Integration building information modeling (BIM) to track the time for controlling of budget and labor productivity (case study: warehouse project)

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Abstract. The rapidly growing world of construction in Indonesia will require more effective support technology. Technological developments in construction are under construction called as Building Information Modeling (BIM). Before Developing Modeling Information (BIM), AutoCAD, SAP2000, Ms. Project is often used for design and project planning. The use of the applications cannot be integrated. It can be implemented as needed. Building Information Models (BIM) encourages the flow of 3D models across different disciplines, so that the process is faster and more direct. Currently, many actors have never adopted in the construction in Indonesia, even not yet understand about Building Information Modeling (BIM). The result of this study is the steel weight for the column is 1,151,596.35 kg. The duration of project with acceleration is 475 days. The labor productivity divided based on the experience, age and education.

Keyword: Building Information Modeling, duration, productivity

1. Introduction
The project by adopting available resources is organized to accomplish a specific purpose. The success of a development project implementation is affected by the selection of the proper method of execution plan as well as the ability to make decisions. In the era of free markets, the construction company should improve its performance to be able to compete with businesses in other construction services. One of the benchmarks that reflect good performance from businessmen in the field of construction services is the accuracy of the cost and time of completion of the project in accordance with the plan [1].

Up to now, Building Information Modeling (BIM) development in Indonesia is still limited. This is due to the limitations of information and lack of knowledge about how the use of BIM among engineers. BIM can help engineers to design a smart building. In addition, BIM can be used to design a building, controlling a project, and calculate plan as well as cost [1]. Application of BIM in building design and its cost is very beneficial because it can provide early notifications about things that may occur in the future. In the building design, A good planning is needed, so that the building can be built as per specifications. It can be achieved as well as the budget plan costs are accurate. By considering these things, to streamline the planning and precision in calculating the cost of a budget plan of construction of the building, then use programs Autodesk Revit Structure 2019. Autodesk Revit is one
piece of software that implement BIM, system software consists of three components, namely structure, the architect, and MEP [2].

BIM is one of the most promising developments in the engineering and construction industry. BIM technology can be created by a virtual model of meticulous with the 3D view [3]. Basic principles of BIM can use 3D three-dimensional building model to get all the necessary project descriptions, including detailed drawing for construction, as well as the calculation of quantity and estimation of the price. A change in one element of the model will automatically update drawing, quantity, and price estimation [4].

However, the application of BIM in the planning stages in Indonesia is still very limited as previously mentioned. Thus, the authors try to analyze the use of BIM application on construction projects in the planning costs.

2. Research Methodology

Figure 1 shows flow diagram for this study. The collecting data is divided into 3 stages: revit modelling, scheduling and labor effectiveness.

![Research Flow Diagram](image)

Figure 1. Research Flow Diagram
3. Results and Discussion

3.1. The results of Modeling Revit Structure 2019
The results of the modeling project warehouse 8 with Revit Structure 2019 can be seen in Figure 1 to Figure 4.

Figure 2. 3D Structure View on Warehouse 8

Figure 3. Column Structure View on Warehouse 8

Figure 4. Trusses Structure View on Warehouse 8

3.2. Weight Calculation Results with Revit Structure 2019
The total length obtained from Revit Structure 2019 can be used to determine the volume by multiplying the length of steel profile with each coefficient of steel profiles (Figures 5-6).

Figure 5. Structural Column Weight

| Structural Column | 1.151,596,35 | 1.401,489,52 |
|-------------------|--------------|--------------|
| Kilogram (kg)     | Revit Structure 2019 | Contractor |
3.3. Analysis Results of The Network Using Critical Path Method (CPM)

Jobs with an independent activity is the Erection of the steel column of axle 1-15, axle 16-27 Column steel fabrication, Steel Erection of the roof of the axle 1-15, axle steel roof and fabrication 16-27 so on the work of the network can be done at the same time. After doing the job continued with steel manufacturing, steel erection job. When work is being carried out erection, fabrication jobs vacant so that there is no work being done. Due to this, then steel fabrication and erection of steel jobs were done simultaneously. Steel erection job is running, the job of fabricating also continues to run so that no jobs are vacant. These networks can be seen in Figure 7.

Thus, the normal duration of a total of 570 days, with network analysis, duration is 475 days with time savings as much as 95 days. At the start, because the calculation activities A2 (Erection of steel Columns of the US 1-15) and activities A3 (steel manufacturing axle Column 16-27) worked together then selected the greatest day. Because activities A3 (steel manufacturing Columns of the US 16-27) has the largest day of activities then A2 (Erection of steel Columns of the US 1-15) is not calculated because it has the smallest day and later became dummy. As well as on the activities of B2 (axle steel roof Erection 1-15) and B3 (U.S. steel roof Manufacturing 16-27), B3 activities (fabrication of steel roof of the US 16-27) has a larger number of days so that the activities of B2 (axle steel roof Erection 1-15) is not calculated because it has today the smallest and then into a dummy. Then determine the critical path, a critical path is determined from the work that has started today and finished the same day. Then the critical path namely: A1-A3-Dummy-A4-B1-B3-B4-Dummy-C1. The intent of the critical path is an earned job belonging to this critical path should not pass from the duration of which has been made on the network, so there is no tolerance for late on a work goes into this critical path.

3.4. Results of the Effectiveness of Each Working Group

Table 1 shows the result of the Effectiveness of Each Working Group based on working time.
Table 1. The Effectiveness of Each Worker Group

| No | Worker Group                | Result Time Measured (Minutes/Day) | Working Time Theory (Minutes/Day) | Difference (Minutes/Day) | Effectiveness % | Theory % |
|----|-----------------------------|------------------------------------|----------------------------------|--------------------------|-----------------|----------|
| 1  | Cut, Drilling & Finishing Labor | 378                                | 418                               | 40                       | 9.57            | 90.43    |
|    | Skilled Labor               |                                    |                                  |                          |                 |          |
|    | Un-Skilled Labor            |                                    |                                  |                          |                 |          |
| 2  | Fit Up Labor                | 360                                | 418                               | 58                       | 13.88           | 86.12    |
|    | Skilled Labor               |                                    |                                  |                          |                 |          |
|    | Un-Skilled Labor            |                                    |                                  |                          |                 |          |
| 3  | Welding Labor               | 300                                | 418                               | 118                      | 28.23           | 71.77    |
| 4  | Finishing Labor             |                                    |                                  |                          |                 |          |
| 5  | Painting Labor              |                                    |                                  |                          |                 |          |
| 6  | Packing Labor               |                                    |                                  |                          |                 |          |

|    | MEAN                        | 564                                | 627                               | 63                       | 15.07           | 134.93   |

3.5. Result of Worker Effectiveness based on Age, Work Experience and Education

Table 2. The Effectiveness of Each Worker Group Based on Age

| No | Worker Group                | Age (Years) | Effectiveness % | Average Effectiveness % |
|----|-----------------------------|-------------|-----------------|-------------------------|
| 1  | Fit Up Labor                | <20         | 86.12           | 94.74                   |
|    | Un-Skilled Labor            |             |                 |                         |
| 2  | Packing Labor               |             | 99.04           |                         |
|    | Skilled Labor               |             |                 |                         |
|    | Un-Skilled Labor            |             | 99.04           |                         |
| 3  | Cut, Drilling & Finishing Labor |        | 90.43           |                         |
|    | Skilled Labor               |             |                 |                         |
|    | Un-Skilled Labor            |             | 90.43           |                         |
| 4  | Fit Up Labor                | 20 - <30    | 91.87           |                         |
|    | Skilled Labor               |             | 86.12           |                         |
|    | Finishing Labor             |             |                 |                         |
|    | Un-Skilled Labor            |             | 99.04           |                         |
|    | Painting Labor              |             |                 |                         |
|    | Un-Skilled Labor            |             | 93.30           |                         |
Table 3. The Effectiveness of Each Worker Group Based on Age

| No | Worker Group                     | Work Experience | Effectiveness | Average Effectiveness |
|----|----------------------------------|-----------------|---------------|-----------------------|
| 1  | Cut, Drilling & Finishing Labor  |                 |               |                       |
|    | Skilled Labor                    | 30 - <40        | 71.77         | 82.54                 |
|    | Painting Labor                   |                 |               |                       |
|    | Skilled Labor                    |                 | 93.30         |                       |

Table 4. The Effectiveness of Each Worker Group Based on Age

| No | Worker Group                     | Education       | Effectiveness | Average Effectiveness |
|----|----------------------------------|-----------------|---------------|-----------------------|
| 1  | Cut, Drilling & Finishing Labor  |                 |               |                       |
|    | Un-Skilled Labor                 |                 | 90.43         |                       |
|    | Fit Up Labor                     |                 |               |                       |
|    | Un-Skilled Labor                 |                 | 86.12         |                       |
|    | Finishing Labor                  |                 | 99.04         |                       |
|    | Skilled Labor                    |                 | 99.04         |                       |
|    | Elementary                       |                 | 94.50         |                       |

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### 3.6. Cost and Time Relationship

Result of cost and time relationship can be seen in Figure 8.

![Figure 8. Cost and Time Relationship](image)

From the chart above, in the time of completion of the project accelerated from normal time, then the fee will be increased from the normal cost. Where normal time project is 570 days with a normal cost of Rp 48,104,441,461.84. The accelerated duration is 475 days, and it is obtained from the addition of 4 hours per day and that carries the additional cost per worker. The total cost of the project becomes Rp 48,311,600,386.68, Rp 207,158,924.8 cost difference.

### 4. Conclusion

It brings 3D modeling with Revit Structure 2019 which can provide information on each of their material and can be seen from all the looks. From calculations using the assistance software Revit Structure 2019 obtained the result total volume of Revit Structure 2019 for structural column amounted to 1,151,596.35 kg than structural truss of 344,768.32 kg. Obtained results the installation cost and Assembly with the approach of the regulation of the Ministry of PUPR 2016 Year of Rp 31,875.13/kg. The duration of the normal time was 570 days, after a simulation acceleration generated by the approach of the Critical Path Method (CPM) time duration be 475 today with the addition of acceleration time 4 hours/day. By the time the effectiveness of work in the field, it brings the cost of wages based on age, work experience, and education on each group of workers. Based on the age of 20 years: < 94.74%, 20-30 years of < 91.87%, 30-40 years of < 82.54%, based on work experience of 2 years: < 95.45%, 2-5 years of 90.43% <, 5-10 years of 85.17% <, based on education: Elementary School, Junior High School of 94.50% of 89.95%, and Senior High School of 71.77%. Of the cost of wages based on the effectiveness of workers and increased hours accelerated, it brings the total cost of the project amounted to Rp 48,311,600,386.68.
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