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Research Paper

Construction Process and Facility Management Optimalization By Integrating The Building Information Modeling (BIM)

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ABSTRACT : *One example of technology that able to be used to facilitate better coordination within construction process is Building Information Modeling (BIM). In recent years, BIM has gained spotlight as a digital construction technology which in fundamental able to change the practices of building and construction industry to pursuit the high quality of the built environment. Due to rapid development of digital method, collaboration process has become the latest topic. The important part of technological transformation of the construction sector is BIM method where it is based on the application of 3 D digital building models enriched with essential information.*

The application of Building Information Modeling (BIM) for construction project in Indonesia is in accordance with PUPR Ministerial Regulation Number 22/PRT/M/2018 concerning the Construction of State Buildings, which at one point explains that the use of Building Information Modeling (BIM) is mandatory to be applied to non-simple state buildings with the criteria of an area of more than 2000 m2 (two thousand square meters) and having more than 2 (two) floors.

During the research, data of project related to research will be collected through some methods like interview with parties involved in the project, direct observation and analysis of project documents. These data then will be used to gain understanding and also for analyzing purposes on how BIM is implemented on the project, as well as how to optimize the use of BIM on future construction projects. The result of this research obtained several conclusions: (1) Modeling in Building Information Modeling (BIM) represents 2D and 3D, 4D, 5D, 6D and 7D. (2) Quantity and Cost dimension have the highest score, indicating a good start in optimizing the implementation of BIM for Rawabuntu Flat Tower Construction Project.

KEYWORDS: *Rawabuntu Train Station, Flat Tower, BIM, Optimalization, Construction Process*

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I. INTRODUCTION

In a construction industry, infrastructure and building construction process in general is involving many parties; such as the project owner, architects, engineers, contractors and subcontractors. Thus, a good coordination between all parties is needed to ensure the project is able to put into practice through efficient and effective ways. Moreover, the management of construction project becomes more complex as the construction industry develops. [1]

One technological method that able to facilitate better coordination within construction process is Building Information Modeling (BIM). In recent years, BIM has gained a lot attention as a digital construction technology which in fundamental will change the practices of building and construction industry aimed to improve the quality of the built environment. Since the digital method has rapid development, the collaboration process has become the latest topic. The important part of technological transformation of construction sector lies in BIM method which based on application of 3D digital building model enriched with essential information.

BIM method is a computer-based 3D model to visualize, plan and manage the process of building construction and managing the facilities. BIM application to construction projects scan bring many benefits such as optimizing construction cost and time, increasing the operational efficiency and facility maintenance, overcoming constraints in type of work which must be carried out in parallel with other work, identifying work

problems fast also able to speed up design process, accuracy project work and project documentation. However, in its application, there are some constraints present when implementing BIM on construction project, like the limited access to centralized data project, lack of availability and skills from workers related to BIM and differences in views and interests between project owners, contractors and subcontractors.

Application of Building Information Modeling (BIM) into construction field is in accordance with PUPR Ministerial regulation (Ministerial of Public Work and Public Housing of Republic of Indonesia) number 22/PRT/M/2018 regarding the Construction for State Buildings which at one point explains the use of Building Information Modeling (BIM) is mandatory to every non-simple state building with area of more than 2000 m2 and having more than two floors.

BIM able to lessen uncertainty, increase safety, solve problems and analyze potential impacts to a construction process because in its concept, BIM able to imagine a virtual construction before the actual construction takes place [2]. Moreover, Eastman et.al. stated that BIM can make process of information exchange goes faster thus it can influence construction implementation because BIM actually provides changes by encouraging the exchange of 3D models among different scientific disciplines [3].

In general, although many studies have discussed application of BIM to 3D,4D or 5D, it is rare to have studies that listing the specific construction project. In usual, this research focuses on BIM usage in a broader context or BIM application into a set of construction projects. In this case study, the research will be carried out regarding BIM implementation on the Rawabuntu Flat Tower Construction project. This project was handled by PT.Adhi Karya (Persero) Tbk and the work site is located next to Rawabuntu Station, South Tangerang. It constructed three tower flat buildings (Tower A, Tower B1, and Tower B2) with height of each tower reaches 34 floors (including the roof on Tower B2) whereas Tower A and Tower B are equipped with podiums up to the second floor.

So far, discussion related to optimalization of construction process and facility management by integrating the Building Information Modeling have not been carried out by many researchers, therefore, the authors raise problem study of: (1) how to implement the construction process and facility management by integrating Building Information Modeling in the Rawabuntu Flat Tower project in South Tangerang, Banten?, (2) How is the independent assessment to requirement condition to use this method from the BIM competency area using the frame of reference of maturity assessment to Rawabuntu Flat Tower project in South Tangerang, Banten?, (3) How is the independent assessment to area map of BIM index evaluation value by using the maturity index evaluation that linking values of each index on the Rawabuntu Flat Tower project in South Tangerang, Banten?.

II. LITERATURE REVIEW

2.1. Previous Researches

There are previous researches from journal articles related to the use of Building Information Modeling (BIM) in the construction project implementation as follows: (1) Pratama and Suharto with article title "Analysis of the Use of BIM in Infrastructure Project: A Case Study of the Trans Java Toll Road Project". This article focuses on analyzing the use of BIM in infrastructure project with a case study from Trans Java Toll Road project. This research showed benefit of BIM for managing and coordinating complex project; (2) Nugraha and Kristanti (2020) with article title "Analysis of Factor Affecting the Use of BIM in Construction Project" reported that the use of BIM in construction project can produce cost efficiency from 6 % to 9 %; (3) Suwignyo *et.al.*, with article title "Utilizing BIM in Construction Project: Critical Review and Future Direction" showed the implementation of BIM able to increase the project productivity up to 30 %; (4) Zhang *et.al.* with article title "BIM for Construction Safety Planning and Management: A Critical Review" showed that factors such as management support, the understanding of BIM technology from the project team, and the existence of regulation that require the use of BIM influence the level of BIM implementation within the construction industry. [4,5,6,7]

The following researches are the previous researches from journal articles related to Building Information Modeling (BIM) in construction process, as follows: (1) Azhar with article title "Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry" explores the BIM application in the AEC (Architecture, Engineering and Construction) sector in general. This research focuses on 3D BIM for design and visualization also discussed the 4D BIM for schedule management and 5D BIM for cost estimation. However, Azhar did not specify the certain construction projects; (2) Succar with article title "Building Information Modeling Framework: A Research and Delivery Foundation for Industry Stakeholders" proposes a framework for applying BIM until the level of 5D BIM in the construction industry. This study did not explore a particular construction project specifically; (3) Cao *et.al.* with article title "Practices and Effectiveness of Building Information Modeling in Construction Project in China" evaluating the effectiveness of using BIM in construction project in China, including 4D and 5D BIM. Although this study involved a variety of projects, the names of specific construction projects were not mentioned. [8,9,10]

2.2. Concept of Optimalization

According to KBBI (*Kamus Besar Bahasa Indonesia),* optimalization derived from basic word of optimal which means the best, the highest, the most profitable, or making the best, making the highest, optimizing process, method, act of optimizing. Therefore, optimization is an action, process or methodology for creating a design, systems, or decisions to become more perfect, functional or more effective. According to Machfud in Sondakh *et.al.,* optimization is an action to improve and optimize. So, optimizing requires intensification and extensification from the subject also the object of what will be optimized. [11]

2.3. Concept of Building Information Modeling (BIM)

Building Information Modeling (BIM) is a process for designing, creating, managing, and utilizing information taken from a building or infrastructure in its entire life cycle. BIM includes geometric modeling, geospatial information, quantity information, time schedule information also related information on quality and characteristics of a building or infrastructure. The application of BIM in the construction industry aims to improve quality, productivity and reduce overall project costs as well as accelerate work according to the specified time limit.

2.4. Definition and Function of Building Information Modeling (BIM)

Eastman, *et.al.,* provide definition and further explanation of BIM by showing that BIM is not only creating 3D models of buildings or infrastructure, but also managing and utilizing information that contained within those models [12]. Meanwhile, Sacks, *et.al.*, provide explanation about BIM in the project life cycle, how it can be used throughout the project life cycle from planning and design stage to construction and operation stage [13]. With BIM, project management is run more efficient and effective. Further, Underwood and Isikdag argue that the use of BIM to increase the productivity and quality of construction project by giving explanation how BIM can be used to level up the productivity and quality of construction projects [14]. BIM enables early conflict detection, better cost management, and increased quality of work output. According to Succar regarding BIM for reducing costs and time in construction projects, his research discusses how BIM can be used as a tool to reduce costs and time in construction project. With BIM, monitoring project can be conducted in more accurate way and risk of error can be minimized, so, the costs and time of the project able to be suppressed [15].

2.5. BIM Implementation on Construction Industry

There are several stages for BIM implementation to the construction industry started from planning stage, design stage, construction stage, operation stage and maintenance stage. Moreover, apart from that, BIM also can be used to manage and monitor projects in real-time, regulates work productivity to avoid idleness, and regulates equipment productivity to suit the time and needs. Implementing BIM in construction industry can provide benefits such as in time and cost efficiency, able to improve coordination between project teams, increases accuracy and quality of work, and simplifying the planning and decision-making process when planning constraints present in construction work field. Further, Arayici *et.al.*, in their research discussed the stages of implementing BIM in the construction industry, which includes the planning, design, construction, operation and maintenance stages [16]. Meanwhile, Azhar *et.al.,* provides explanation related to time and cost efficiency through BIM, by implementing BIM in the construction industry perceived as very necessary to increase cost and time efficiency [17]. Meanwhile, Kunz and Gilligan suggested BIM is capable to improve coordination among project team, emphasizing how BIM can be applied to improve coordination between them and to reduce the misunderstanding and speed up the work processes [18]. In addition, Barlish and Sullivan in this research explain how BIM can be used to improve the accuracy and quality of work in construction projects [19]. Furthermore, Gu & London explain in sector of planning and decision making, by saying BIM can be used to simplify the planning and decision-making process in construction projects [20]. With BIM, project information can be analyzed in more accurate and goes faster (quickly), so the decision-making stage can work in more effective way.

III. RESEARCH METHOD

3.1. The Research Object

The research object is located at Rawabuntu Flat Tower Building construction project, a 34 floors apartment tower located in South Tangerang, right next to Rawabuntu Station. The choice of research object was based on several considerations of:

1. Project Complexity: a-34 floors building which make this project quite complex and challenging to be a good study example of BIM implementation in a large-scale construction project.
2. Its strategic location: the site of the project is next to Rawabuntu station represents a unique challenge from the traffic management aspect also from coordination aspect to the train station

which located near the work site. These challenges added another layer of complexity that can be studied in relation to BIM implementation.

3. Its relevance to research: this project has used the BIM in their construction and management process, so it is relevant to the focus research on optimizing the construction process and managing facilities by integrating these work process with BIM.

Data of project related to research will be collected through some methods like interview with parties involved in the project, direct observation and analysis of project documents during the research. These data then will be used to find understanding and also for analyzing purposes on how BIM is implemented on the project, as well as how to optimize the use of BIM on future construction projects.

3.2. Research Framework

The research framework is shown in Figure 1. There are three main aspects must be carefully considered when applying BIM in actual construction project (to maintain its feasibility): BIM maturity level, BIM index system and BIM evaluation criteria. The BIM maturity level determines feasibility, capability, and benefit of a construction project using BIM based on technology, software and hardware limitations, also various exterior environments. The BIM index system determines influential factors to BIM maturity. BIM evaluation criteria determine the maturity condition of each index based on information gained from actual construction project.

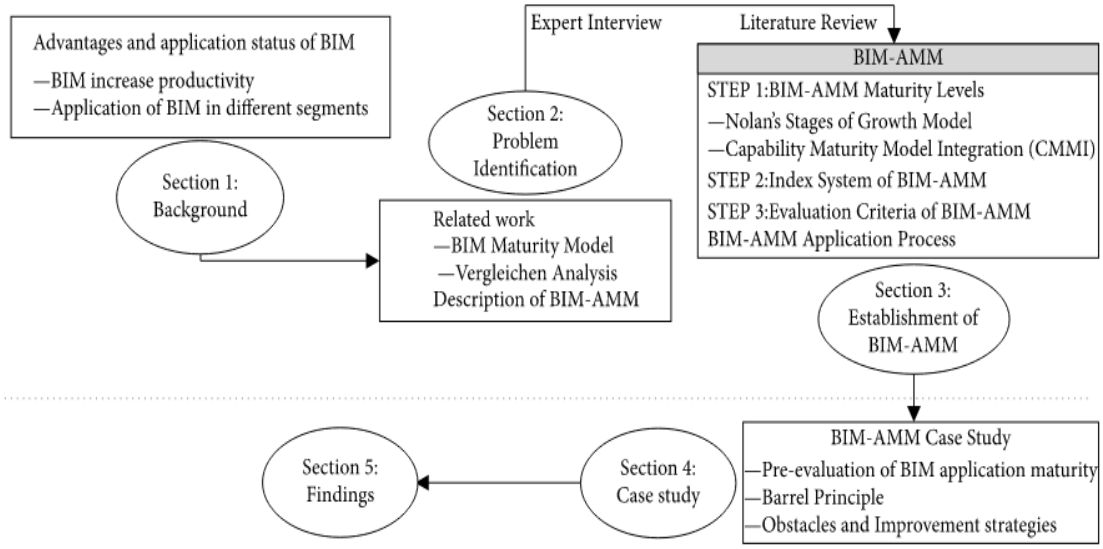

Figure 1: Feasibility of BIM Implementation. [21]

Step 1. First task is determining the BIM level with type of methodology used in setting up the maturity in integrated BIM application model is based on existing maturity models such as the growth stage model for determining maturity level of BIM that combined with the characteristics of BIM application.

Step 2. This research uses a systematic review of the research results aimed to select a BIM application maturity measurement index. The correct choice to measurement direction depends on the point of view of the research problem and the characteristics of the research subject. Through analysis of relevant research on BIM maturity, the direction of BIM application must be considered with inclusion of the shortcomings (minus points) from existing researches, also considering the characteristic of project implementation so the factors influencing BIM can be determined. Next, through interview with BIM-related experts and practitioners in the industry, dimensions of the BIM measurement as well as the indicators can be finally determined.

Step 3. Combined with BIM classification and interview results, meaning of each measurement index at different levels is explained which later will be used as the BIM evaluation standard. Finally, actual project case is selected and used to verify the effectiveness of BIM in a construction project. The last task, according to the result of BIM evaluation, suggestions for BIM adoption to the project will be provided.

IV. RESULT AND DISCUSSION

4.1. The Result of BIM Implementation to Rawabuntu Flat Tower Construction Project

4.2.1. Results of modelling assemble according to PUPR ministerial regulation No. 22 Year 2018

The PUPR Ministerial regulation mandates the BIM application into construction of state buildings with criteria and specific outputs as mentioned in appendix IV. By conforming to criteria of State Buildings according to PUPR Ministerial regulation, this project is included within the mentioned criteria. With our qualification and understanding to ways in implementing BIM, both for PUPR Ministry project and to similar building construction projects, the fulfilment of requirement asked by BIM mandate have been completed into these technical documents.

4.2.2. 3D modelling: Architecture

The creation of concept design by Architecture 3D Modelling for Rawabuntu Flat Tower Building through REVIT software, as one of many software of Building Information Modeling (BIM) available options.

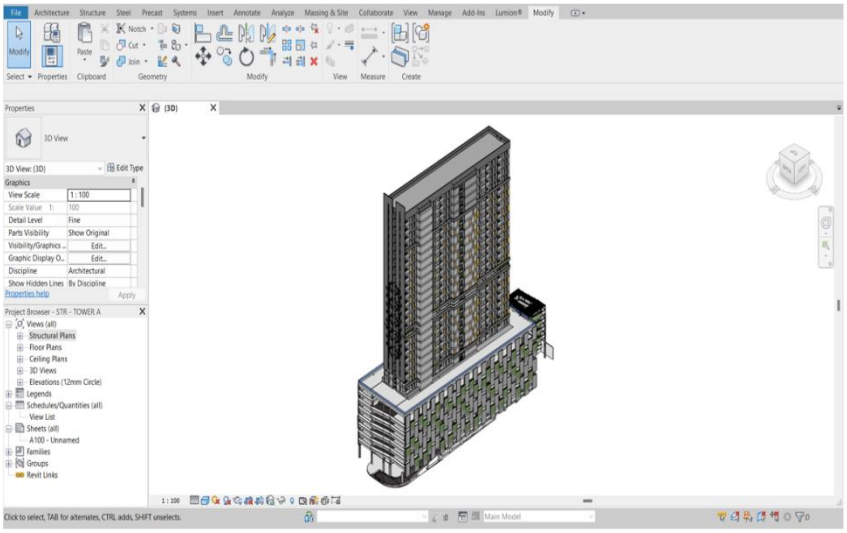

Figure 2: 3D Architectural Modelling for Tower A

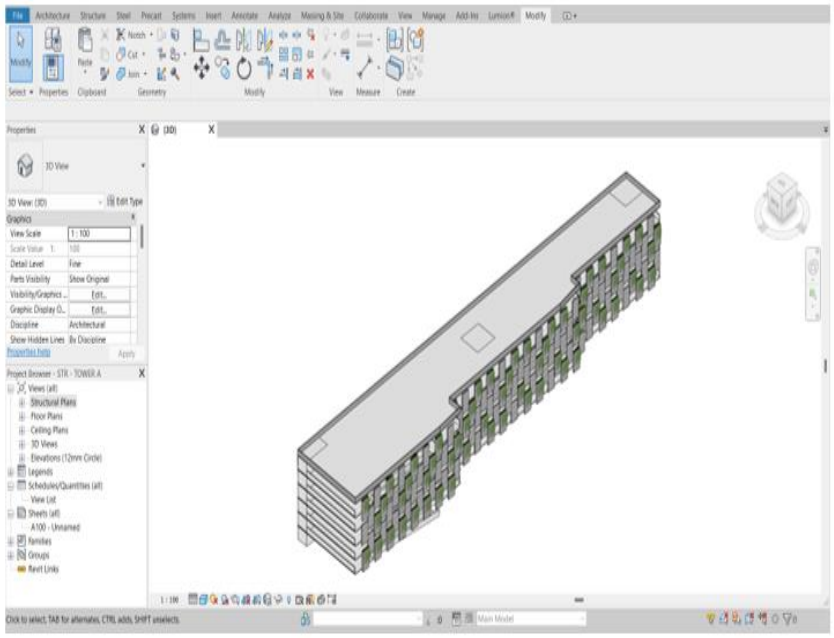

Figure 3: 3D Architectural Modelling for Tower B

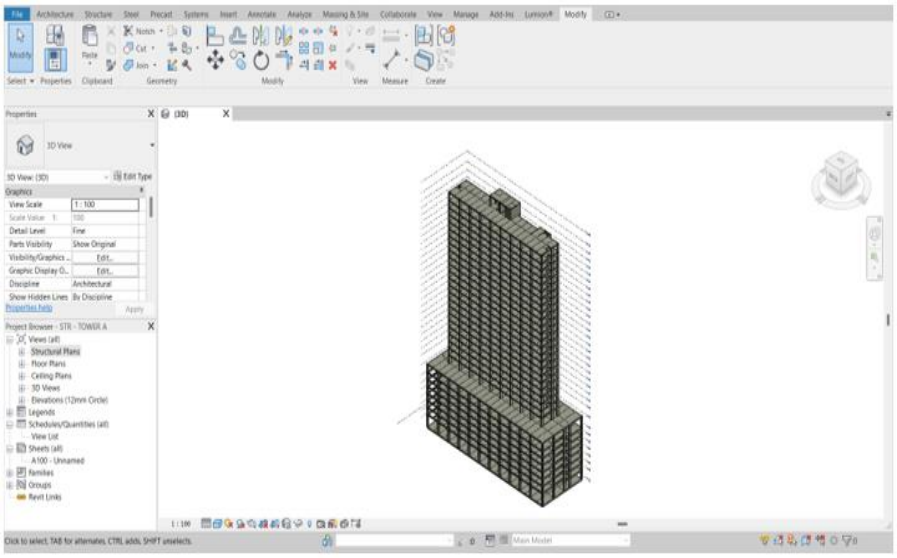

Figure 4: 3D Architectural Modelling for Tower A Model Structure

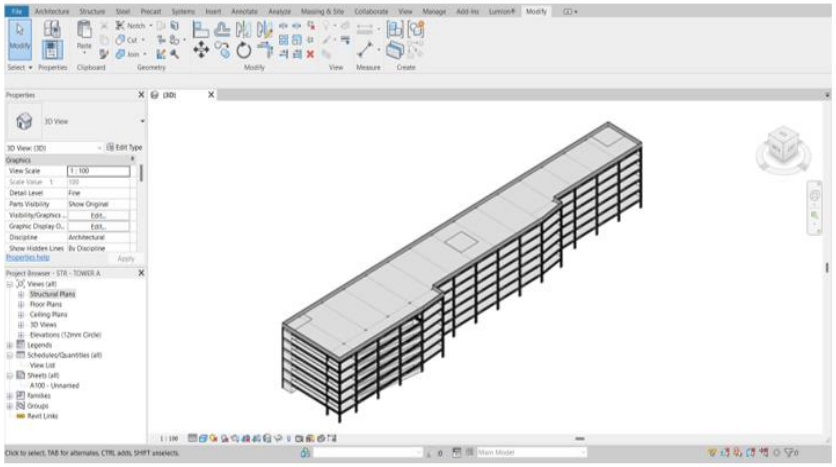

Figure 5: 3D Architectural Modelling for Tower B Model Structure

4.2.3. 4D modelling: Schedule simulation

A creation of 4D modeling dimension image to Rawabuntu Flat Tower Building project is conducted by using REVIT software as one available option of many Building Information Modeling (BIM) softwares.

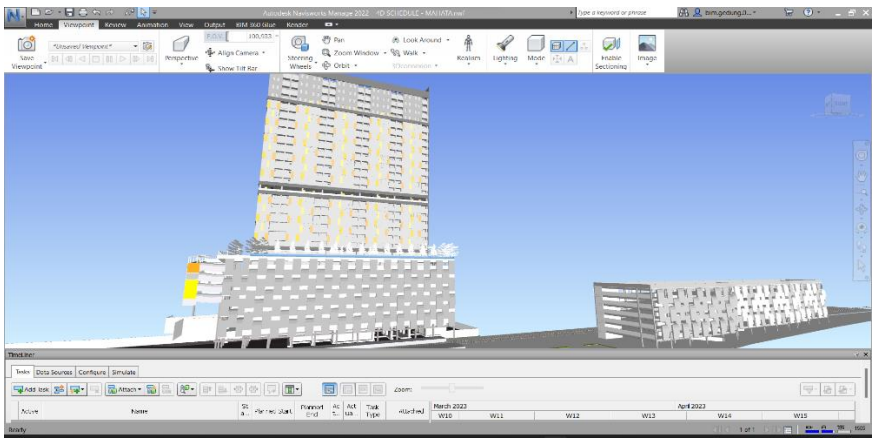

Figure 6: 4D Modelling of the Schedule Simulation

4.2.4. 5D modelling: Quantity take off

A creation of 5D modeling dimension image to Rawabuntu Flat Tower Building project is conducted by using REVIT software as one option available of many Building Information Modeling (BIM) softwares.

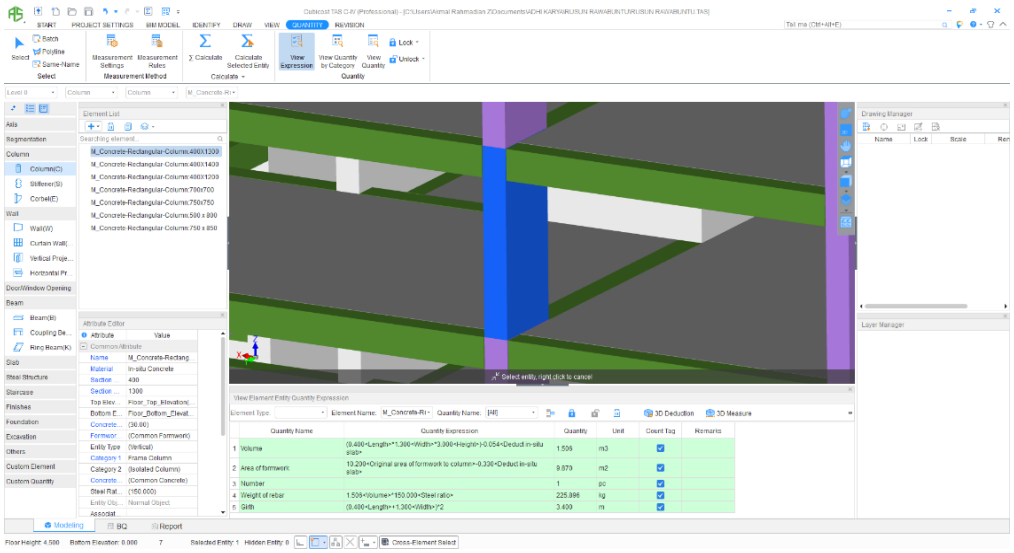

Figure 7: 5D Modelling of Quantity Take Off

4.2. The Result of Evaluation to Implementation of BIM to Rawabuntu Flat Tower Construction Project

Data collection is carried out through a questionnaire where the questionnaire filling becomes an independent assessment to the condition when BIM is applied. The self-assessment method was chosen by consideration to obtain feedback for adjustment during the process aimed for encouraging and improving work performance.

4.2.1. Self-assessment of BIM area of competency

The Self-Assessment method was chosen by consideration to obtain feedback with aim to adjust the process in terms of encouraging and improving work performance. Meanwhile, the regional map of index evaluation values is taken based on the evaluation results of each maturity index, as presented in Table 1.

Table 1. The Tabulation of Accelerated Activities Result

TOTAL SCORE	TOTAL SCORE	RATING SCORE TEXTUAL	DESCRIPTIONS
1	Initial	Low Maturity	The process of BIM has product target and service which already reach mutual understanding (agreed), unfortunately no assistance or guidance while implementing the process. No supportive environment to ensure BIM process to work well.
2	Define	Medium - Low Maturity	BIM process has been planned and implemented according to the agreeable rules, having human resources with competency to produce deliverable BIM as targeted, the process is involving related stakeholders, there is a monitoring activity, there is a controlling activity, there is a review activity, also there is evaluation activity for each process stage.
3	Manage	Medium Maturity	BIM implementation is working according to the

TOTAL SCORE	TOTAL SCORE	RATING SCORE TEXTUAL	DESCRIPTIONS
			standard policy of the organization as adjusted to the needs in project site. Use the BIM implementation as lesson learnt as an input to process improvement of organization assets.
4	Integrated	Medium - High Maturity	BIM process has been integrated to every management process, where all processes is capable of producing output that can be calculated quantitatively and measurably, so it can evaluate and predict process of work performance to make sure the mitigation and corrective actions can be taken as needed.
5	Optimized	High Maturity	The BIM process continues to be improved and enhanced with innovative processes and the latest technology that aligned based on business goals and organizational work performance level.

The maturity distribution graph of the adopted BIM technology to the project is obtained by correlating values of each index. From figure 8, the maturity of each project index is very visible, and the closer the project location to the centre, the lower the maturity level of the index where it needs to be improved on the original basis.

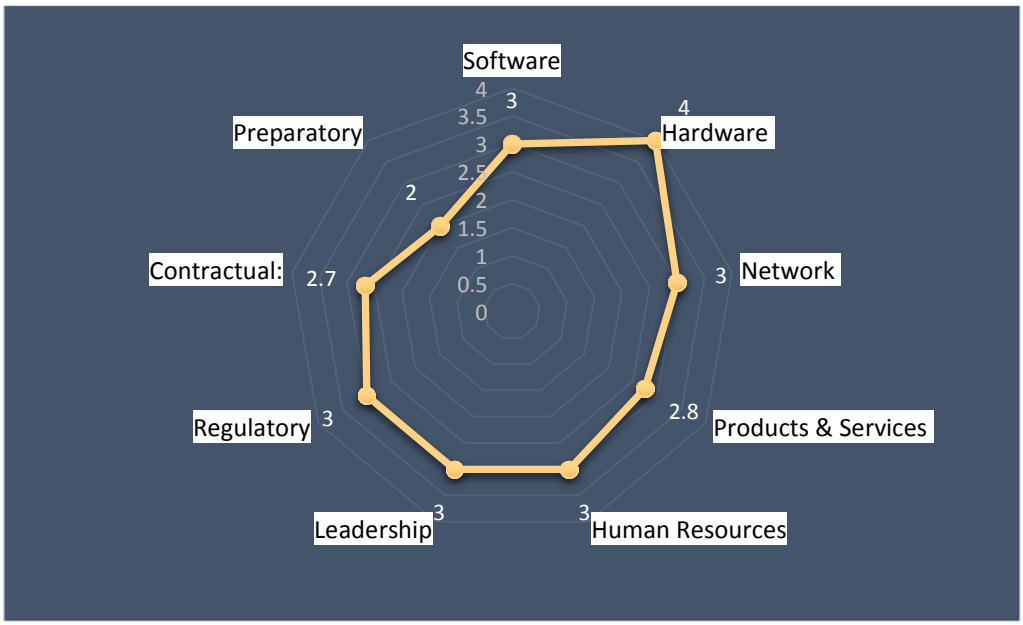

Figure 8: Maturity of the Project Indexes

According to Barrel Principle, only if all indicators meet the requirements of BIM implementation, then the project can adopt the BIM technology to achieve high benefits. When there existed serious shortcomings, even if other aspects have their implementation requirements fulfilled, the overall benefits of BIM will attain low result or worse, it can cause other detrimental consequences. Therefore, for question can BIM brings value to a project will depend on the shortcomings of BIM on the project which is also the key to decide whether the project can adopt BIM.

The result of the assessment revealed that condition of contractual project was very unfavourable, also the product and service level reached Stage 2. The project owner has no awareness of BIM. The designers and other project personnel have had little experience with BIM and the project manager has BIM experience. The project owner is unable to carry out BIM related work, and this is the biggest obstacle for implementing BIM within the project. The chosen business flow is very traditional, which is contrary to the BIM project management concept of information digitalization and management integration. BIM is meaningless and even

causes more work problems. This problem is approaching stage 2 level, making it less feasible to implement BIM.

Although the project had good BIM technical conditions, BIM was not suitable to be the main technical tool for the project due to obvious defects in the contractual project also in the product and service aspect of the project. It is necessary to carry out a maturity assessment again according to the new project situation, only if all prerequisites meet the requirements for BIM implementation, then the main benefits of BIM implementation be ensured.

The maturity of BIM hardware indicators for the project is basically consistent as proven by reaching stage 4 of maturity level. The project organization has good electronic office equipment and basic BIM technology software, which basically meets the requirements of business processes and BIM cooperation between different interdisciplinary sciences.

V. CONCLUSION

According to the research data analysis which previously described, the following conclusions can be drawn:

1. BIM implementation to object has been obtained to all objects that have information ranging from materials, dimensions, thickness with direct depiction in 3 (three) dimensions with a bi-directional relationship where the image object is related to other objects. Modeling in Building Information Modeling (BIM) represents 2D,3D, 4D, 5D, 6D and 7 D.
2. From the result of research to BIM competency area from 28 indicators employed for assessment, it was found that the process parameters, especially for the parameter of quantity and cost has the highest score, indicating a good start for optimizing the implementation of BIM on Rawabuntu Flat Tower Building project.
3. Based on the result of research on the distribution of BIM technology maturity which obtained by connecting values of each index, the results showed that contractual conditions of the project were very unfavourable and the product and service level reached stage 2.

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