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THE IMPLEMENTATION OF BUILDING INFORMATION MODELING TECHNOLOGY ON BUILDING CONSTRUCTION

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Abstract:-

The development of the digital technology is sophisticated so that in construction field undergoes technology needs change resulting good quality to improve time and cost efficiency in organizing construction. Planning and actuating the construction uses AutoCad, Ms.Project, previously, but these applications have not been integrated to the other application. It makes time consuming in using them. Nowadays, technology in construction scope has resulted in a system called Building Information Modeling or BIM. It is a system or technology involving some important information in construction project and is used in architecture, engineering and construction (AEC). Construction employer in Indonesia has not much used BIM system, in fact that BIM make the construction process is easy and fast especially in building construction compared to the conventional construction. It, therefore, needs further research to investigate the superiority of BIM in building skyscraper. The type of the study was qualitative by comparing the skyscraper building using conventional system and BIM system. This present case study expects to insist the construction employer that the use of BIM technology promises time and cost efficiency although it requires high investment compared to the conventional method. The result of the study inferred that using Building Information Modeling (BIM) technology results in time and cost efficiency and effectiveness in constructing building compared to the conventional method, which needs long time to complete the work and high cost.

Keywords:-*Conventional Method, Building Information Modelling, Time Efficiency, Cost Efficiency*

INTRODUCTION

The development of technology in construction building which contains AEC (Architecture, Engineering, and Construction) is very fast. The AEC in Building Information Modeling (BIM) that is accurate digital virtual construction model. A range of study conducted in several countries like Canada, Germany, and Australia indicated that Construction Company get the developed benefit in their companies by adopting the technology innovation in completing the construction demand (Karen, Steve and Stephen 2009). The development of BIM in Indonesia has still not used widely and the application is still limited according to Fundra Yulian (2014). The Indonesian government supports it through policy encouraging and requiring the construction employers to implement Building Information Modeling in completing construction project working.

The advantage of implementing BIM is reducing cost, saving time, and more efficient control of the whole cycle of the project (Bryde, Broquetas dan Volm, 2014). Of the fact that for cost consultant, the capacity of BIM in integrating graphic and nongraphic data model, providing further accurate cost information (McCuen, 2008). The technology development has changed business behavior of construction to get better result in case of time and cost which is conducted using conventional method.

It makes the writer is interested to analyze the superiority of the implementation of Building Information Modeling technology. In the present study, the construction project working is compared in phase of preparation, lower structure, upper structure, architecture, Mechanical Electrical Plumbing, outer area, and additional working.

The result of the study is expected to show the superiority of using Building information modeling technology in construction project working by seeing the phase of the working consisting of preparation, lower structure, upper structure, architecture, Electrical Plumbing, outer area, and additional working.

Construction Operating Cost

Construction cost is cost expended to complete project working consisting of direct and indirect cost. Asiyanto (2004) states that in construction activity, controlling production cost is critical and Husen (2010) adds that to monitor the projects needs project cash flow showing planning and actual using cost in a period of time.

Counting cost is highly important to do from the initial planning to the cost realization based on the planning. Construction cost consists of direct and indirect resource. The direct cost is the entire cost relating to the physical project consisting of material, equipment, wage, and subcontractor cost. While the indirect cost is the entire cost relating indirectly consisting of marketing, secretary, personell, financial, vehicle, and general cost.

The project delay has direct proportional to the effect occurs, which is cost overrun. The relation between time overrun and cost overrun in several developed countries, like United Kingdom, still causes project delay of about 10% (Supriadi Asri, Budi Susetyo, 2020)

BIM Technology

BIM or Building Information Modeling is popular since 2002 when the Autodesk released a paper discussing the technology of BIM entitled “Building Information Modeling”. The term of Building Information Modeling was discussed again in the middle of 2005 after some time forgotten when General Services Administration (GSA) in United States decided to build new court building in Jackson, Mississippi on the land total width of 410.000 ft2. Then, technology of 2D software is used to plan and to document the whole construction phase on while GSA asked the personell to turn from 2D to 3D approach (Robert L. R., 2011).

BIM has dimension of 3D (long, wide, and height), 4D (time), and 5D (cost) (Forgues et al., 2012; Logothetis et al., n.d.; Stanley & Thurnell, 2014). Eastman et.al (2007) states that BIM is integration between design and process of construction to get qualified building with lower cost and reducing time for completing.

Adoption of BIM results in returning positive investment of BIM to collaborate project through saving from the project cost. The previous studies showed that the adoption of BIM support the decreasing of design and construction cost, improving productivity, and better risk manajement process. Enriched BIM model figures building through object class containing geometry 3D and other characteristics (cited by Usman Haider, Usman Khan, Muhammad Humayon, 2020)

Time for Completing Construction

Walean, et.al. (2012) state that completing project construction has planned schedule and determined activities in completing the project. Time performance is output of working achieved in completing the project activity in interval of time from the preparation to the completion based on the time agreed or faster/shorter.

Sedarmayanti (2001) argues that working efficiency is best comparation between a work being finished and the result achieved fererring to the target either in case of quality or result involving optimum time and quality of the maximum performance.

Make shorter the time of project completion is an effort to make time faster than the scheduled time in normal condition Novitasari (2014). When the project must be shorter due to the demand of the project employer, the project is called crash program. Frederika (cited by Novitasari, 2014) states that maximum shorter duration is limited by the project width or working location. There, however, are four factors poured to complete the faster activity, namely addition of worker, work late schedule, heavy equpment use, and changing construction method on the area.

This study proposed that BIM is better in time efficiency than conventional method, and BIM is better in cost efficiency than conventional method.

DATA AND METHOD

The present study was conducted by using event study, which compared the projec of the skyscraper building through conventional method and Building Information Modeling (BIM) method. The type of the study was quantitative. Cost efficiency was defined as pressing cost used as resource to complete the building project. Time effectiveness was level of achieving the determined goal. Efficiency and effectiveness were the most important thing in company strategy to get optimum profit.

The researcher involvement in this present study was minimal interference due to the researcher collected data from the two skyscraper building projects then analyzed the data and concluded the result.

Study Setting used in this present study was non-contrived because the study was conducted in the skyscraper building project using conventional and Building Information Modeling methods. The researcher limited the object of the study on two project of PT WIKA Gedung Tbk, which were project using conventional method in Telkom Group Office building project in Manyar Surabaya and project using BIM product on Pelindo III Office Center project.

Cross Sectional was time horizon conducted in this study because the time allocation of the two projects was separately performed or in different time. The project of building Telkom Group office in Manyar Surabaya and project Pelindo III Office Center begun in.

DISCUSSION

Comparison between Conventional Method and BIM Method

In this study, the researcher compared two building project of skyscraper conducted by PT.Wijaya Karya Gedung, Tbk, which were the project using conventional method on the building of Telkom Group Office in Manyar Surabaya and project using BIM product on the building of Pelindo III Office Center.

Recently, the implementation of BIM in PT.Wijaya Karya Gedung, Tbk was still on 3 Dimension or 3D Modeling making the contractor, owner/employer, and user easy in understanding data.

The conventional method on the building of skyscraper of Telkom Group Office in Manyar was as follow:

The implementation of BIM method on the building project of skyscraper of Pelindo III Office Center was as follow:

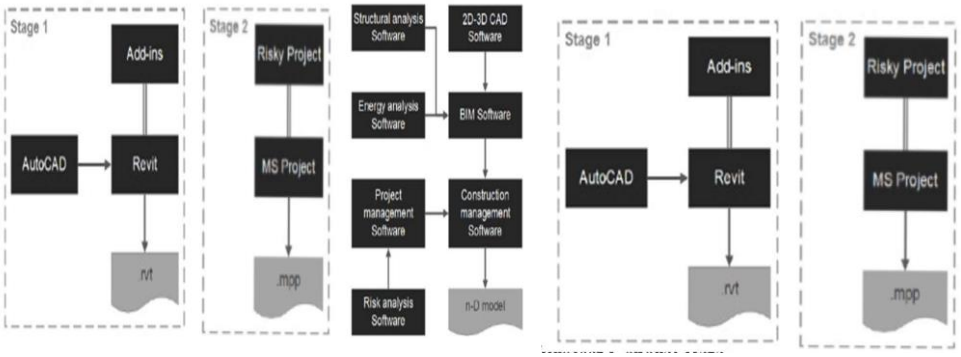
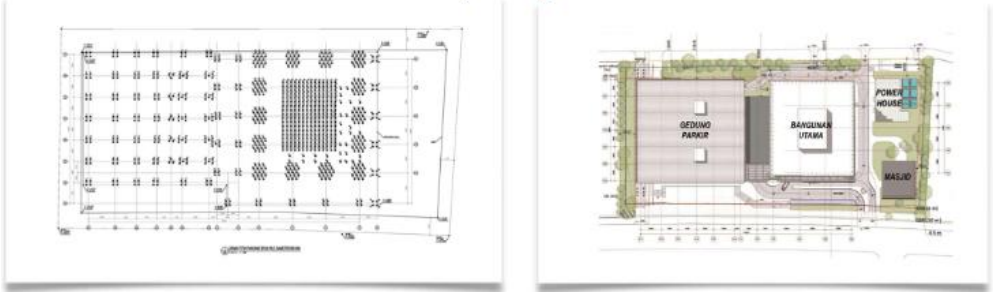


Table 1. Project General Data

Illustration of Using BIM on Telkom Manyar Project

Illustrasi of Using Conventional Method on Pelindo III Manyar Project



URAIAN	METODE KONVENSIONAL	METODE BIM
Nama Proyek	Pembangunan Kantor Telkom Group Manyar	Proyek Pelindo III Office Center
Pemilik Proyek	PT.Graha Sarana Duta (GSD)	PT. Pelabuhan Indonesia III (Persero)
Lingkup Pekerjaan	Pekerjaan pondasi & penahan tanah sementara (Soldier Pile) Pekerjaan Struktur,Arsitektur,MEP gedung perangkat & gedung office tower Pekerjaan jalan & perkerasan	Design & build pekerjaan struktur , arsitektur , MEP dan Lansekap
Waktu Pelaksanaan	Januari 2018 s/d November 2019 660 (Enam Ratus Enam Puluh) hari kalender	09 Mei 2018 s/d 10 Juni 2020 773 (Tujuh Ratus Tujuh Puluh Tiga) hari kalender
Luas Bangunan	37.009 m2 Office Tower : 36.446 m2 STO : 563 m2	67.083 m2 Gedung Kantor : 49.838 m2 Gedung Parkir : 16.544 m2 Masjid : 300 m2 Bangunan MEP : 400 m2
Jumlah Lantai	24 Lantai Office Tower : Basement + 17 lantai STO : 7 lantai	30 Lantai Gedung Kantor : Basement + 23 lantai + Atap Gedung Parkir : Basement + 6 lantai Masjid dan Bangunan MEP : 1 Lantai
Nilai Kontrak	Rp. 277.200.000.000,- (exclude PPN)	Rp. 425.333.000.000,- (exclude PPN)

Based on the data collected, the writer analyzed them on the project of office building of Telkom Manyar and Pelindo office. It showed that the projects had 7 phases of acrtivity measured by using time and cost of eevery single phase.

1. Time of Project Completion

The following is the timechart of conventional method on the project of Telkom Manyar and BIM project of Pelindo III Office Center.

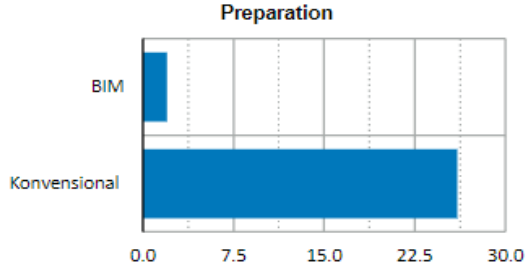
Table 2. Timechart of Conventional Method of Telkom Office Building

No	Aktifitas	Bulan
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
1	Preparation	
2	Lower Structure	
3	Upper Steucture	
4	Architec	
5	Mechanical, engineering and Plumbing (MEP)	
6	Outer Area	
7	Additional Work	

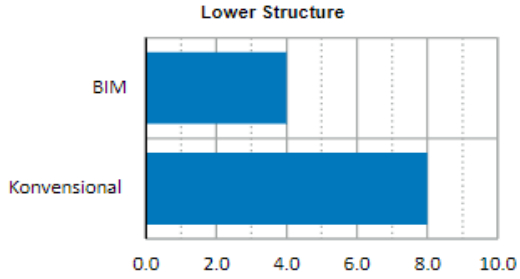
Table 3. Timechart of BIM Method-Pelindo III Office Center

No	Aktifitas	Bulan
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1	Preparation	
2	Lower Structure	
3	Upper Steucture	
4	Architec	
5	Mechanical, engineering and Plumbing (MEP)	
6	Outer Area	
7	Additional Work	

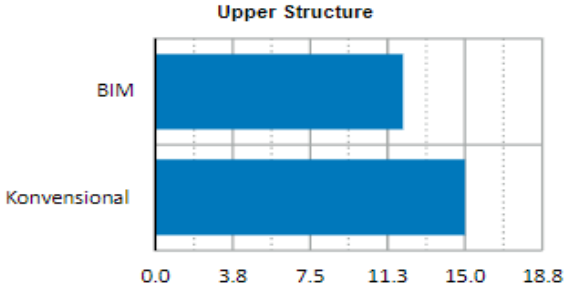
of BIM Method-Pelindo III Office Center



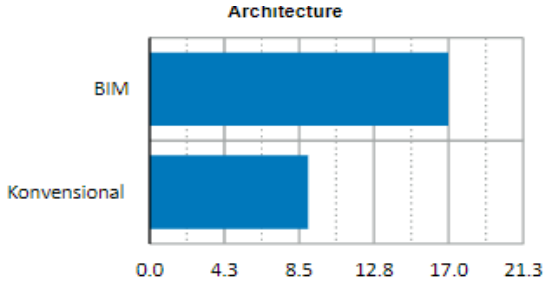
Of the table, every stage of the 0.07.515.0 22.530.0 working has preparation containing counting volume and cost needed during 26 months project completion. The preparation stage for the project using BIM was done alligned to the time needed during 2 months.



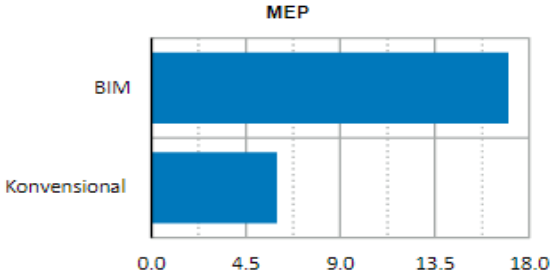
The conventional and BIM method projects showed that the lower structure was done on the second months, but the completion time needed different time, 4 months for BIM and 8 months for conventional methods, respectively.



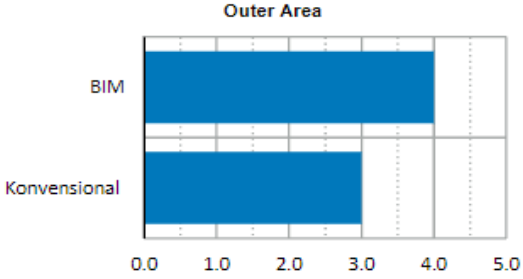
The conventional method project and the BIM method of the upper structure were conducted in 15 months and 12 months, respectively.



The architecture stage for the conventional method project can be completed simultaneously with the structire stage in 9 months started on the sixteenth month.
The architecture stage of the project using BIM method can be completed simultaneously with the structure in 17 months started on the sixth month.



The project using conventional method for Mechanical Electrical Plumbing/MEP needed time of 6 months and the project using BIM method needed time 17 months. The completion of MEP was started on the sixth month and can be conducted alligned to the architecture stage.



The conventional method project for outer area stage needed 3 months completion started on the twenty second month amd the BIM method project needed time 4 months started on the nineteenth month.
The additional working stage was likely on every stage of working. There was additional and reduce of working. The conventional method project was started from the second month to the twenty second month during project completion. Project using BIM method was conducted on the twenty second month.

2. Counting Cost using Conventional and BIM Methods

3.

Table 4. Conventional and BIM Construction Cost

Aspect	CONVENTIONAL METHOD	BIM METHOD
NamE OF Project	**Building Telkom Group Office in Manyar**	**Project of Pelindo III Office Center**
Preparation, Facility and Support	IDR 23,544,277,174	IDR 5,633,288,070
Lower Structure	IDR 13,501,964,202	IDR 18,775,399,411
Upper Structure	IDR 62,091,763,472	IDR 92,469,961,991
Architecture	IDR 78,591,839,144	IDR 84,810,178,912
MEP	IDR 58,556,247,143	IDR 121,820,771,498
Outer Area	IDR 287,375,723	IDR 5,572,473,436
Additional Working	IDR 13,072,717,843	IDR 6,202,335,583
Income Tax	IDR 8,197,755,369	IDR 12,759,997,908
Risk	IDR 1,366,292,562	IDR 4,229,461,273
BUP	IDR 4,098,877,685	IDR 7,953,554,805
Gross profit	IDR 13,662,909,091	IDR 30,399,205,049
Total	IDR 276,972,019,408	IDR 390,626,627,937
Building Width (m2)	**37,009**	**67,083**
Preparation, Facility and Support	IDR 636,177	IDR 83,975
Lower Structure	IDR 364,829	IDR 279,883
Upper Structure	IDR 1,677,748	IDR 1,378,441
Architecture	IDR 2,123,587	IDR 1,264,257
MEP	IDR 1,582,216	IDR 1,815,971
Outer Area	IDR 7,765	IDR 83,068
Additional Working	IDR 353,231	IDR 92,458
Income Tax	IDR 221,507	IDR 190,212
Risk	IDR 36,918	IDR 63,048
BUP	IDR 110,754	IDR 118,563
Gross profit	IDR 369,206,055	IDR 453,158,103
Total of Building Cost/M2	IDR 7,483,910	IDR 5,823,035

Counting cost per m2 on the building project of Telkom Group office in Manyar using conventional method are:

1) Total construction cost : Rp. 7,003,555,-/ m2.
2) Preparation, Facility and Support : Rp. 636,177,-/ m2
3) Lower Structure : Rp. 363,177,-/ m2.
4) Upper Structure : Rp. 1,677,748,-/m2
5) Architecture : Rp. 2,123,587,-/m2
6) MEP : Rp. 1,582,216,-/m2
7) Outer Area : Rp. 7,765,-/m2
8) Additional Working : Rp. 353,231,-/m2
9) Income Tax : Rp. 221,507,-/m2
10) Risk : Rp. 36,918, -/m2
11) BUP : Rp. 110,754, -/m2
12) Gross profit : Rp.369.206.055,-/m2

Counting cost per m2 on the project of Pelindo III Office Center using BIM method are as follow:

1) Total construction cost : Rp. 67,083,-/m2
2) Preparation, Facility and Support : Rp. 83,975,-/ m2
3) Lower Structure : Rp. 279,883,-/ m2.
4) Upper Structure : Rp. 1,378,441,-/m2
5) Architecture : Rp. 1,264,257,-/m2
6) MEP : Rp. 1,815,971,-/m2
7) Outer area : Rp. 83,068,-/m2
8) Additional working : Rp. 92,458,-/m2
9) Income Tax : Rp. 190,212,-/m2
10) Risk : Rp. 63,048, -/m2
11) BUP : Rp. 118,563, -/m2
12) Gross profit : Rp. 453,158,103, -/m2

Table 5. Comparation of Total Cost of Width

Aspect	Conventional Method	BIM Method	Difference
Name of project	**Project of Building Telkom Group Office in Manyar**	**Project of Pelindo III Office Center**	
Preparation, Facility and Support	IDR 23,544,277,174	IDR 5,633,288,070	**IDR (17,910,989,104)**
Lower Structure	IDR 13,501,964,202	IDR 18,775,399,411	IDR 5,273,435,209
Upper Structure	IDR 62,091,763,472	IDR 92,469,961,991	IDR 30,378,198,519
Architecture	IDR 78,591,839,144	IDR 84,810,178,912	IDR 6,218,339,768
MEP	IDR 58,556,247,143	IDR 121,820,771,498	IDR 63,264,524,355
Outer Area	IDR 287,375,723	IDR 5,572,473,436	IDR 5,285,097,713
Additional working	IDR 13,072,717,843	IDR 6,202,335,583	**IDR (6,870,382,260)**
Income tax	IDR 8,197,755,369	IDR 12,759,997,908	IDR 4,562,242,539
Risk	Rp 1,366,292,562	IDR 4,229,461,273	IDR 2,863,168,711
BUP	Rp 4,098,877,685	IDR 7,953,554,805	IDR 3,854,677,120
Gross profit	IDR 13,662,909,091	IDR 30,399,205,049	IDR 16,736,295,958
Total	IDR 276,972,019,408	IDR 390,626,627,937	IDR 113,654,608,529

Calculation cost per m2 on project of Pelindo III Office Center using BIM were as follow:

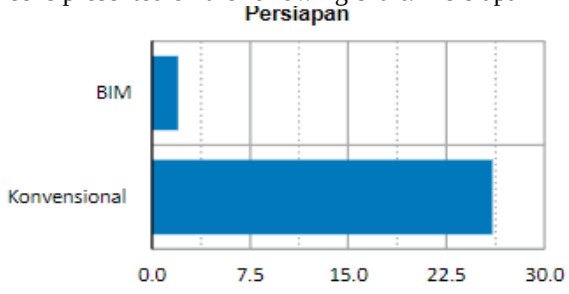
1. Cost for preparation, facility and support Rp.552,202,-/m2
2. Cost for lower structure in meter square showed the difference of Rp. 84,946,-/m2
3. Cost for upper structur in meter square showed difference of Rp. 299,307,-/m2
4. Cost of architecture in meter square showed the difference of Rp.859,330,-/m2
5. Cost for additional working in meter square difference was Rp.260,773,-/m2
6. Cost for income tax in meter square difference was Rp. 31,295,-/m2
7. Total cost in meter square difference was Rp. 1,660,875,-/m2

Table 6. Comparation of Cost per Square Width (M2)

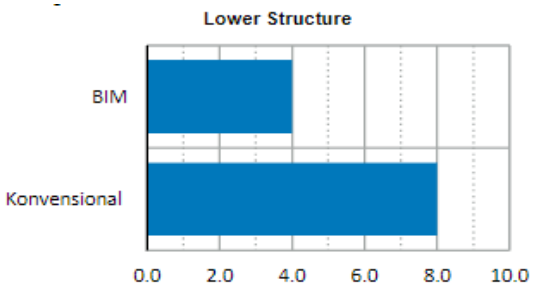
Building Width (m2)	37,009	67,083	Selisih (m2)
Preparation, facility and support	IDR 636,177	IDR 83,975	**IDR (552,202)**
Lower structure	IDR 364,829	IDR 279,883	**IDR (84,946)**
Upper structure	IDR 1,677,748	IDR 1,378,441	**IDR (299,307)**
Architecture	IDR 2,123,587	IDR 1,264,257	**IDR (859,330)**
MEP	IDR 1,582,216	IDR 1,815,971	IDR 233,754
Outer area	IDR 7,765	IDR 83,068	IDR 75,303
Additional working	IDR 353,231	IDR 92,458	**IDR (260,773)**
Income taxt	IDR 221,507	IDR 190,212	**IDR (31,295)**
Risk	IDR 36,918	IDR 63,048	IDR 26,130
BUP	IDR 110,754	IDR 118,563	IDR 7,809
Total Building cost /M2	IDR 7,483,910	IDR 5,823,035	**IDR (1,660,875)**

1. Time of Project Completion

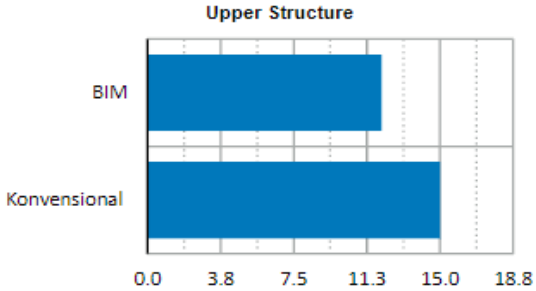
Based on time of completion, project of Telkom Group Office in Manyar and project of Pelindo III completed in different time. The significant difference is presented on the following chart: Persiapan



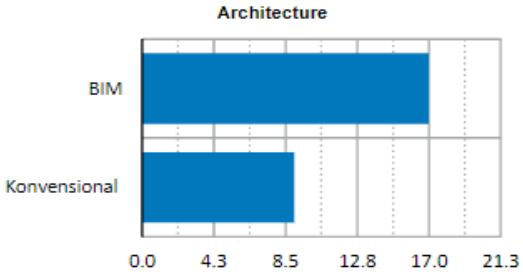
Preparation Stage consisted of estimating volume and cost by using conventional method in 26 months. For the project using BIM method, it used alligned to tne time for completion needed only 2 months so that it has performed in shorter time



Conventional and BIM method on the stage of lower structure were completed on the second month. However the time for completion required different time, which were 4 months and 8 months for BIM method and conventional method, respectively. It, therefore, can be concluded that BIM method was more effective in reducing time for completion up to 50% on the lower structure phase.

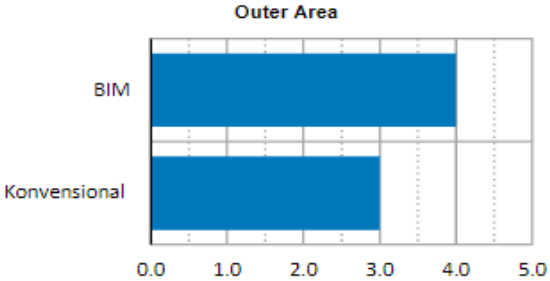


The upper structure was completed for 15 months and 12 months, for conventional method and BIM method, respectively.
Architecture



The Architecture stage was completed simultaneously with the structure stage and it was finished for 9 months and started in the sixteenth month for the conventional method.
Otherwise, the architecture stage using BIM method could be completed simultaneously with the structure stage completed for 17 months and started in the 6th month. The building, therefore, was finished faster due to the partial of building foundation was based on the architecture illustration and the integrated one. Proses approval was done by seeing visually to make it easy in design processing and the material had been prepared before the structure working was completed. In changing the design, it was easy because it only adjust the illustration as asked by the owner. However in conventional method, the architecture design could not be completed when the physical illustration has not been finished.

Project using conventional method on the stage of Mechanical Electrical Plumbing/MEP needed time 6 months and the project using BIM method needed time 17 months. Working MEP was began on 6th month and completed in parallel during the architecture working.



On project using conventional method, the outer stage needed 3 months starting on 22nd month and on the project using BIM method it needs time 4 months starting from 19th month.
On additional working, each working stage had addition/reducing working. In conventional method it was started on the second month to 22nd month during the project completing. On project using BIM method, it was conducted on 22nd month.

2. Cost of Completing Project

Counting cost for the building total width on the Telkom manual project was 37,000 m2 and Pelindo III Office, which is twice was 67,083 m2 showed the difference as follow:

1. Preparation, facility and supporting construction phase – using BIM technology was cheaper, which was Rp.17,910,989,104 compared to the conventional method.
2. Lower structure phase BIM method had higher cost, which Rp. 5,273,435,209 was compared to the conventional method having total width of twice smaller than the BIM width achieving 67,083m 2. Thus, if it was compared to the cost per m2 of the project using BIM was superior with saving Rp.84,946/m2 .
3. Upper structure phase on the conventional construction project was cheaper, which was Rp.30,378,198,519, but seen from the width per /m2 the cost of the construction BIM technology was cheaper about Rp.299,307/m2 compared to the conventional.
4. Architecture phase showed that the cost of BIM was seen more expensive, which was minus Rp.63,264,524,355 compared to the conventional. However, compared to the cost m2 using BIM technology was much cheaper which was Rp.859,330.
5. Working Mechanical Enjiniring Plumbing or MEP was completed manually or conventionally cheaper of Rp.63,264,524,355/m2 and the meter square width used BIM was more expensive than the conventional one, which was Rp.233,754/m2
6. Out area phase either in case of total building width or the personal cost were more expensive of Rp.5,285,097,713/m2
7. Additional working with normal width, which was twice wider than the project of Pelindo III contributed positively about Rp.6,870,382,260/m2 so that it was # per m2 of conventional method was more expensive about Rp. 260,773/m2.

Of the analysis the writer had done, it showed that the cost of meter square width using BIM was much cheaper than the conventional method. The cost saving per meter square totally was Rp.1,660,875 per M2.

CONCLUSION

Of the result of the study discussed based on the data the writer collected relating to "THE IMPLEMENTATION OF BUILDING INFORMATION MODELING TECHNOLOGY IN BUILDING CONSTRUCTION" on the project of office building project of Telkom Manyar and Pelindo office, it can be concluded that.

Based on time aspect when the construction process was still in preparation, architecture, mechanical Electrical and Plumning (MEP), additional work using BIM helps the process to be completed faster more than 50% of time saving compared to conventional method.

Besides, of the cost aspect on the entire phase above, in general, by using BIM has saved cost up to Rp.1,660,875 per M2 with width of the project twice than the conventional method.

The data of the present study was historical data from the ongoing project so that it likely showed the different situation at the present time. Thus, it can be concluded that the technology of BIM assisted the effectiveness and profitability of the building construction compared to the conventional method.

For the next researcher, it suggested to conduct further research on the difference of conventional construction method and Building Information Modeling BIM method by involving the process data relating to other working unit on a company entirely, such as Human Capital and material providing process. It will help readers to see the description of the whole process involved in the two methods.

For company of construction and Developer Property by understanding the benefit of construction innovation of BIM, it is expected to assist them in improving margin and cash flow of the company as well as reducing environment pollution causing by construction activity.

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