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ESTIMATION OF COST BUDGET PLAN CALCULATIONS USING BIM (BUILDING INFORMATION MODELING) BASED APPLICATIONS IN THE PROJECT OF MITRA KASIH FOUNDATION JUNIOR HIGH SCHOOL BUILDING

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ABSTRACT

In the implementation of construction, cost estimation is important in planning future projects. There is a technology with a concept that helps in calculations to be more efficient, namely Building Information Modeling (BIM). The research raised the comparison of the efficiency of using BIM based cost estimation using Tekla Structures to manual cost estimation in the building structure of the Mitra Kasih Foundation Junior High School Building.

Modeling is carried out using Tekla Structures software. The output of the designed modeling is in the form of an estimate of the cost of structural work, while the manual cost estimate is calculated using Microsoft Excel software.

From the results of the second analysis of cost estimates, a cost difference comparison of 10,62% was generated. Based on these results, the use of BIM based cost estimation is reliable because it produces a more efficient cost estimate which is more efficient than manual calculations.

Keywords: BIM based cost estimation, Tekla Structures, building structures

1. INTRODUCTION

There are some errors or errors in estimating the calculation of the cost budget plan. Teknology which is used as a tool in calculating the volume of work to make it more effective and efficient, namely Building Information Modeling (BIM) (Minawati et al., 2017).

The use of BIM can be applied from the initial stage until the project has been completed (Hatmoko et al., 2020). The obligation to implement BIM as a method of implementing building construction for technological & cost efficiency project work based on Government Regulation (PP) Number 16 of 2021 & Permen PUPR No. 22 2018.

The use of BIM really needs to be applied to projects because in addition to cost and time efficiency, but also as stated in the Pupr Regulation No. 22 of 2018 that this Junior High School project has an area above 2000 m^2 and above two floors. The review studied

in this final project is the work of reinforced concrete structures on the building of the Mitra Kasih Foundation Junior High School Building.

2. THEORITICAL STUDY

2.1 Bill of Quantity

A bill of quantity is a document in the form of a description of items and a calculation of the volume of work of a project. A bill of quantity is posted on the tender document for bidders to enter bids based on items and volumes of work indicated on the basis of their own version of the price. The Bill of quantity makes it easy to input data to be effective and makes it easier to recheck.

2.2 Quantity Take Off

Quantity take off is an estimate of the quantity of the cost budget plan calculation roughly. Accurate quantity take off can increase material efficiency according to actual circumstances. It needs accuracy in calculating the quantity of take off.

2.3 Cost Budget Plan (CBP)

CBP is an estimate of the amount of expenditure (cost) of the type of work that corresponds to the bestek drawings and requirements of a construction building. The CBP is made with the function of knowing how much the cost plan is needed in the work on the activity, knowing the required volume, as well as as a requirement in the proposal document for the proposed implementation of the activity. Through the CBP, we can calculate and know exactly how much it costs to erect a building according to the owner's request.

2.4 Building Information Modeling (BIM)

Building Information Modeling (BIM) is a means or concept in the form of an approach to understanding a building using digital modeling (Minawati et al., 2017). Technicalrequirements and good performance will have an impact on information requirements because it defines what can be done with the model rather than how the database is built (Eastman et al., 2011).

2.5 Tekla Structures

In calculating the estimated cost, Tekla Structures utilizes a feature, namely Organizer. The use of features from the Organizer aims to produce a calculation consisting of several formula properties. The collection of various formula properties will be arranged into a sequence of rows and columns called browser objects. From the object browser, you can see a table containing the calculation of estimated costs.

3. METODE

3.1 Research Location

The research was conducted on the construction project of the Mitra Kasih Banjarmasin Junior High School Building, which is located inside the Citraland Housing Complex Jalan A. Yani Km. 7.8 Pemurus Dalam, Kertak Hanyar District, Banjar Regency, South Kalimantan.

Figure 1. Research Location

3.2 Research Data

In this study, secondary data was used in the form of work drawing data from the project containing the type and reinforcing (pile cap, pile, column, tie beam, beam, floor plate, and ladder), each floor plan, as well as a list of work items in the form of Bill of Quantity. Another secondary data is the AHSP / HSPK (basic price) of Banjar Regency in 2020.

3.3 Stages of Research

The stages carried out in this study are:

1. Preparation by studying Tekla Structures software, determining problem identification, and taking care of administration to obtain data.
2. Collection of data that has been obtained from the project and AHSP / HSPK data.

3. Data processing by modeling with Tekla Structures and manual volume calculations with Microsoft Excel.

4. RESULT AND DISCUSSION

4.1 Modeling

3D modeling using Tekla Structures. The initial step is to set up the grid. Next, set the concrete material in the Catalogs. The quality of concrete consists of K-300 and K-450. For 3D modeling, it can be seen in Figure 2 to Figure 7. For reinforcing can be seen in Table 1 to Table 7.

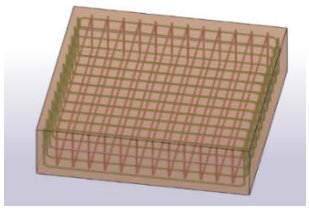

Figure 2. Pile Cap Modeling

Table 1. Pile Cap Reinforcing

Properties	Input
Type	Tapered N
Number of cross sections	2
Name	Pile Cap Rebar
Grade	SD400
Size	16 mm and 13 mm (main reinforcement); 10 mm (locking reinforcement)
Spacing	150 mm

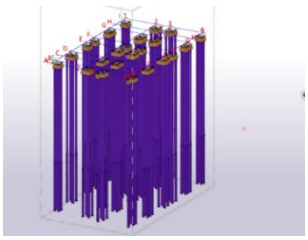

Figure 3. Pile Modeling

Table 2. Pile Properties

Properties	Input
Name	TP Upper; TP Middle; TP Bottom
Profile	400*400
Material	K450
Class	14
Top	-1900 mm; -13900 mm; -25900 mm
Bottom	-13900 mm; -25900 mm; -37700 mm
Cast unit numbering	TPU, TPM, TPB; 1
Cast unit	Precast

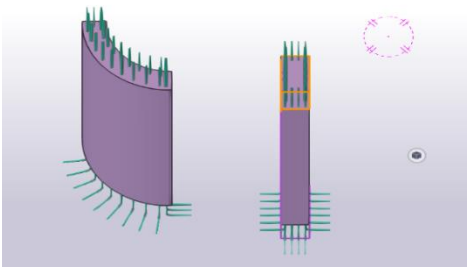

Figure 4. Column Modeling

Table 3. Column Reinforcing

Properties	Input
Name	Column reinforcement, column type, floor position
Grade	T ; SD400
Size	8 (T); 10,13,16,19 (SD400)
Class	5 (main reinf.), 4 (stirrup reinf.), 8 (bridle reinf.)

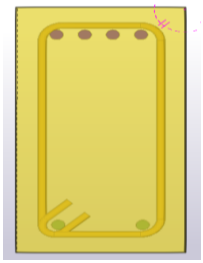

Figure 5. Tie Beam Modeling

Table 4. Tie Beam Reinforcing

Properties	Input
Name	Tie beam reinforcement, tie beam type, floor position
Grade	T ; SD400
Size	8 (T); 10,13,16 (SD400)
Class	14 (upper main reinf.), 3 (lower main reinf.), 13 (stirrup reinf.), 2 (bridle reinf.)

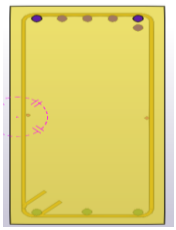

Figure 6. Beam Modeling

Table 5. Beam Reinforcing

Properties	Input
Name	Beam reinforcement, beam type, floor position
Grade	T ; SD400
Size	8 (T); 10,13,16,19,22 (SD400)
Class	14 (upper main reinf.), 3 (lower main reinf.), 13 (stirrup reinf.), 2 (bridle reinf.)

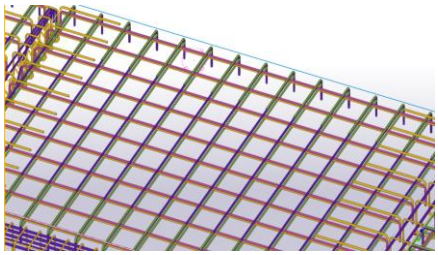

Figure 7. Floor Plate Modeling

Table 6. Floor Plate Divider Reinforcement Reinforcing

Properties	Input
Name	Plate reinforcement, plate type, floor position
Grade	T
Size	10
Class	1

Figure 8. Reinforcing Floor Plate

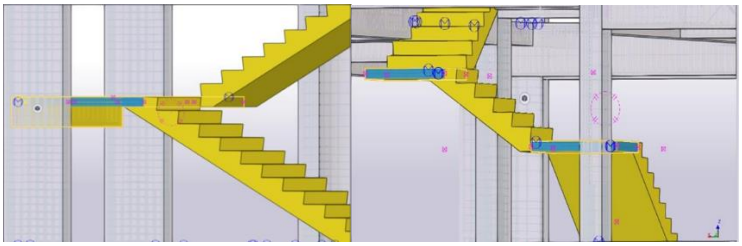

Figure 9. Stair Modeling

Table 7. Staircase Reinforcing

Properties	Input
Name	Ladder reinforcement, floor position
Grade	T ; SD400
Size	8,10,13 (ladder); 13 (plate); 8,16 (bordes beam)
Class	5, 9, 10, 11, 13, 14 (ladder); 3, 9, 13, 14 (plate); 14 (upper main landing beam reinf.), 3 (bottom main landing beam reinf.), 13 (stirrup reinf. of bordes beams), 2 (bonding reinf. for bordes beams)

4.2 Cost Estimation

Calculation of cost estimation in Tekla Structures using the Organizer feature. While the calculation of cost estimation manually uses Microsoft Excel. The job step starts from calculating the AHSP/HSPK according to Table 8. Furthermore, input the unit price in Tekla with the User-defined attributes tool as shown in Figure 10. Then click the Organizer feature and set the division of work items as shown in Figure 11. The results of the comparison of the cost of work based on manual calculations with BIM are listed in Table 9. The difference in comparison is in the form of percentages.

A.4.1.1.9. Making 1 m3 of concrete quality f'c = 24 MPa							
A	LABOR						
	worker	L.01	OH	1,650	Rp	130.000,00	Rp 214.500,00
	masonry	L.02	OH	0,275	Rp	175.000,00	Rp 48.125,00
	chief handyman	L.03	OH	0,028	Rp	225.000,00	Rp 6.300,00
	foreman	L.04	OH	0,083	Rp	210.000,00	Rp 17.430,00
						number of labor	Rp 286.355,00
B	MATERIAL						
	portland cement			kg	406,000	Rp 3.000,00	Rp 1.218.000,00
	concrete sand			kg	684,000	Rp -	Rp -
	gravel (max 30mm)			kg	1026,000	Rp -	Rp -
	water			liter	215,000	Rp -	Rp -
						number of material	Rp 1.218.000,00
C	EQUIPMENT						
						number of equipment	Rp -
D	TOTAL (A+B+C)						Rp 1.504.355,00
E	OVERHEAD & PROFIT 15% (15% x D)						Rp 225.653,25
F	BASIC PRICE WORK (D+E)						Rp 1.730.008,25

A.4.1.1.17. 10 kg reinforcing with plain iron or trimmed iron							
A	LABOR						
	worker	L.01	OH	0,070	Rp	130.000,00	Rp 9.100,00
	blacksmith	L.02	OH	0,070	Rp	175.000,00	Rp 12.250,00
	chief handyman	L.03	OH	0,007	Rp	225.000,00	Rp 1.575,00
	foreman	L.04	OH	0,004	Rp	210.000,00	Rp 840,00
						number of labor	Rp 23.765,00
B	MATERIAL						
	rebar (plain/threaded)			kg	10,500	Rp 14.000,00	Rp 147.000,00
	concrete wire			kg	0,150	Rp 35.000,00	Rp 5.250,00
						number of material	Rp 152.250,00
C	EQUIPMENT						
						number of equipment	Rp -
D	TOTAL (A+B+C)						Rp 176.015,00
E	OVERHEAD & PROFIT 15% (15% x D)						Rp 26.402,25
F	BASIC PRICE WORK (D+E)						Rp 202.417,25

F.04.c	Per m' of concrete piles o 40 or 40 x 40 cm squares					
A	Labor					
1	Worker	L.01	OH	0,6600	130.000,00	85.800,00
2	Welder	L.02	OH	0,1100	175.000,00	19.250,00
3	Foreman	L.04	OH	0,0660	210.000,00	13.860,00
					Number of Labor	118.910,00
B	Material					
	Concrete piles size 30x30 cm			m	1,00	145.000,00	145.000,00
					Number of Material	145.000,00
C	Equipment					
1	Tripod height 7 m	E.45.b	Rent-day	0,1100	397.000,00	43.370,00
2	Hammer 1 - 2 ton (manual)	E.01.c	Rent-day	0,1100	80.000,00	8.460,00
					Number of Equipment	49.830,00
D	Total Prices for Labor, Materials and Equipment (A+B+C)					313.740,00
E	Overhead + Profit (Example 15%)				15% D	47.061,00
F	Basic Price Work per - m' (D+E)					360.801,00

Table 8. AHSP/HSPK Work Items (Banjar Regency in 2020)

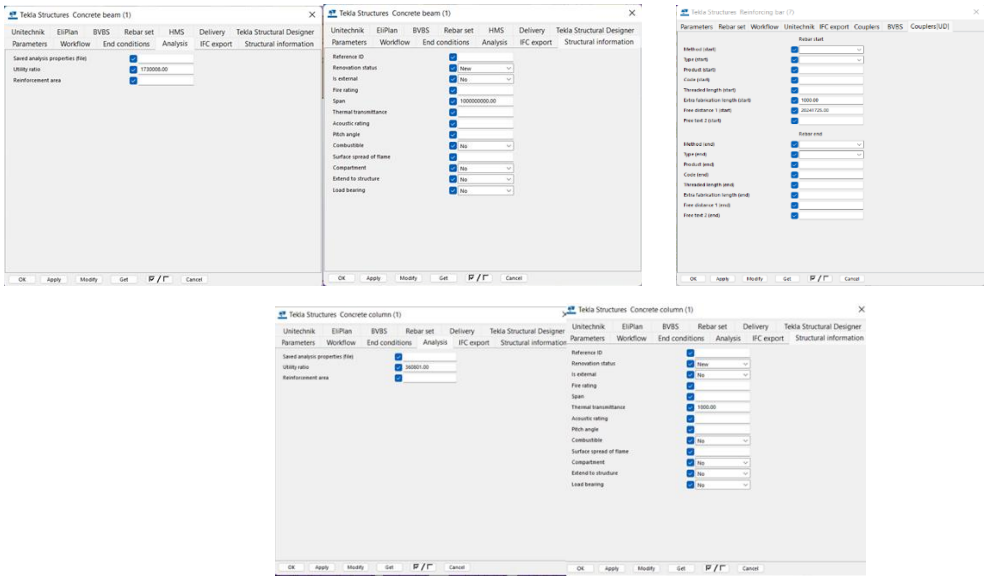

Figure 10. Input Unit Prices Using User-Defined Attributes Tools

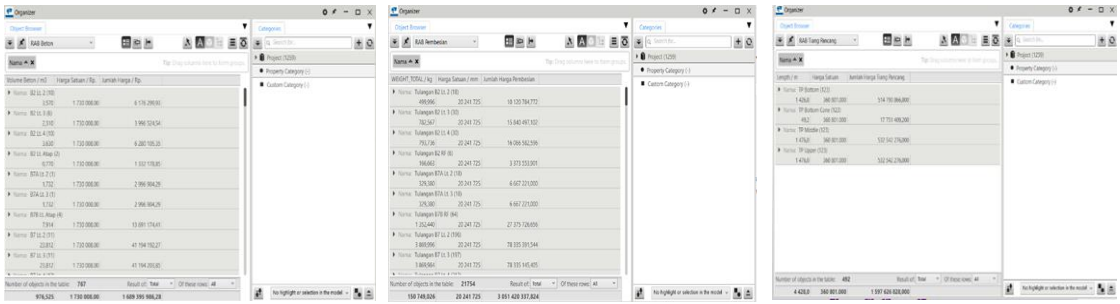

Figure 11. Work Item Cost Estimation Organizer

Table 9. Comparison of Work Costs Based on Manual Calculations with BIM

Job Description	Number of Prices by Manual	Amount of Price Based on BIM	Difference
TOTAL JOBS FOUNDATION	Rp 1,597,626,828	Rp 1,597,626,828	0,00%
TOTAL JOBS STRUCTURE	Rp 5,305,982,875	Rp 4,742,653,763	10,62%

5. CONCLUSION

From this study it can be concluded that:

1. The estimated cost of the structure in the Mitra Kasih Foundation Junior High School Building Construction Project with BIM-based Tekla Structures is worth:
   - Pile Work: Rp 1.597.626.828
   - Concrete Work: Rp 1.689.911.529

- Reinforcing Work: Rp 3.052.742.234
  Total: Rp 6.340.280.591,-

2. The difference in the estimated structure cost in the Mitra Kasih Foundation Junior High School Building Construction Project is based on manual calculations with Tekla Structures software worth Rp 563.329.112,- with a percentage of 10.62%.
3. The difference in the percentage difference in cost estimation calculations between manual calculations and calculations using Tekla Structures software is because Tekla Structures software is more thorough and detailed in calculating modeling volumes.

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