

Implementation Building Information Modeling (Bim) 5D In Development Project of The Dakwah Building Campus 2 UIN Antasari Banjarbaru

Husnul Khatimi¹, Muhammad Rodlin Afif²

^{1,2}Department of Civil Engineering, Faculty of Engineering,
Lambung Mangkurat University, General A. Yani Road, Km. 36
Banjarbaru

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Abstract — In the world of construction, the calculation of cost estimates by planning consultants plays an important role in implementing tenders. The cost estimate calculated by the planning consultant after being reviewed by the authorities will be determined as the owner estimate (OE) as a reference for assessing the fairness of the price to determine the upper limit for legal bids. This inaccuracy in calculating the volume of work will impact cost overruns if the calculated quantity is too large and a decrease in building quality if the calculated quantity is too small. However, with the development of technology, the calculation of work quantity can be done quickly and efficiently with Building Information Modeling (BIM). This study will discuss the comparison of the estimated cost of BIM-based cost estimation with the calculation of the cost estimate manually on the building structure of the Dakwah Building Campus 2 UIN Antasari Banjarbaru. Building structure modelling includes modelling of reinforced concrete, formwork, piles, and steel. Modelling is done using software Tekla Structures with a South-East Asia environment that refers to the plan drawing. The output of this modelling is direct cost estimation for structural work, while manual cost estimation is calculated using Microsoft Excel. The price of the work unit used in calculating the estimated cost refers to the AHSP / HSPK of Banjarbaru City in 2020. From the analysis of the two cost estimates, a very small cost difference comparison is produced. The difference between manual cost estimation and BIM-based cost estimation is 1.4%. Based on these results, it can be said that the use of BIM-based cost estimation is reliable because it produces a more efficient cost estimate and is not far from manual calculations.

Keywords — BIM-based cost estimation, Tekla Structures, building structures

I. INTRODUCTION

With the development of technology, the calculation of the volume of work can be done quickly and efficiently, namely Building Information Modeling (BIM). The application of BIM in a development project can be utilized starting from the concept planning stage until the project is completed[1]. With BIM, building modelling can be carried out realistically according to conditions in the field. BIM can detect a mismatch in the modelling based on the plan drawing so that the user can easily adjust the modelling so that it can be applied in the field. After the modelling has been completed, BIM can provide information in the form of work volume, which is used as a bill of quantity in the tender.

II. LITERATURE REVIEW

A. Information Modeling (BIM)

Building Information Modeling (BIM) is an information technology that can study buildings without building them first. BIM is a system, management, method, or sequence of work on a project applied based on related information from all aspects of the building being managed and then projected into a 3-dimensional model. All the building information is attached, which serves as a means of planning, designing, building, and maintaining the building and its infrastructure for all parties involved in the project, such as consultants, owners, and contractors.[2]–[10]

B. Bill of quantity (BQ)

The stages of the detailed cost analysis process must observe design drawings, identify building component items, and calculate the volume and area of each building component item, generally said BQ (Bill of Quantity). The process of identifying BQ is quite time-consuming and requires adequate technical skills. Even though the estimation of housing costs or other construction costs is accurate or not, depending on the BQ data, BQ can be completed if the picture design was drawing there. [11]–[13]



C. Quantity Take-off (QTO)

The activity of producing a quantity take-off can be done using the BIM method. Quantity take-off is not without purpose as it is an important part of the construction process. In the initial stage, it is used to estimate the initial cost. It is used to decide whether a project will be realized or not. In the tender, the quantity take-off quantity is applied with a more accurate cost estimation and the basis for selecting the contractor.[14]–[18]

D. Cost Estimation

Detailed cost estimation is generally referred to as the process of predicting project costs at the work level based on detailed design drawings/documents and defined construction methods/specifications. During this process, defining the scope of the construction project and establishing a Work Breakdown Structure (WBS) is the first step. Then, the take-off quantity is surveyed according to the detailed design drawings or Building Information Modeling (BIM). Next, direct cost is obtained by multiplying a quantity by unit cost; Other costs, such as indirect costs, are calculated by taking a percentage of the direct costs. Finally, project costs are calculated by adding up direct costs with other costs. [19], [20]

E. Similar Research

Similar research is a source of reference for the author to determine the difference in using BIM 5D in various research objects. Three similar studies as a reference in completing the author's research, as follows:

Table 1. Research by[21]

Researcher	Title Research	Results
Isti Ari	Application of BIM (Building Information Modeling) For the Analysis of Work Volume at the DPRD City Building Office of Banjarbaru The	volume obtained from the results of the volume comparison analysis using BIM and manual methods obtained the percentage comparison of 1.37% with the smallest difference value of 0% and the largest difference value of 8.33. %.

Table 2. Research by[22]

Researcher	Title research	Results
Muhammad Reza Fardian	Effectiveness of the Implementation of BIM (Building Information Modeling) Based Cost Estimation in the Syamsudin Noor Airport Development Project, Banjarmasin	The difference in the estimated cost of steel roof structures based on manual calculations with BIM-based costs Estimation using Revit ranges from a percentage of 14% - 20%.

Table 3. Research by[23]

Researcher	Title Research	Results
Hana Regina Carelia	Effectiveness of the Implementation of BIM (Building Information Modeling) for Project Cost Analysis Banjarbaru District Head Office.	The percentage difference in cost obtained between the initial volume and the effectiveness of BIM in the Banjarbaru District Office project was 6.1%.

III. TYLERESEARCH METHODOLOGY

The object taken in this study is the Construction Project of the UIN Antasari Campus 2 Da'wah Building which was carried out by PT. PP (Persero) Tbk, located in Landasan Ulin Tengah Sub-District, Liang Anggang District, Banjarbaru City, South Kalimantan. This building has a total floor area of 3,021.7 m2 consisting of 3 floors and 1 floor without a roof. The work of the Da'wah Building structure covered 23.52% of the total construction cost. This study focuses more on the structural part of the building because it adapts to the software used, namely Tekla Structures as BIM software which specializes in modelling building structures in more detail.

The data used in this study is only secondary data, namely data that has been previously available. Secondary data used in this research are:

1. Plan drawing as a basic reference in 3D modelling. The files obtained are in the form of CAD DWG files.
2. Job Description, as a reference for calculating the volume of work.
3. AHSP / HSPK of Banjarbaru City in 2020, as unit price data to be inputted in calculating the estimated cost.

This research begins with processing 3D modelling based on the reference plan image. After that, take-off quantity and

input the unit price according to the type of work into the software Tekla Structures to get a cost estimate (BIM-based cost estimation/ 5D). Job description data obtained from the project are used as a reference in calculating the volume of work manually. After obtaining the volume of work manually, then the data is processed by inputting the unit price of work so that it produces a cost estimate manually using Microsoft Excel. After obtaining cost estimates using BIM and manual cost estimates, the two results are compared, and conclusions are drawn. The research flow diagram can be seen in Figure 1.

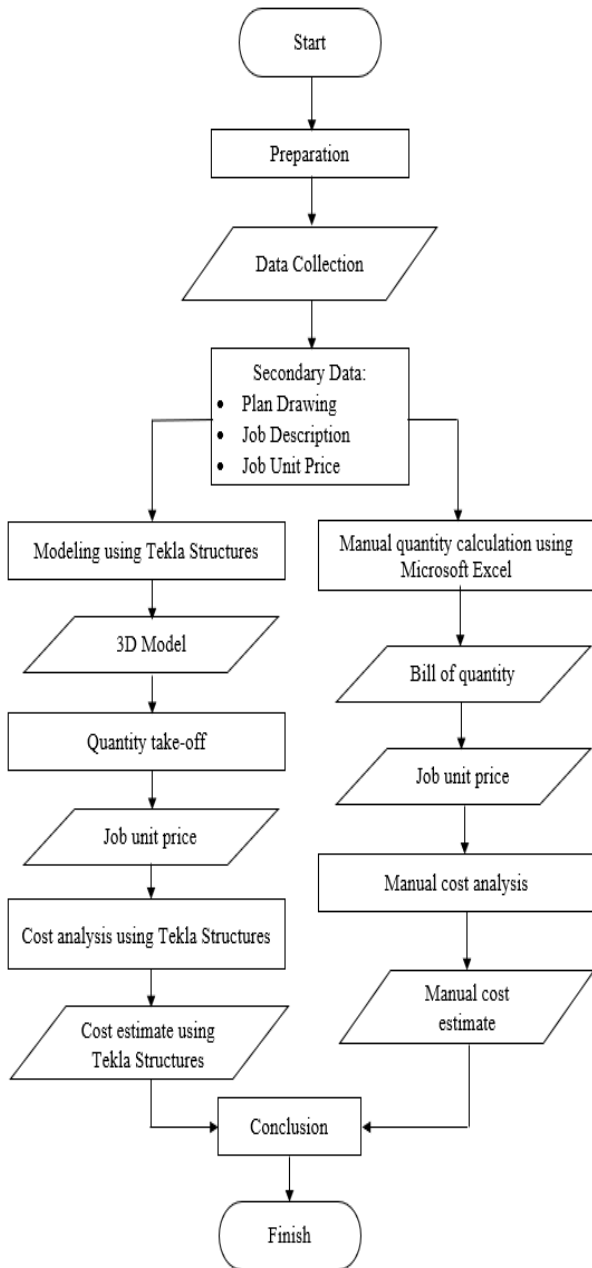


Fig. 1 Research flow diagram

IV. RESULTS AND DISCUSSION

A. Modelling

Modelling was created using Tekla Structures 2020 in a South-East Asia environment because the project location is in the Southeast Asia region. Before making modelling, first, a grid is made according to the plan drawing as a basic reference in making modelling. Next is to create a view by the grid that has been made to make modelling easier. Modelling made is part of the building structure, which includes foundation, tie beam, column, beam, floor plate, stairs, formwork, and steel. The results of building structure modelling can be seen in Figure 2.

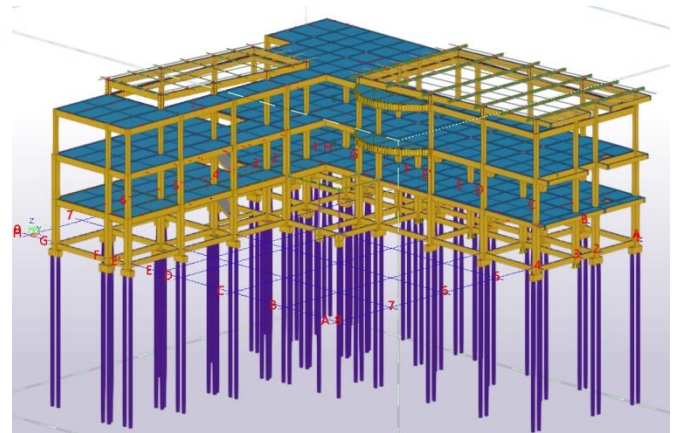


Fig. 2 Modeling results of building structures

B. Input Unit Price Work

Price refers to the unit price of work issued by the Banjarbaru City Government in 2020. The unit price required is for concrete casting, ironwork, formwork, piles, and steel materials. After getting the price for each job, then input the price for the material that has been modelled on the section User-defined attributes.

C. Tekla Structures Cost Estimation Output

Output cost estimation using Organizer grouped by type of work. The cost estimation output is grouped into the estimated cost of concrete work, ironing, formwork, piles, and steel profiles. Before exporting cost estimates, each cost estimate should be grouped by name so that output will be generated according to the type of job description. Output cost estimates derived from modelling entered by job descriptions that summarize the results obtained in Table 4.

Table 4. The estimated cost of Tekla Structures

Job Description	Total Bim Price
FOUNDATION	Rp642.741.693,42
1 ST FLOOR STRUCTURE	Rp1.108.256.934,68

2 nd FLOOR STRUCTURE	Rp2.476.154.734,26
3 rd FLOOR STRUCTURE FLOOR	Rp2.278.210.535,55
ROOF FLOOR STRUCTURE	Rp1.285.505.293,48
STEEL STRUCTURE	Rp859.221.610,37
Total	Rp8.650.090.801,76

D. Manual Cost Estimation Calculation

Cost estimation is calculated by multiplying the volume and unit price using the help of Microsoft Excel. Volume is obtained by calculating the geometric area of the object under review by the unit volume of each work. The dimensions of the geometric planes are obtained or measured manually from the plan drawing. Calculation of the volume of work varies, depending on the work unit, geometric shape, and standard details. The results of calculating the cost estimation manually can be seen in Table 5.

Table 5. Manual cost estimation

Job Description	Total Manual Price
FOUNDATION	Rp. 641,612,113.01
1 st FLOOR STRUCTURE	Rp1,128,290,525.67
2 nd FLOOR STRUCTURE	Rp2,519,235,671.56
3 rd FLOOR STRUCTURE	Rp2,318,792,720.80
ROOF FLOOR STRUCTURE	Rp1,304,161,653.39
STEEL STRUCTURE	Rp858,303,656.40
Total	Rp8,770,396,340.82

E. Discussion

Cost estimation is calculated by multiplying the volume and unit price using the help of Microsoft Excel. Volume is obtained by calculating the geometric area of the object under review by the unit volume of each work. The dimensions of the geometric planes are obtained or measured manually from the plan drawing. Calculation of the volume of work varies, depending on the work unit,

geometric shape, and standard details. The results of calculating the cost estimation manually can be seen in Table 5.

a) How to Input Unit Price in Modeling Tekla Structures does not provide a column for inputting unit price values on User-defined attributes. One way to input unit price values is by installing the UDA plug-in list on Tekla Warehouse. However, after trying a plug-in to install them, use it cannot define attributes simultaneously with multiple objects. Using the UDA list can only define the attributes of an object by selecting them one by one. This method is very time-consuming when inputting unit price values using this plug-in, considering that the object being modelled reaches tens of thousands of items. Therefore, to input the unit price value, it is done by utilizing the available User-defined attributes. Attributes with the numeric format are selected to input the unit price of work so that the input value can be processed mathematically. One of the attributes with a numeric format is the Utility ratio on the Analysis tab, as in Figure 3.

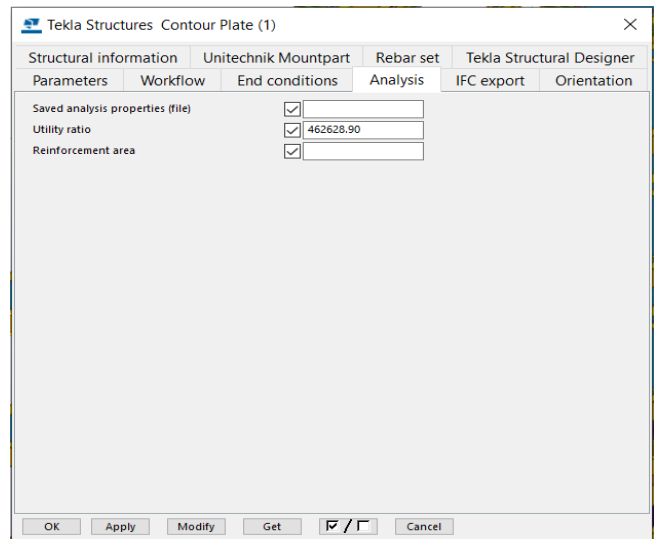


Fig. 3 Inputting unit price values for workers

b) How to Produce Output Tekla Structures Cost EstimationTo produce a cost estimate, a mathematical process is needed by multiplying the volume by the unit price of work so that the total price is generated. Producing data output at volume, unit price, and total price can only be done using the Organizer. The Organizer has an advantage over Reports, namely the ease of generating custom data output according to user needs. The Organizer can make a formula for the amount of price that multiplies the volume and the unit price of work so that the resulting output can be directly in the form of a cost estimate. The results of the organizer for estimating concrete casting costs can be seen in Figure 4.

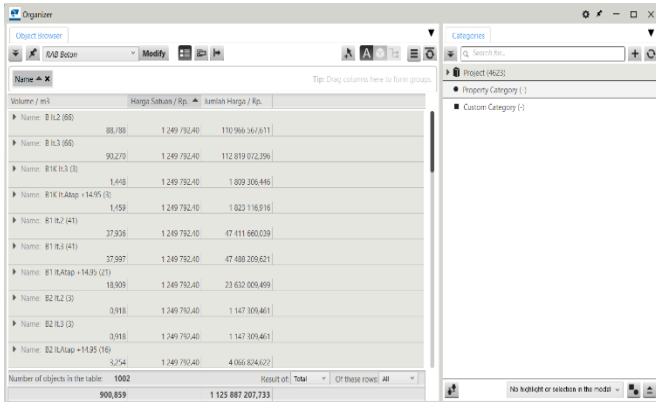


Fig. 4 Organizer for estimating concrete casting costs

c) Comparison of the Difference between Tekla Structures' Cost Estimates and Manual Cost Estimates

Table 6. Comparison of cost estimates

Job Description	Manual Prices	Bim Prices	Difference
Foundation	Rp641,612,13,01	Rp642,741,693.42	-0.2%
1 st Floor Structure	IDR 1,128,290,525,67	Rp1,108,256,934.682	1.8%
2 nd Floorstructure	Rp2,519,235,671.56	Rp2,476,154,734.263	1.7%
3 rd Floor Structure	Rp2,318,792,720.80	Rp2,278,210,535.55	1.8%
Roof Floor Structure	Rp1.304.161.653,39	Rp1.285.505.293,48	1.4%
Steel Structures	Rp858.303.656,40	Rp859.221.610,37	-0.1%
Total	Rp8.770.396.340,82	Rp8,650,090,801.76	1.4%

Based on Table 6. the results of the comparison of the difference in the number of prices between manual calculations and the output of Tekla Structures as a whole do not show a significant difference, which is only 1.4%. The work of reinforced concrete structures on floors 1 to floor 3 shows a similar price difference, which is around 1.8%. The floor structure work on the roof did not show a lower difference, namely 1.4%. Meanwhile, the foundation and steel

structure work show the lowest price difference, which is about 0.1% higher than the price-output of Tekla Structures.

V. CONCLUSIONS

A. Conclusion

- The estimated cost of the structure of the Campus 2 Da'wah Building Construction Project at UIN AntasariBanjarbaru using the software is BIM Tekla Structures Rp. 8,650,090,801.76.
- The difference in the estimated cost of the structure of the Campus 2 Da'wah Building Construction Project at UIN AntasariBanjarbaru based on manual calculations with BIM-based cost estimation using Tekla Structures is 1.4%. So it can be concluded that BIM-based cost estimation is reliable because it produces a more efficient cost estimation and is not far from manual calculations.

B. Suggestions

- It is hoped that Trimble as the developer of Tekla Structures, can improve the plug-in UDA List so that attributes can be defined with many objects at once. Also, another obstacle that the author encountered was the Formwork plug-in that did not appear on Application & Components after it was installed, so the formwork had to be made manually.
- In Tekla Structures, there is a CMU Tools plug-in for modelling brick walls that can be used for further research.
- Implementation of BIM 4D related to scheduling can be used as a topic for further research.

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