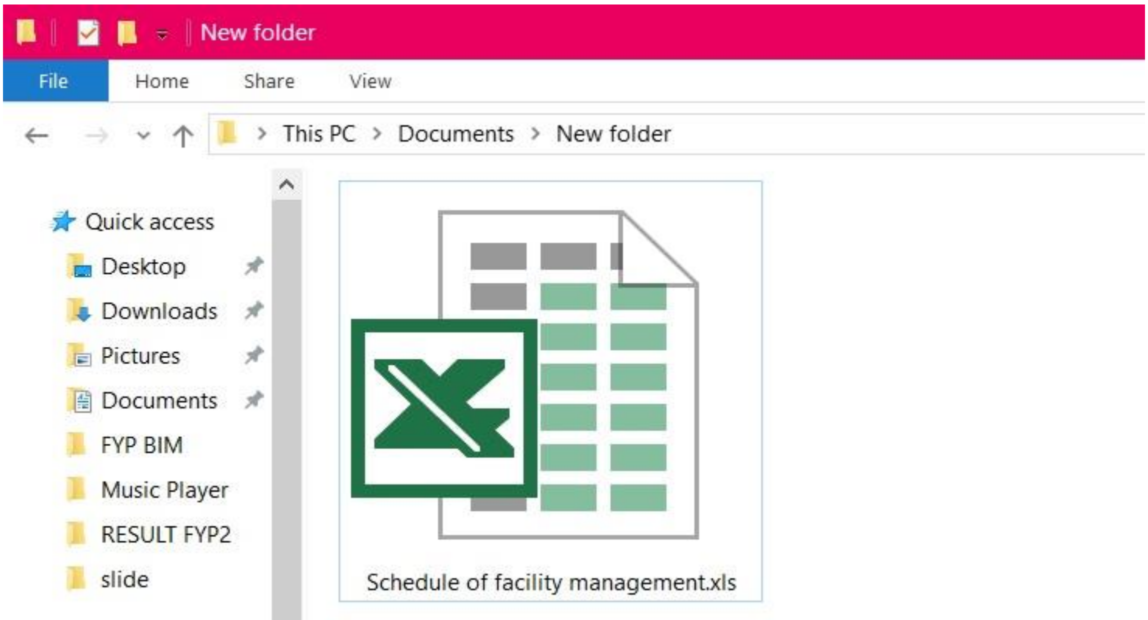


Figure 4.5 Change format from txt to xls file

4.3 Manage schedule from Revit to Microsoft Office Excel

After all the data has been insert in the parameter and scheduling has been come out, user may sorting the data in schedule by family, location, work trade, work status and date so that it more easier to make the analysis. In schedule properties also can generate the amount of elements that has been recorded in the project parameter as shown in Figure 4.6. The schedule facility management will convert into sheet drawing to be more systematic as shown in Figure 4.7. The final result has been convert into Microsoft Office Excel so that the analysis of the data easy to record.

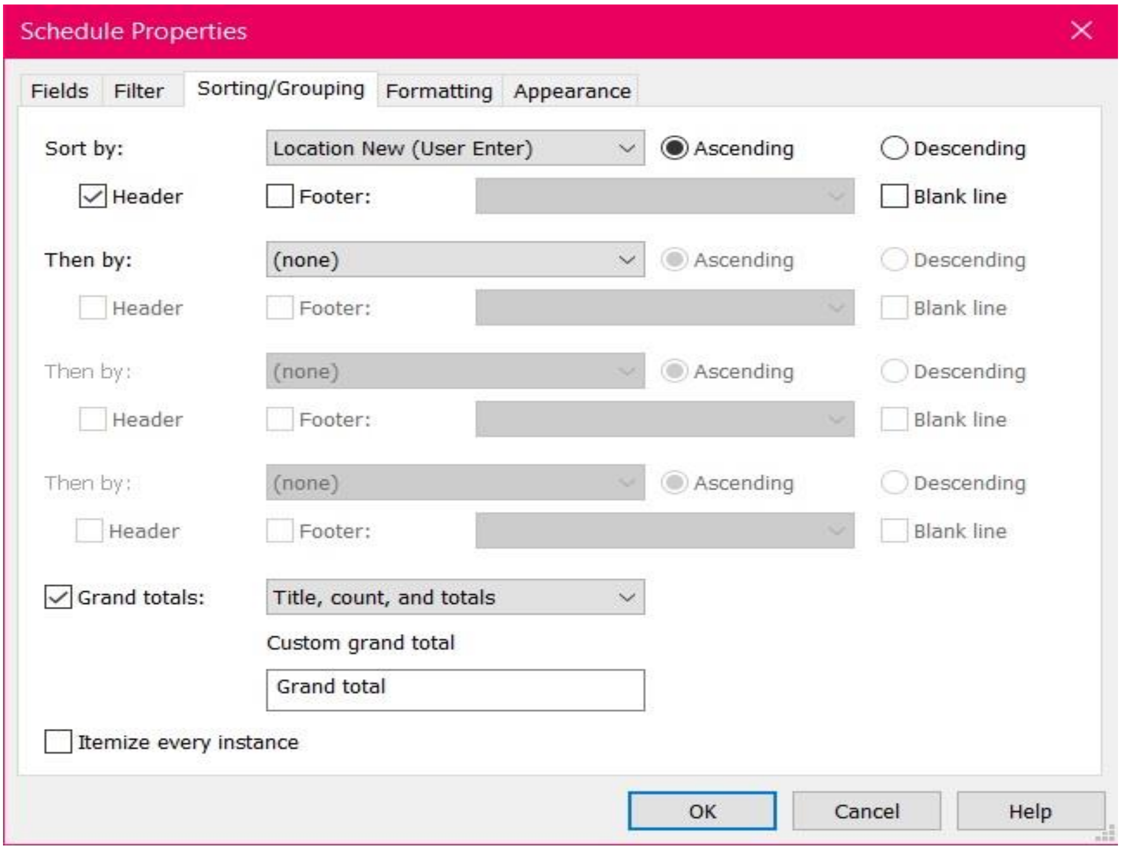


Figure 4.6 Schedule properties for sorting the data

Multi-Category Schedule								
Family	Image	Emp/Req	Location New(User Enter)	Problem Description	Work Priority	Work Trade	Received Date / Time	Work Status
106-04								
M_Bed-Shaker		MOHAMMAD HAKIMI BIN KAMARUDIN	106-04	RANGKA KAYU KATIL PATAH	NORMAL (P3)	FURNITURE	20 MAR 2018, 09:53	CLOSED
201-4								
D1		MOHAMMAD HAKIMI BIN KAMARUDIN	201-4	TUKAR TOMBOL	NORMAL (P3)	DOOR	05 MAR 2018, 15:49	CLOSED
205-1								
M_Toilet-Domestic-3D		MOHAMAD AZRI BIN RAHIM	205-1	FLUSH LEAKING	NORMAL (P3)	TOILET	23 MAR 2018, 15:00	CLOSED
402-2								
W1		MOHD RAZALI BIN MOHAMMAD	402-2	BROKEN WINDOW	NORMAL (P3)	WINDOW	15 MAR 2018, 14:15	CLOSED
402-4								
M_Bed-Shaker		MOHD RAZALI BIN MOHAMMAD	402-4	KAKI KATIL SENGET	NORMAL (P3)	FURNITURE	26 MAR 2018, 08:52	CLOSED
501-1								
M_Toilet-Domestic-3D		MOHD RAZALI BIN MOHAMMAD	501-1	TIDAK DAPAT FLASH AIR DARI TANGKI AIR TANDAS	NORMAL (P3)	TOILET	05 MAR 2018, 08:09	CLOSED
601-1								
M_Toilet-Domestic-3D		MOHD RAZALI BIN MOHAMMAD	601-1	FLUSH ROSAK	NORMAL (P3)	TOILET	13 MAR 2018, 08:04	CLOSED
601-2								
M_Toilet-Domestic-3D		MOHD RAZALI BIN MOHAMMAD	601-2	FLUSH TANDAS ROSAK	NORMAL (P3)	TOILET	05 MAR 2018, 14:34	CLOSED
607-2								
W2		SAIFULNIZAM BIN ABD RAZAK	607-2	TINGKAP RETAK	NORMAL (P3)	WINDOW	15 MAR 2018, 14:31	CLOSED
703-1								
M_Toilet-Domestic-3D		MOHAMMAD HAKIMI BIN KAMARUDIN	703-1	FLUSH ROSAK	NORMAL (P3)	TOILET	14 MAR 2018, 08:09	CLOSED
Grand total: 1879								

Figure 4.7 Convert schedule into sheet drawing

Family	Image	Emp/Req	Location New (User Enter)	Problem Description	Work Priority	Work Trade	Received Date / Time	Work Status
Bed-Shaker		MOHAMMAD HAKIMI BIN KAMARUDIN	106-04	RANGKA KAYU KATIL PATAH	NORMAL (P3)	FURNITURE	20 MAR 2018, 09:53	CLOSED
D1		MOHAMMAD HAKIMI BIN KAMARUDIN	201-4	TUKAR TOMBOL	NORMAL (P3)	DOOR	05 MAR 2018, 15:49	NEW
M_Toilet-Domestic-3D		MOHAMAD AZRI BIN RAHIM	205-1	FLUSH LEAKING	NORMAL (P3)	TOILET	23 MAR 2018, 15:00	PENDING
W1		MOHD RAZALI BIN MOHAMMAD	402-2	BROKEN WINDOW	NORMAL (P3)	WINDOW	15 MAR 2018, 14:15	CLOSED
Bed-Shaker		MOHD RAZALI BIN MOHAMMAD	402-4	KAKI KATIL SENGET	NORMAL (P3)	FURNITURE	26 MAR 2018, 08:52	NEW
M_Toilet-Domestic-3D		MOHD RAZALI BIN MOHAMMAD	501-1	TIDAK DAPAT FLASH AIR DARI TANGKI AIR TANDAS	NORMAL (P3)	TOILET	05 MAR 2018, 08:09	CLOSED

Figure 4.8 Final result convert into Microsoft Office Excel

4.4 BIM vs Traditional mode

Table 4.1 Comparing BIM approach with traditional facilities management method

	BIM Imported Mode	Traditional Mode	Traditional Mode
		Management Information System	Paper Works
Information Presenting	3D visual model External related information files	Screen display 2D CAD-based	2D figures Related paper report
Information Recording	BIM-based model to save information Save in external related information files Searching by combination functions of model and software	Related information files E-System to save information	Paper works to save information
Information Searching	Linking to external related information files Searching by standard report which was exported by BIM model and software	Searching the information in the system	Searching the information on paper reports

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 facility management can be estimated quickly and accurately throughout the construction phase in Malaysia.

5.2 Conclusion

The application of FM integrated with the BIM approach for building projects during the maintenance phase is discussed in this work. This study implements the FM system for all facility staffs as a facility management platform. The FM system provides insight into factors impacting FM activities, which in turn assists facility staffs in managing interface events to improve facility management performance. The FM 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.

In short, it can be mentioned that the future interest for FM is very enthusiastic. On the other hand, the challenge is to educate building owners as to the benefits of FM. The ultimate advantage of FM, example value appreciation of the property, image and long-term cost, must be completely understood and increased in value by building owners for the industry to develop. In other words, building owners ought to have the capacity to see the long-term gain.

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 accurate facility management and better workstation for conducting more quickly data interpretation in Revit Software.

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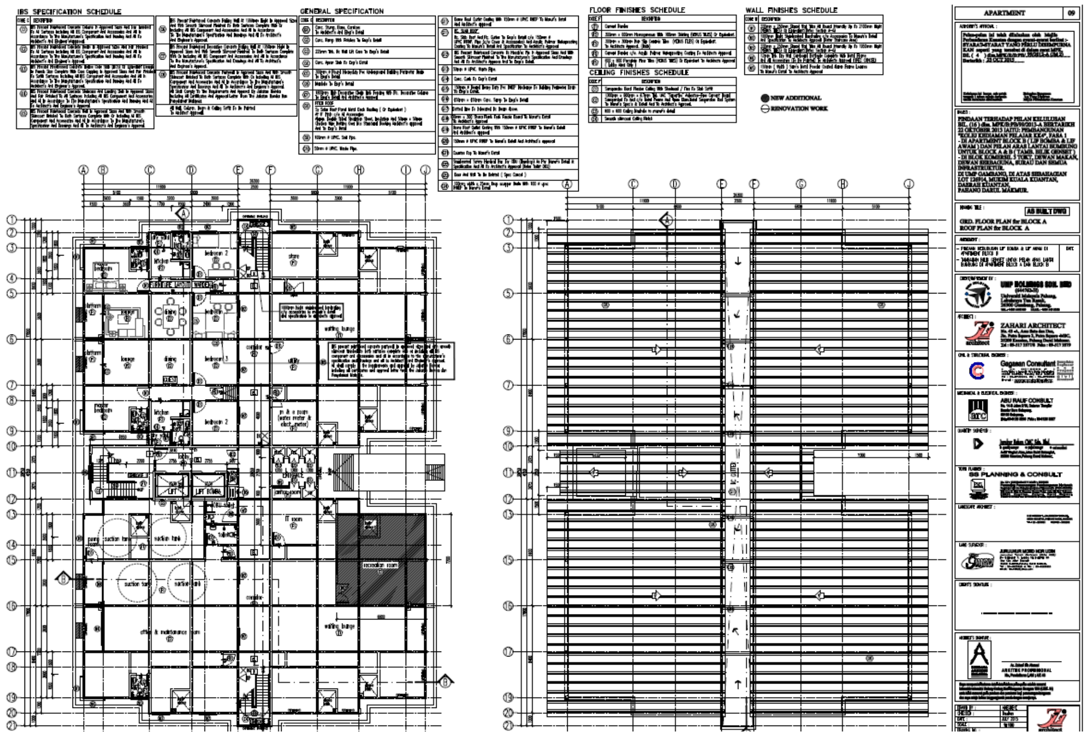
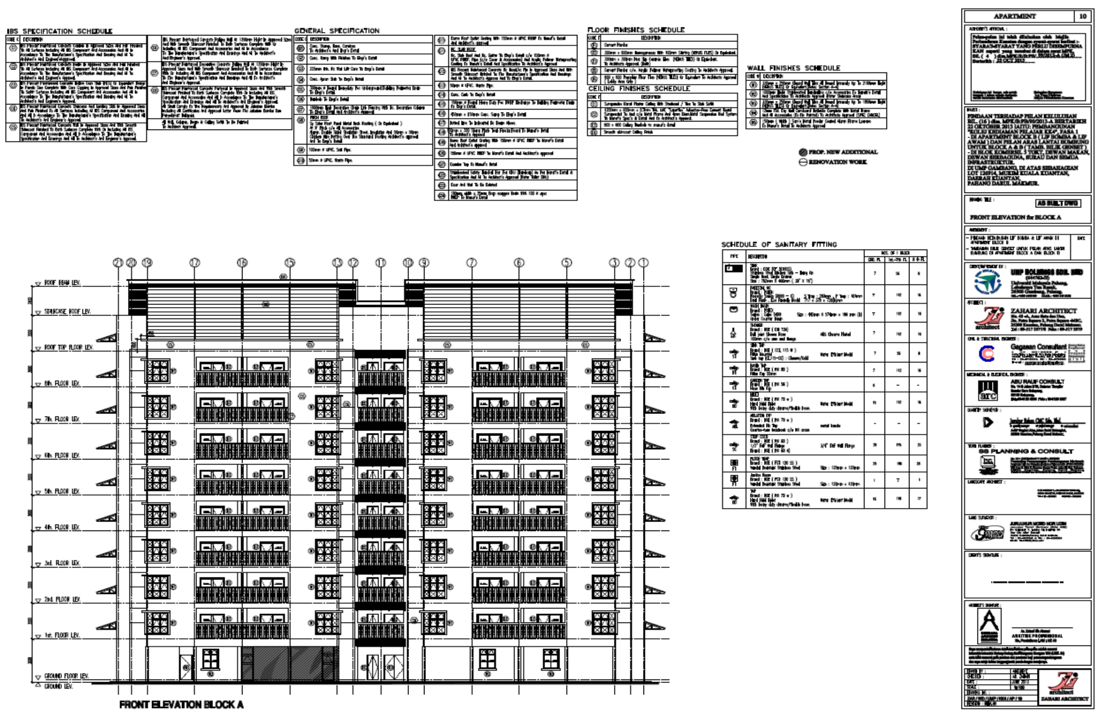
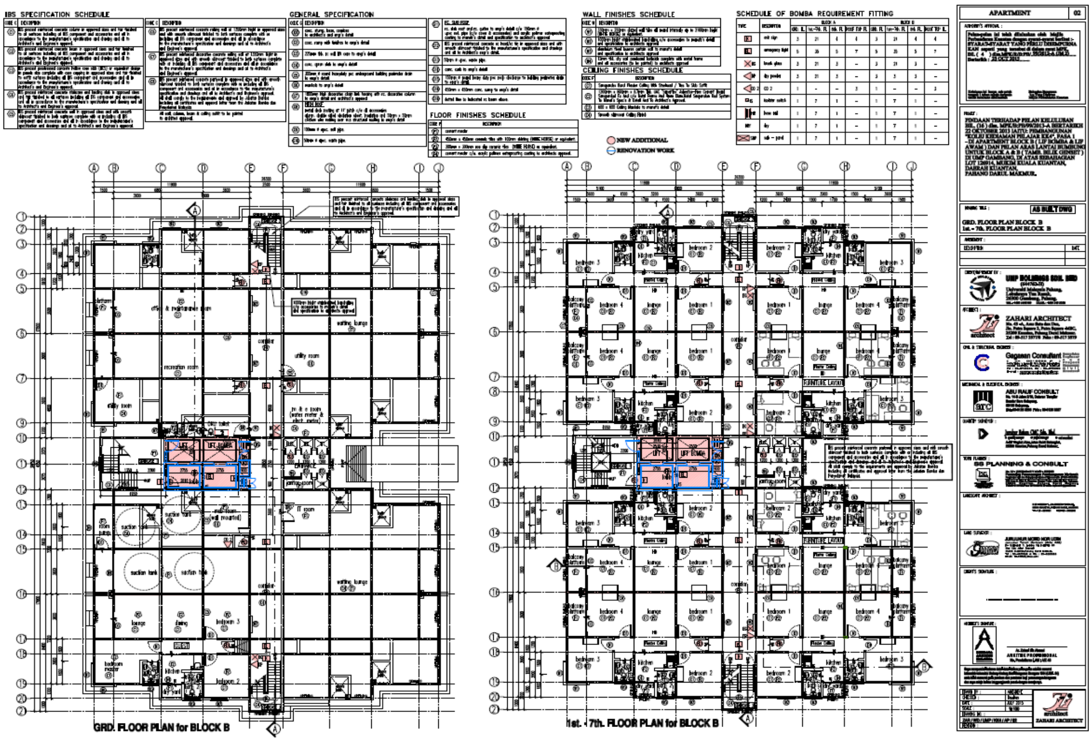
APPENDIX A
2D CAD DRAWING OF KOLEJ KEDIAMAN 4

GROUND FLOOR LEVEL

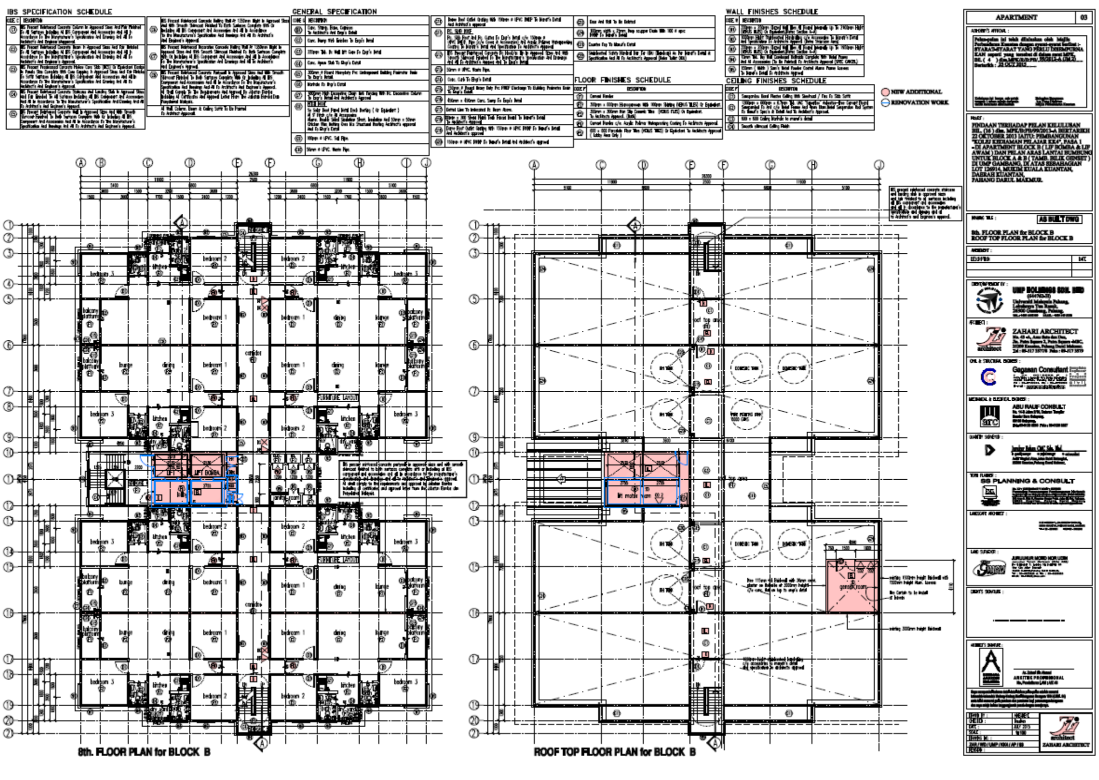




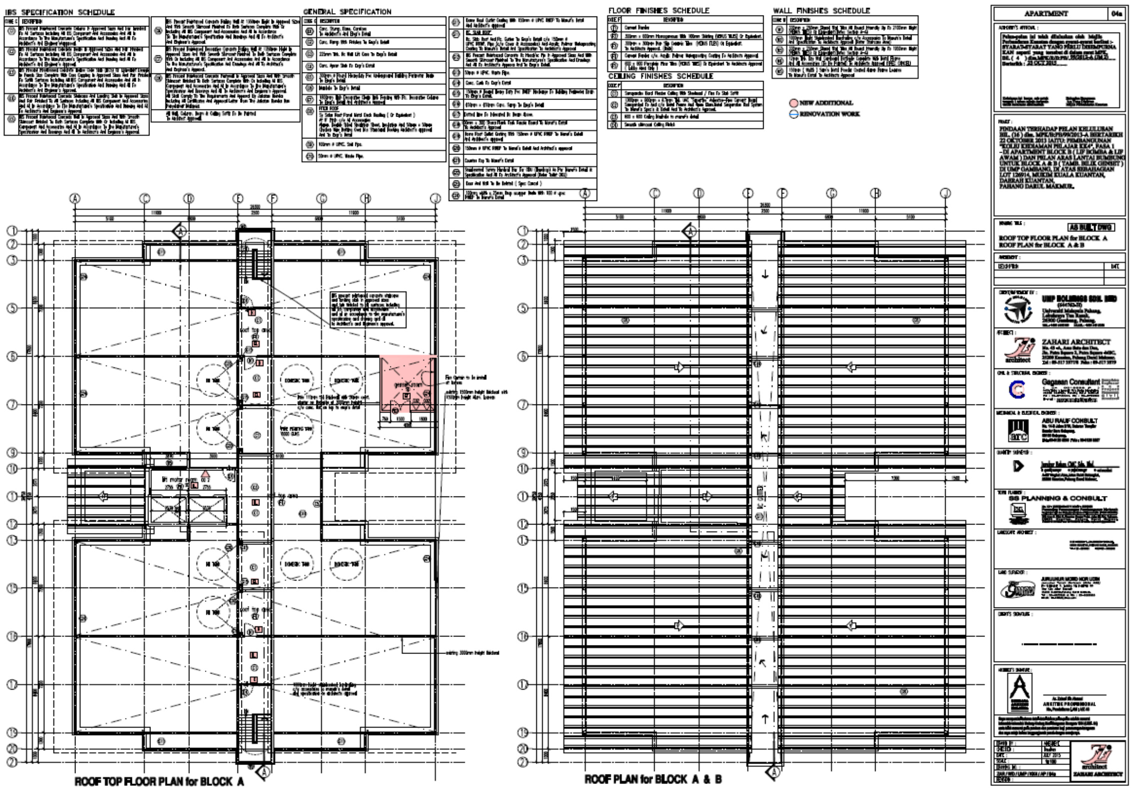
1ST-7TH FLOOR PLAN



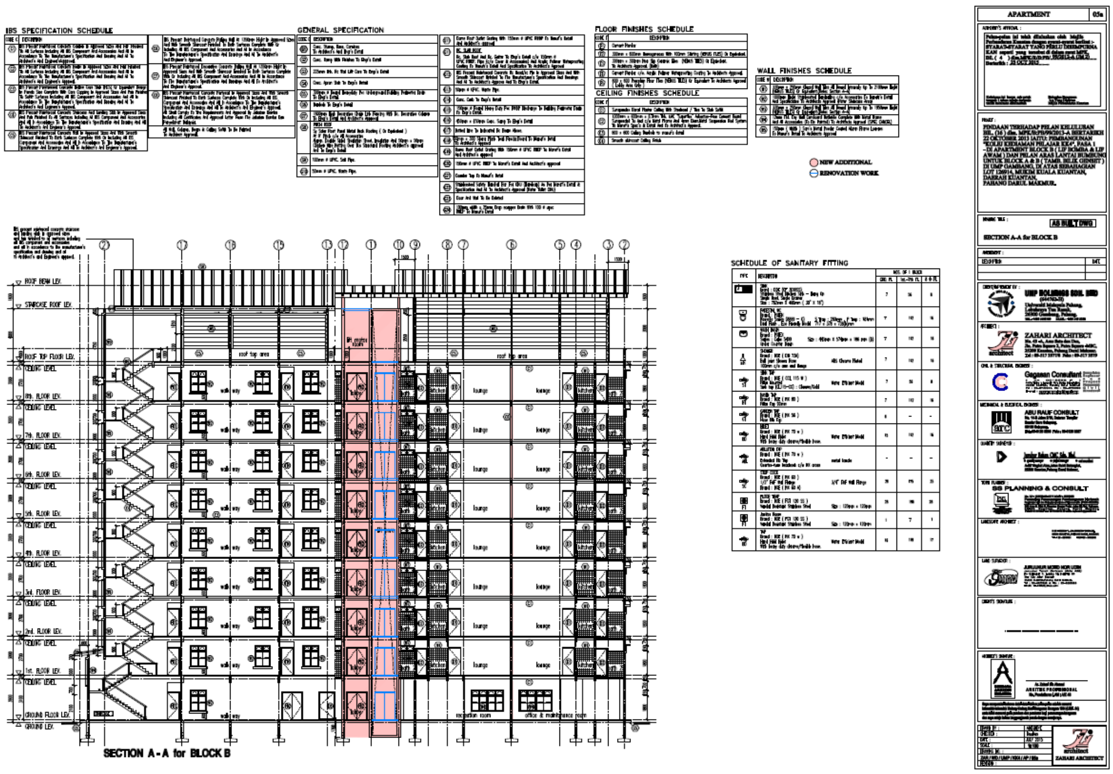
8TH FLOOR PLAN AND ROOF PLAN



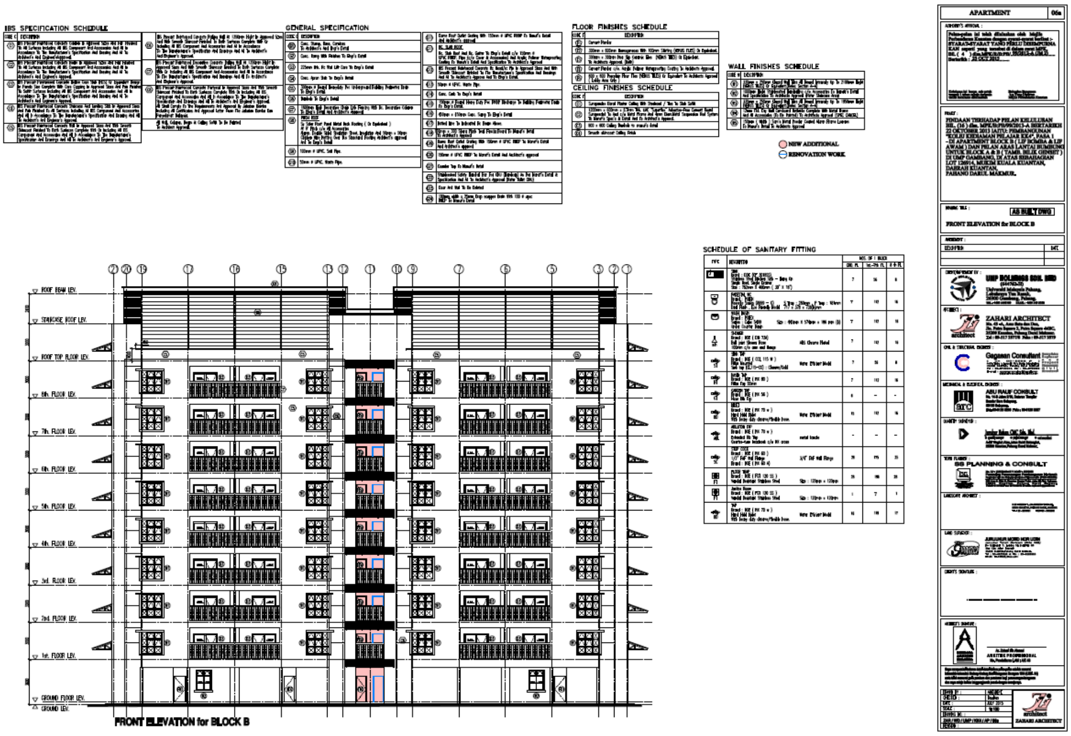
ROOF TOP FLOOR LEVEL



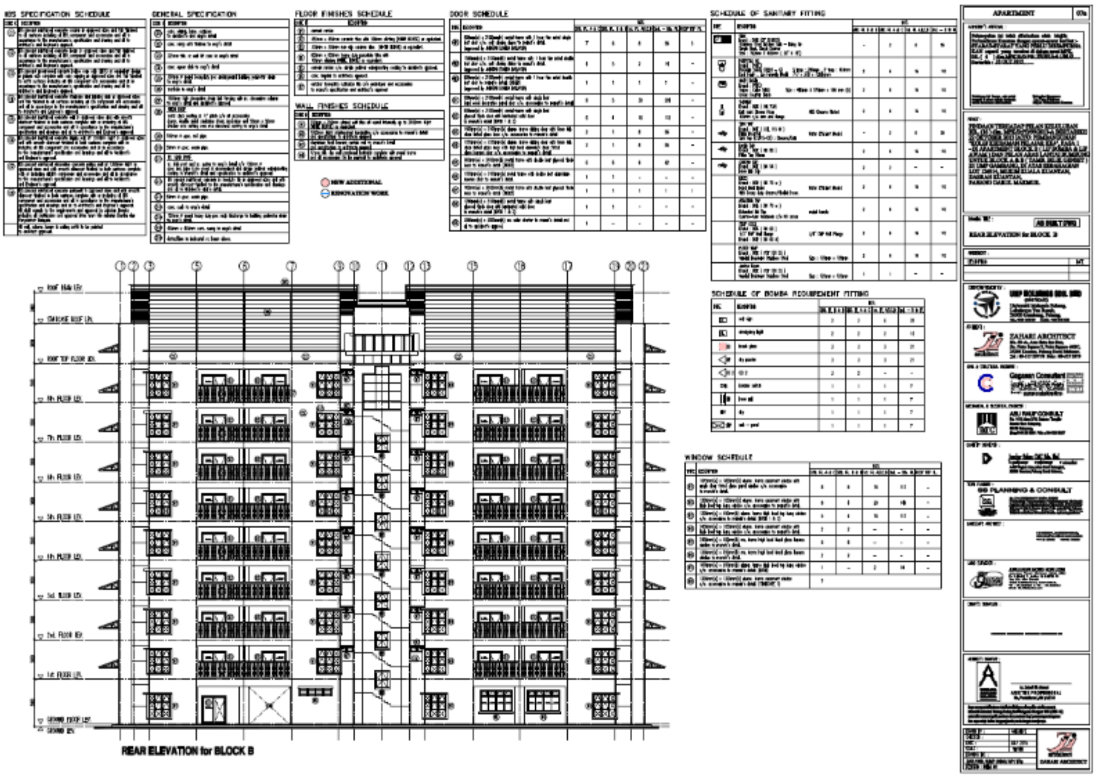
SECTION A-A



FRONT ELEVATION



REAR ELEVATION



APPENDIX B
LIST OF WORK ORDER

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	SAIFULNIZAM BIN ABD RAZAK
Telephone No	
Mobile No	
Email	
Received Date / Time	07 MAR 2018, 10:11
Problem Description	flush rosak
Work Type	BREAKDOWN
Work Priority	NORMAL (P3)
Work Trade	TOILET
Location No	
Location Name	, , ,
Location New (User Enter)	B502
Work Status	CLOSED

Close

Details Workorder ×

Work Order Details

Emp/Req	**MOHD RAZALI BIN MOHAMMAD**
Telephone No	
Mobile No	
Email	
Received Date / Time	**12 MAR 2018, 08:10**
Problem Description	**Support beam untuk kerusi patah. Kaki kerusi akan terserong ke kiri bila duduk. Berlaku secara tiba-tiba semasa duduk. B60703**
Work Type	BREAKDOWN
Work Priority	NORMAL (P3)
Work Trade	FURNITURE
Location No	
Location Name	, , ,
Location New (User Enter)	B-607-3
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, 08:08**
Problem Description	**SINKI ROSAK**
Work Type	BREAKDOWN
Work Priority	NORMAL (P3)
Work Trade	COLD WATER PLUMBING
Location No	
Location Name	, , ,
Location New (User Enter)	A408
Work Status	CLOSED

Close