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Calculation of Cost Estimation Based on Building Information Modeling in Construction Projects

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Abstrak

BIM (Building Information Modelling) saat ini merupakan konsep yang dapat mencakup informasi-informasi penting pada perencanaan. Adapun tujuan dari penelitian ini adalah untuk mengetahui kemampuan software yang berbasis BIM dalam melakukan pemodelan 3D hingga perhitungan estimasi biaya, kemudian membandingkan dengan dokumen metode konvensional pada PT. Kosmetika Global Health Indonesia Kawasan Ejip, Cikarang. Pada penelitian ini dilakukan pemodelan 3D struktur baja bangunan berdasarkan pada dokumen shopdrawing dari lokasi penelitian. Selanjutnya dilakukan perhitungan quantity take-off hingga estimasi biaya pekerjaan struktur baja menggunakan software autodesk revit. Dapat disimpulkan bahwa penggunaan software autodesk revit dapat mengoptimalkan proses pemodelan 2D kedalam bentuk 3D sehingga perhitungan quantity take-off dapat lebih detail dan akurat serta mampu mengurangi waste material dan sudah mendukung BIM 5D guna membantu perhitungan estimasi biaya. Hasil perhitungan estimasi biaya yang menggunakan software autodesk revit 3,45% lebih kecil dibandingkan dengan perhitungan konvensional, hal ini karena metode konvensional dihitung secara manual berdasarkan pada gambar 2D yang memungkinkan terdapat perbedaan karena kurang mendetail.

***Kata kunci*:** *BIM, Revit¸ Estimasi Biaya.*

Abstract

BIM (Building Information Modeling) is currently a concept that can include important information in planning. This study aims Kosmetika Global Helath Indonesia, Ejip Area, Cikarang. In this research, 3D modeling of steel structures was carried out based on shop drawing documents from the research location. Next, calculate the quantity take-off for the estimated cost of steel structure work using Autodesk Revit software. It can be concluded that using Auusingit software can optimize the 2D modeling process into the 3D form so that the quantity take-off calculations can be more detailed and accurate and reduce material waste. It also already supports BIM 5D to help calculate estimated costs. The results of calculating estimated costs using Autodesk Revit software are 3.45% smaller than conventional calculations. It is because conventional methods are calculated manually based on 2D images, which allow for differences due to lack of detail.

Keywords: BIM, Revit¸ Cost Estimating.

1. INTRODUCTION

The population growth that occurred in Indonesia has had an impact on the growing number of construction builders. Many projects include housing, shops, hotels, bridges, and so forth (Khamistan, 2018; Liman, Adianto, & Wimala, 2020). It is hoped that these projects will be carried out with optimal processes and consider sufficient construction funds so that there will be no shortage of funds, resulting in stalled building construction (Haider, 2020; Laorent, 2019). Communities as owners of land and buildings are expected to be smart in choosing and managing the construction processes and methods used to suit the objectives and available costs (Agustapraja & Affandy, 2017; Saputra, Hasbullah, & Sukono, 2020)

However, in development planning activities, most construction actors in Indonesia still use conventional methods (Muhammad & Yunus, 2020; Umam, Erizal, & Putra, 2022). Of course, this conventional method is quite behind in terms of time efficiency because the process of processing this conventional method cannot be done simultaneously, and it takes quite a lot of time to make a development plan (Dewi, Yana, & Susilawati, 2019; Jawat &

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Suwitanujaya, 2018). Along with technology development, technology in the construction field is also growing. The presence of BIM (Building Information Modeling) is currently a concept that can include important information that can make it easier to carry out a plan to be built (Troncoso-Pastoriza, López-Gómez, & Lara, 2018; Zahro, Ratnaningsih, & Hasanuddin, 2021). So the quality of the planning will be better. Modeling methods in BIM can also generate 4D, 5D, 6D, and 7D models in addition to 2D and 3D (Mardhani, Ratnaningsih, & Arifin, 2022; Setiami & Maulana, 2021). BIM provides facilities such as 3D for object-based parametric modeling, 4D to provide scheduling information or it can be called a time element, 5D to provide integrated cost estimates from 3D design, 6D to be able to analyze energy in a building, up to the top BIM level, namely 7D, 7D is facility management in a building, this 7D BIM level is for the maintenance stage, and these facilities are already integrated with accurate data (Husin, Sihombing, Kussumardianadewi, & Rahmawati, 2020; M. N, Wang, Wei, Chi, & Ni, 2021). One of the software based on BIM is Autodesk Revit.

Autodesk Revit is software for modeling architectural, structural, mechanical, electrical, and plumbing (MEP) projects. In addition to presenting 2D design working drawings, users can build a building by modeling each component in 3D (Danny Laorent, Nugraha, & Budiman, 2019; Ramadhan & Maulana, 2020). Users can also simulate planning for scheduling or assigning execution phases for each building component while providing schedule details and being able to provide cost estimates (Anjani, Bayzoni, Husni, & Niken, 2022; Rosmyanto, 2022). Therefore, in this study, image modeling was carried out up to the cost estimation stage using Autodesk Revit software. This study aims to carry out 3D modeling to calculate estimated costs with the help of Autodesk Revit software. In this study, the modeling to calculate cost estimation in terms of the steel structural elements of the PT. Global Health Cosmetics Indonesia EJIP Area, Cikarang.

2. METHODS

Data collection was carried out at PT. Global Health Cosmetics Indonesia EJIP Area, Cikarang. The material used is in the form of shop drawing documents. In this study, the implementation of 3D BIM was carried out by modeling the steel structure of the building and calculating estimated costs for implementing 5D BIM with the help of Autodesk Revit software. The outline of this research can be seen in Figure 1.

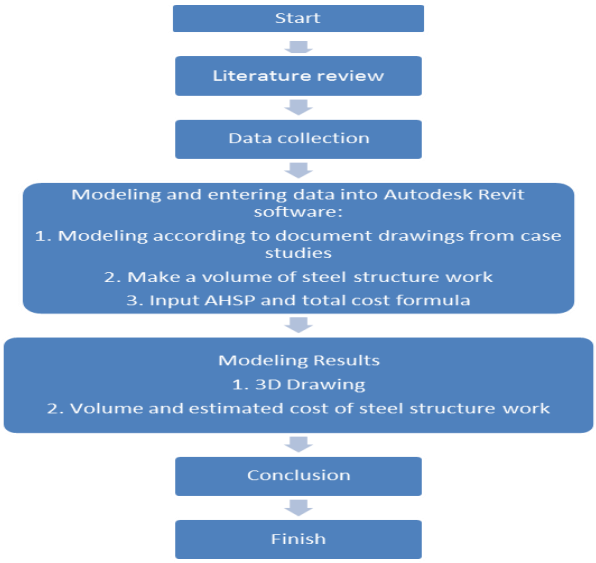


Figure 1. Research Flowchart

The available data is in the form of shop drawing documents of PT. Global Health Cosmetics Indonesia EJIP Area, Cikarang. Furthermore, 3D image modeling was carried out until the implementation of 5D BIM with the help of Autodesk Revit software. The results of modeling and cost calculations are compared with conventional methods. Conclusions are drawn based on differences in estimated cost estimates between BIM and conventional manual calculation methods.

3. RESULTS AND DISCUSSION

Result

3D modeling was carried out based on documents obtained from the case study site. The structural elements of the building being modeled were steel structural work on columns, beams, and steel roofs. The results of 3D modeling using the Autodesk Revit software are shown in Figure 2, Figure 3, Figure 4, and Figure 5.

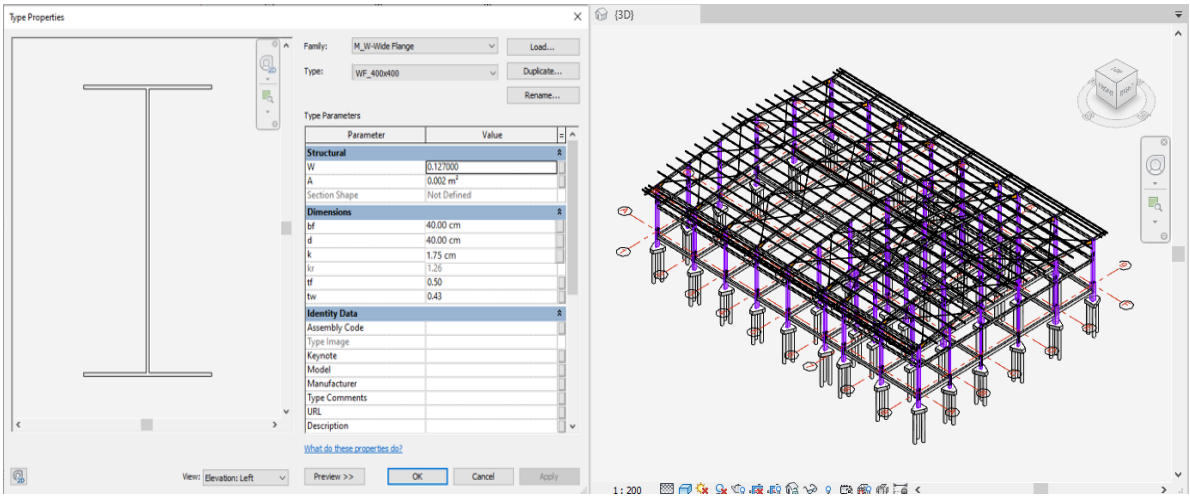


Figure 2. 3D Model of Column Structure

The types of steel columns used are IWF steel 400x400x21x13 for K1-K78 main columns and IWF steel 150x150x7x10 for KG1-KG7 Gable Columns. The total number of columns used is 85 columns. 78 main columns and 7 gable columns.

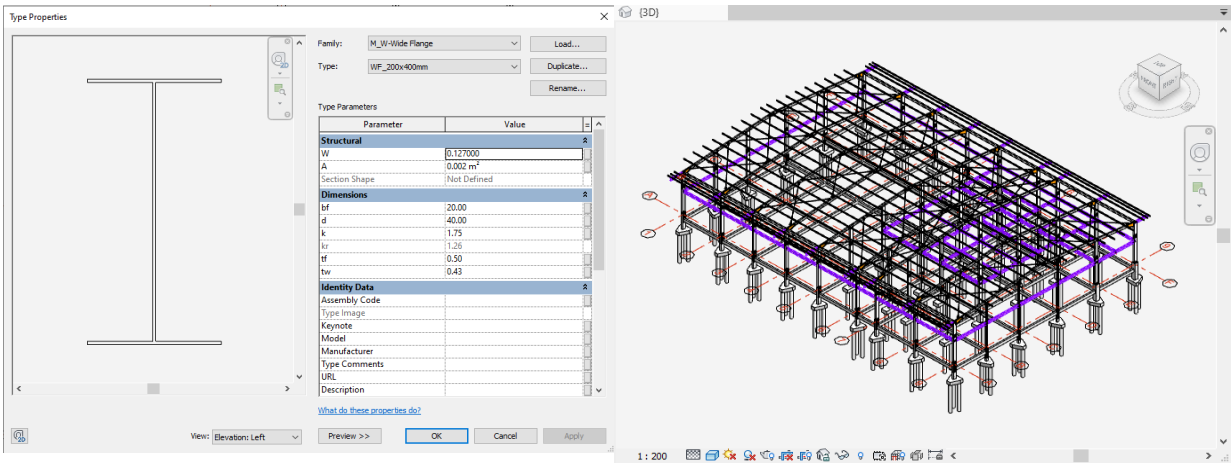


Figure 3. 3D Model of the Beam Structure

The steel beams used are IWF steel 400x200x13x8 for the main beam and 200x150x6x9 for the joists. The total number of columns used is 66 main and 11 joist beams.

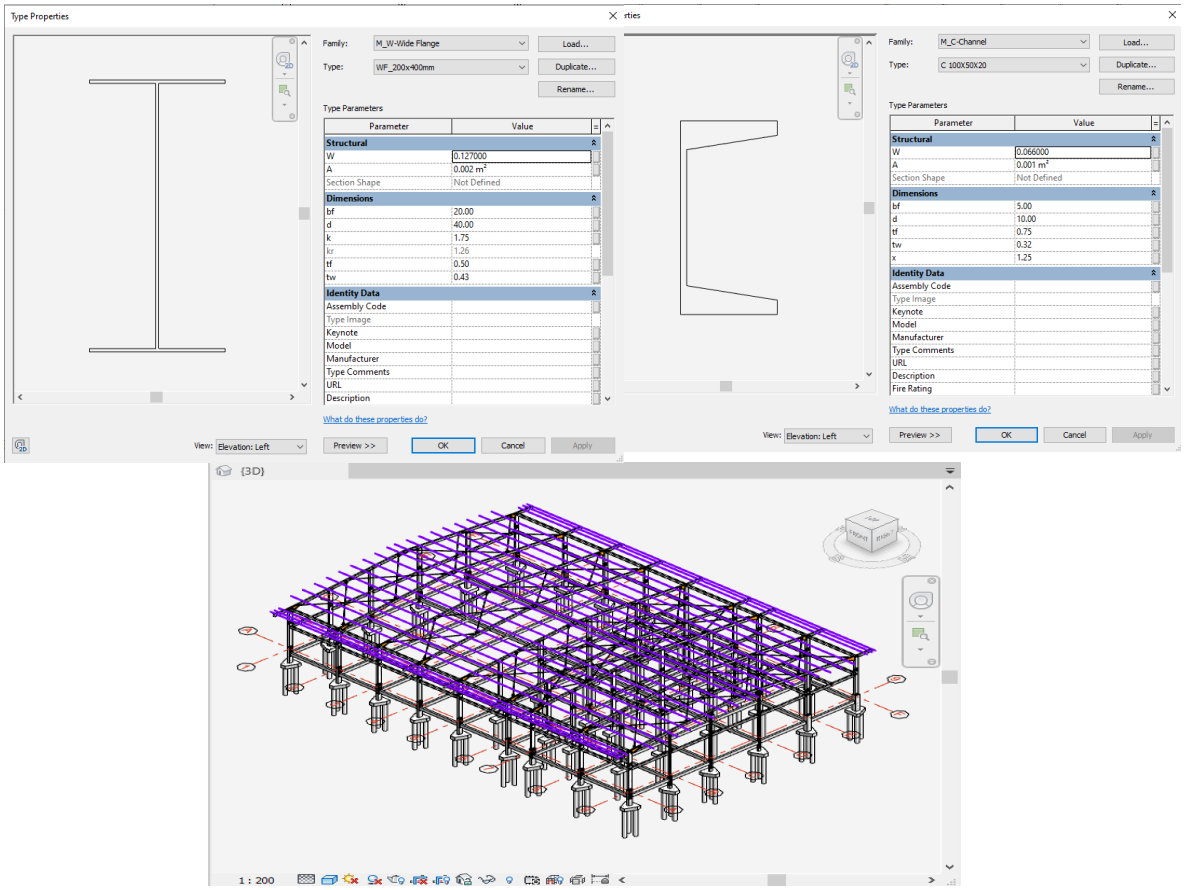


Figure 4. 3D Model of the Roof Structure

Namely steel IWF 400x400x21x13 for the rafter, C 200x75x20x2.3 for purlin, and D16 concrete iron for the brace. The total steel in the roof structure is 58 steel, 34 rafters, 24 purlins, and 40 D16 concrete iron for the brace.

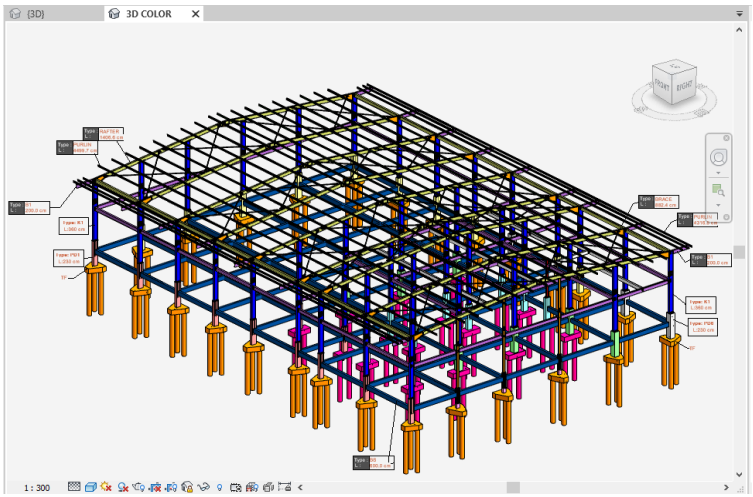


Figure 5. 3D Model of Steel Structure

Based on the 3D BIM image above, it can be concluded that BIM-based modeling can provide important information related to the modeling, information such as the identification of the structural elements used and the coloring of each structural element to make it easier for construction workers to identify each work in carrying out a project development. After the 3D modeling is complete, the application of BIM 5D is carried out. BIM 5D is a cost estimate that has been combined with the 3D object design and can estimate the flow of costs that may be incurred. To find volumes in modeling, Revit already provides a standard BIM software schedule feature for identifying objects or structural elements to make volume calculations easier. As shown in Figure 6.

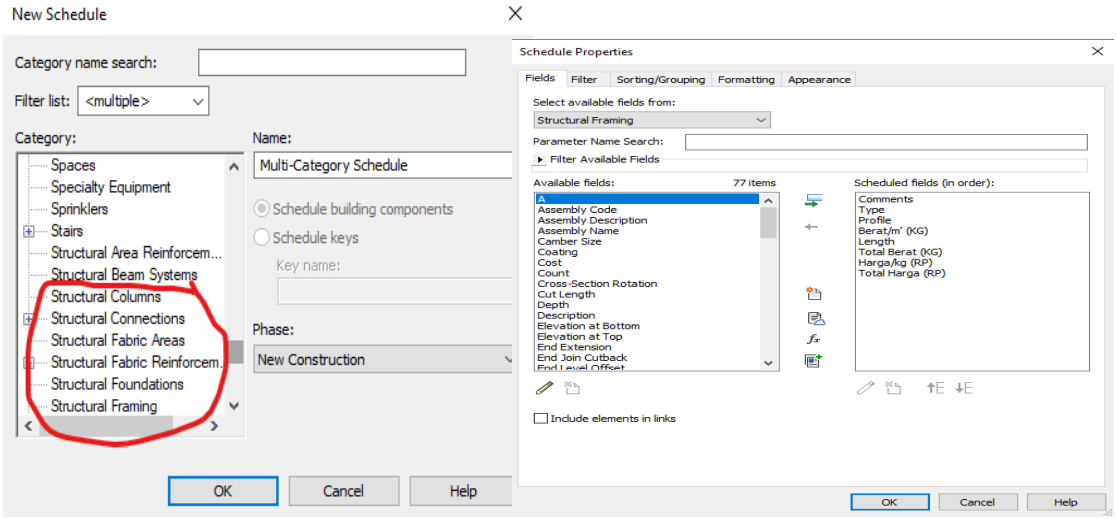


Figure 6. Schedule Identification of Structural Objects

The picture above shows the stages of making a schedule for identifying structural objects whose volumes will be searched. Then input the unit price in the modeling by preparing the AHSP document for steel structure work. AHSP document table data for steel structure work can be seen in Table 1.

Table 1. AHSP of steel structure work

1 Kg WF Profile Steel						
	Description	**Code**	**Unit**	**Coefficient**	**Unit Price (IDR)**	**Price (IDR)** **Total**
A	LABOR					
	Worker	L.01	OH	0.06	105.000	6.300
		L.02	OH	0.06	120.000	7.200
	Blacksmith's Chief	L.03	OH	0.006	130.000	780
	Foreman	L.04	OH	0.003	155.000	465
	Total Labor Prices					14.745
B	MATERIAL					
	WF Steel		Kg	1.1	12.000	13.200
	Welding		Cm	1	2.000	2.000
	Zincromate + Finishing Paint		M2	0.03	32.000	960
	TOTAL PRICES OF LABOR					16.160
C	EQUIPMENT	TOTAL EQUIPMENT PRICE				
D	Total (A+B+C)					30.905
E	General Fees and Profits (Maximum 15%)					3.090

1 Kg WF Profile Steel							
	Description	**Code**	**Unit**	**Coefficient**	**Unit Price (IDR)**	**Price (IDR)**	**Total**
F	Work Unit Price (D+E)					33.995	
1 Kg CNP C-75 Steel							
	Description	Code	Unit	Coefficient	Unit Price (IDR)	Price (IDR)	Total
A	Labor						
	Worker	L.01	OH	0.06	105.000	6.300	
		L.02	OH	0.06	120.000	7.200	
	Blacksmith's Chief	L.03	OH	0.006	130.000	780	
	Foreman	L.04	OH	0.003	155.000	465	
	Total Labor Prices					14.745	
B	MATERIAL						
	CNP C-75 Steel		Kg	1.1	9.000	9.000	
	Welding		Cm	1	2.000	2.000	
	Zincromate + Cat Finishing		M2	0.03	32.000	960	
	TOTAL PRICES OF LABOR					16.160	
C	EQUIPMENT	TOTAL EQUIPMENT PRICE					
D	Total (A+B+C)					26.705	
E	General Fees and Profits (Maximum 15%)					2.670	
F	Work Unit Price (D+E)					29.375	

The AHSP data above is input for each steel structure work item. Then make a formula or formula on the parameters added in the structure object identification schedule. The parameter filled in the formula is the cost parameter to get the value of the total cost of the work. As shown in Figure 7.

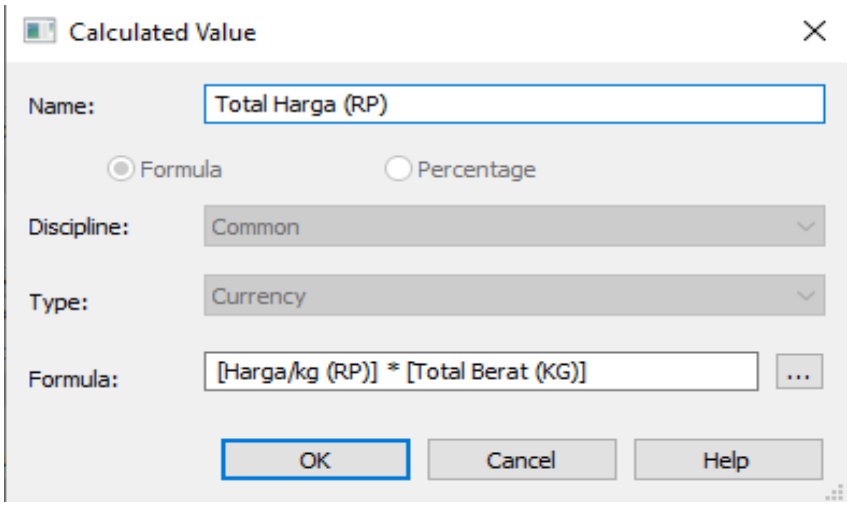
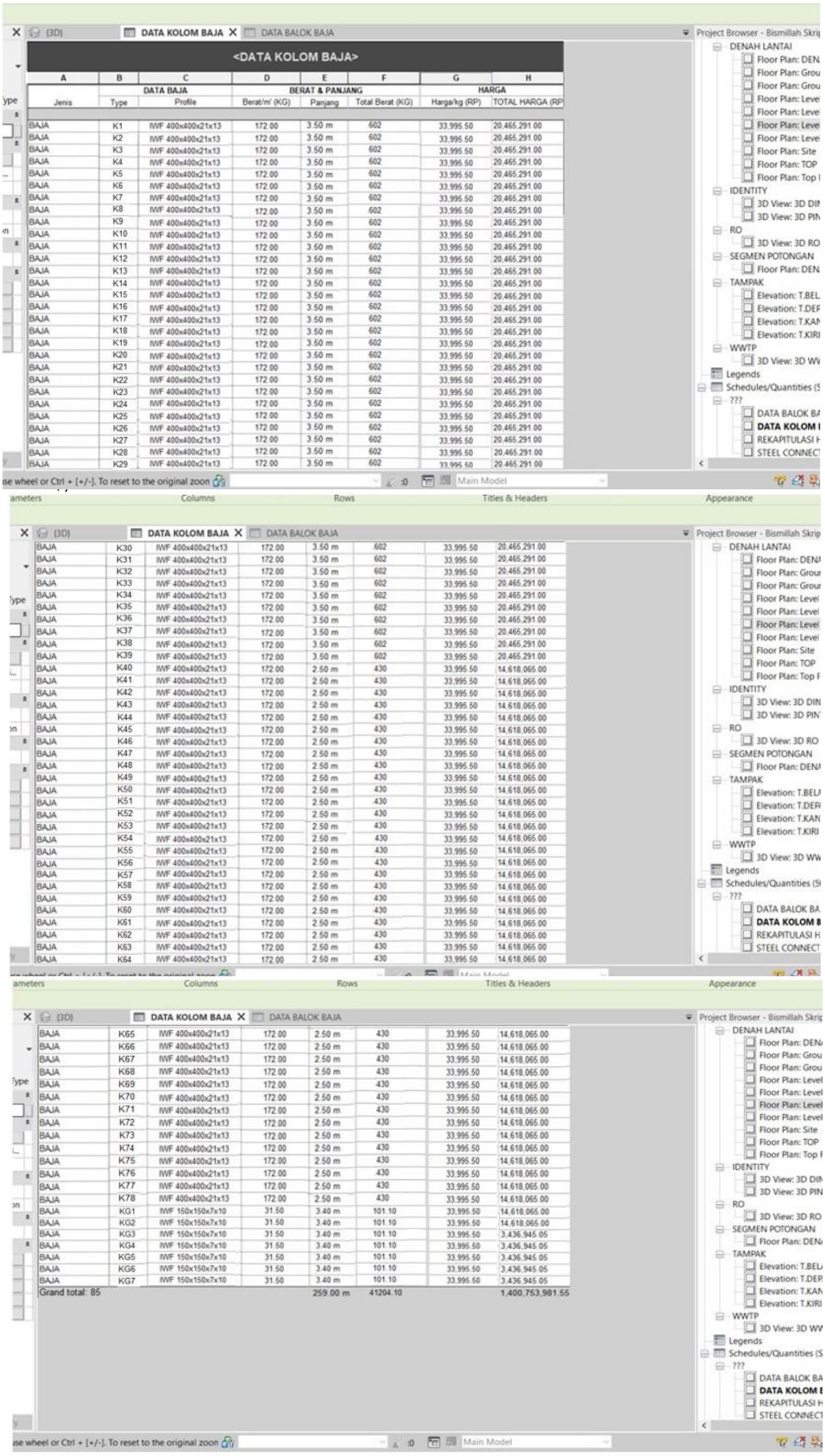


Figure 7. The Formula for Identification Needs

After that, the total price value for each job will automatically appear. The total cost value for each steel structure work can be seen in Figure 8.



<DATA KOLOM BAJA>

A	B	C	D	E	F	G	H
	DATA BAJA		BERAT & PANJANG			HARGA	
Jenis	Type	Profile	Berat/m' (KG)	Panjang	Total Berat (KG)	Harga/kg (RP)	TOTAL HARGA (RP)
BAJA	K1	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K2	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K3	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K4	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K5	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K6	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K7	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K8	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K9	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K10	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K11	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K12	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K13	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K14	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K15	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K16	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K17	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K18	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K19	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K20	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K21	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K22	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K23	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K24	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K25	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K26	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K27	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K28	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K29	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K30	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K31	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K32	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K33	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K34	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K35	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K36	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K37	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K38	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K39	IWF 400x400x21x13	172.00	3.50 m	602	33,995.50	20,465,291.00
BAJA	K40	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K41	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K42	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K43	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K44	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K45	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K46	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K47	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K48	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K49	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
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BAJA	K53	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
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BAJA	K58	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K59	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K60	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K61	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K62	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
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BAJA	K67	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K68	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K69	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K70	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
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BAJA	K72	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
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BAJA	K77	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	K78	IWF 400x400x21x13	172.00	2.50 m	430	33,995.50	14,618,065.00
BAJA	KG1	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	14,618,065.00
BAJA	KG2	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	14,618,065.00
BAJA	KG3	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	3,436,945.05
BAJA	KG4	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	3,436,945.05
BAJA	KG5	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	3,436,945.05
BAJA	KG6	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	3,436,945.05
BAJA	KG7	IWF 150x150x7x10	31.50	3.40 m	101.10	33,995.50	3,436,945.05
Grand total: 85				259.00 m	41204.10		1,400,753,981.55

Figure 8. The Total Cost of Steel Column Structure Work

From the image data above, it is known that the total cost of the steel column structure work was found to be Rp. 1,400,753,951.55. Then the results of the total cost of the steel roof structure work can be seen in Figure 9.

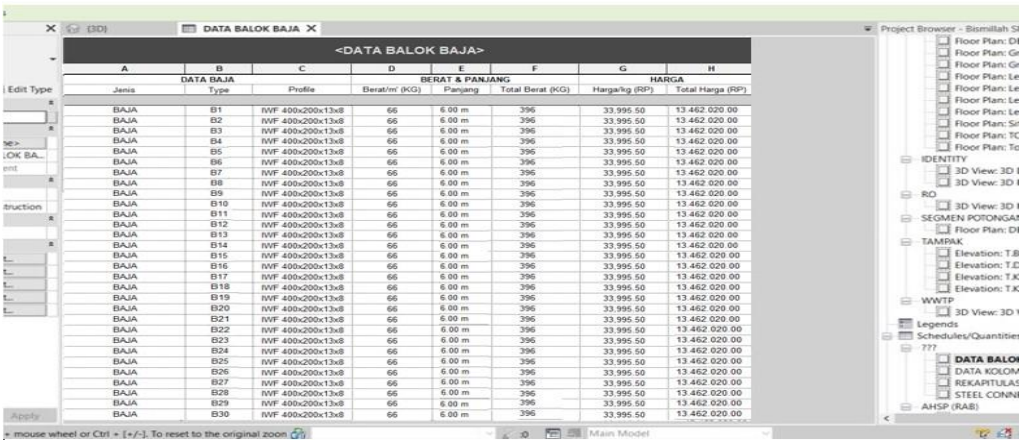
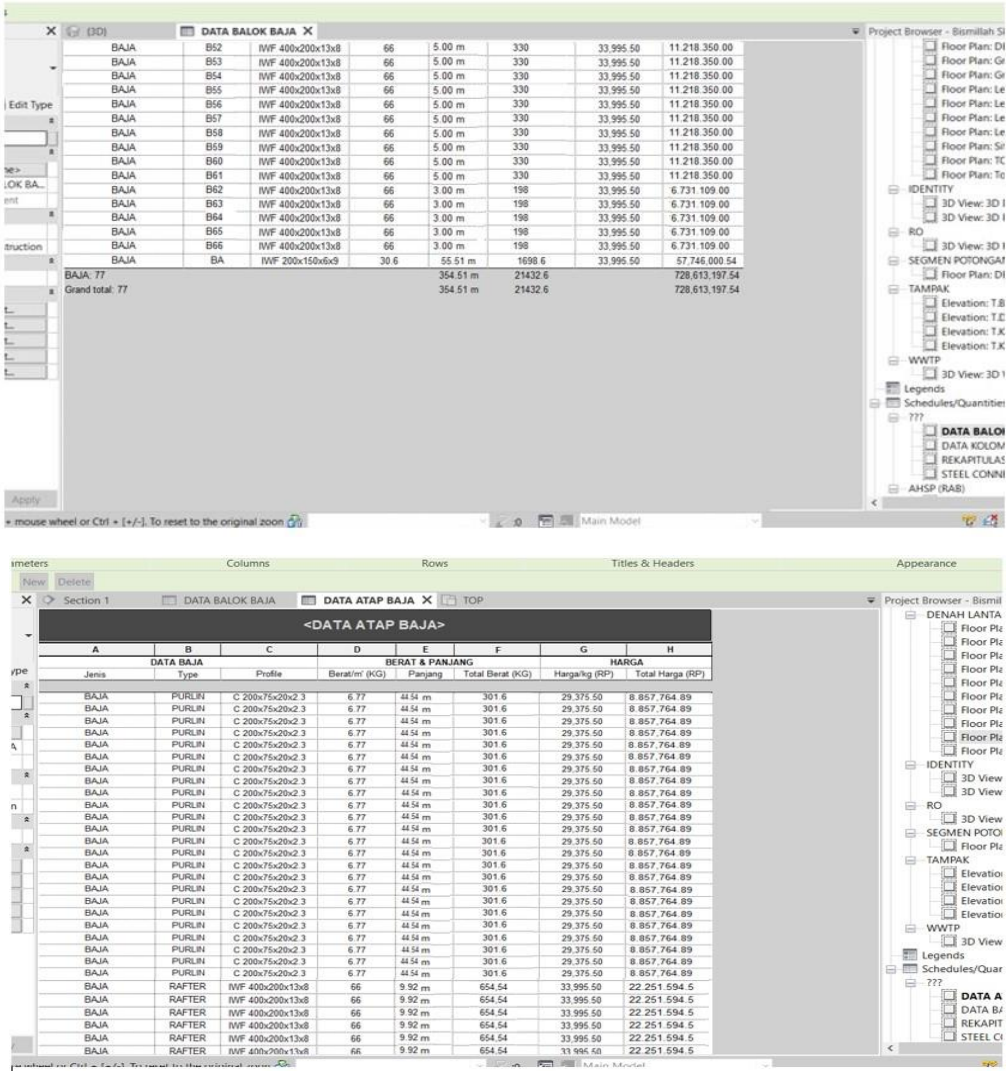


Figure 9. The Total Cost of Steel Beam Structure Work

From the image data above, it is known that the total cost of the beam structure work was found to be Rp. 718,613,197.54. Then the total cost data on steel column structure work can be seen in Figure 10.



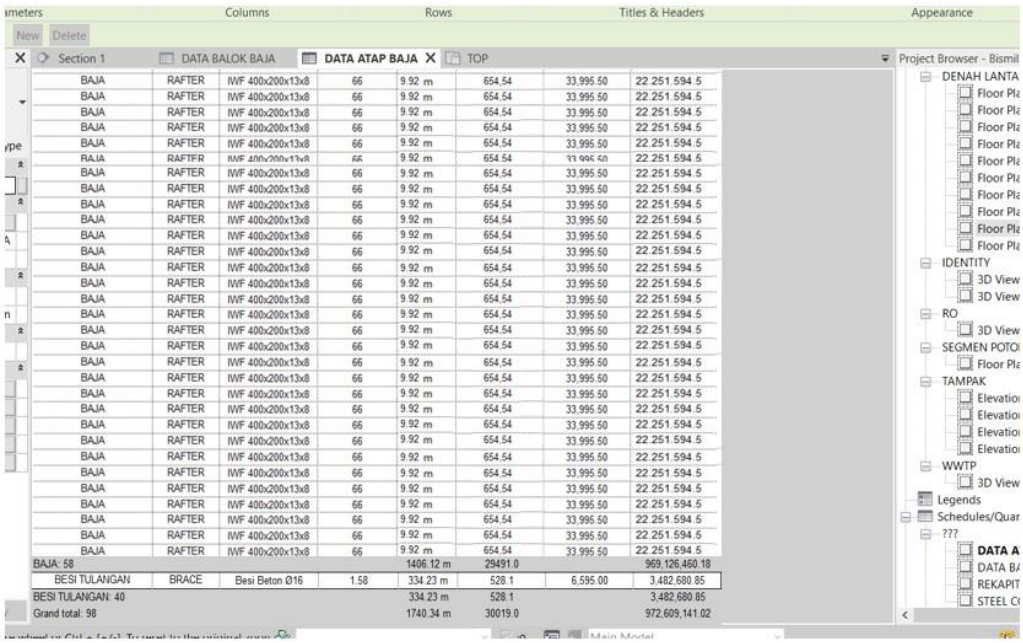


Figure 10. The Total Cost of Steel Roof Structure Work

The steel roof structure is IWF steel 400x400x21x13 for the rafter, C 200x75x20x2.3 for purlin, and D16 concrete iron for the brace. The total steel in the roof structure is 58 steel, 34 rafters, 24 purlins, and 40 D16 concrete iron for the brace. Next is data recapitulation of the total cost of steel structure work which can be seen in Figure 11.

REKAPITULASI HARGA

<REKAPITULASI HARGA>

A	B	C
JENIS ELEMEN	BERAT TOTAL BAJA (KG)	TOTAL HARGA BAJA (RP)
KOLOM	41204.1	1,400,753,981.55
BALOK	21432.6	728,613,197.54
PURLIN	7236.7	212,580,689.57
RAFTER	22254.3	756,545,770.60
BRACE	528.1	3,482,680.85
Grand total: 5	92655.8	3,101,976,320.11

Figure 11. Price Recapitulation

The recapitulation of prices for steel structure work found a value of Rp. 3,101,976,320.11. This value is based on the sum of the structural work of columns, beams, and steel roofs. It can be seen that the results of price recapitulation on steel structure work found a value of Rp. 3,101,976,320.11. While the total cost of steel structures using conventional calculations based on the case study documents can be seen in Table 2.

Table 2. Conventional Costs

No	Description	Coefficient	Unit	Unit Price (IDR)	Price Total (IDR)
I	Steel Beam Structure				
1	B1 IWF 400.200.13.8 uk. 6 m	13.168.00	kg	IDR. 33.995.50	IDR. 447.652.774.00
2	B1 IWF 400.200.13.8 uk.	3.350.00	kg	IDR.	IDR.

No	Description	Coefficient	Unit	Unit Price (IDR)	Price Total (IDR)
	5 m			33.995.50	113.884.925.00
3	B1 IWF 400.200.13.8 uk. 3 m	990.00	kg	IDR. 33.995.50	IDR. 33.655.545.00
4	B1 IWF 400.200.13.8 uk. 2 m	2.732.40	kg	IDR. 33.995.50	IDR. 92.889.304.20
5	BA IWF 200.150.6.9 uk. 6 m	1.468.00	kg	IDR. 33.995.50	IDR. 49.905.394.00
6	BA IWF 200.150.6.9 uk. 3 m	275.40	kg	IDR. 33.995.50	IDR. 9.362.360.70
	Sub Total I				IDR. 747.350.272.90
II	Steel Beam Structure				
1	K1 IWF 400.200.21.13 uk. 3.5 m	23.278.00	kg	IDR. 33.995.50	IDR. 798.146.349.00
2	K1 IWF 400.200.21.13 uk. 2.5 m	18.782.40	kg	IDR. 33.995.50	IDR. 638.517.079.20
3	KG1 IWF 150.150.7.10 uk. 3.5 m	759.50	kg	IDR. 33.995.50	IDR. 25.819.582.25
	Sub Total II				IDR. 1.462.483.010.45
III	Steel Beam Structure				
1	Rafter IWF 400.200.13.8 uk. 28 m	16.632.00	kg	IDR. 33.995.00	IDR. 565.404.840.00
2	Rafter IWF 400.200.13.8 uk. 48 m	6.336.00	kg	IDR. 33.995.00	IDR. 215.392.320.00
2	Purlin C 200.75.20.2,4	7.439.00	kg	IDR. 29.375.50	IDR. 218.524.344.50
3	Brace Besi Beton D16	540.00	kg	IDR. 6.595.00	IDR. 3.561.300.00
	Sub Total III				IDR. 1.002.882.804.50
	Total				IDR. 3.212.716.087.85

The total steel structure cost in the estimation table above is Rp. 3,212,716,087.85. The volume value in conventional cost estimates is larger. It is because conventional calculations are done manually, and there may be some differences due to less accuracy, which makes the volume value larger. Based on the results of the cost estimation generated by BIM and the conventional method, it can be seen that there is a difference in the total cost value generated by the two methods. The results of calculating the estimated cost of the conventional method are found to be Rp. 3,212,716,087.855, while calculating the estimated cost using Revit, found a value of Rp. 3,101,976,320.11. there is a difference between Rp. 110,739,767.74. which means that calculations using BIM assisted by Revit software are 3.45% smaller than conventional method calculations.

Discussion

BIM (Building Information Modeling) is currently a concept that can include important information that can make it easier to carry out a plan to be built (Novita &

Pangestuti, 2021; P, Adhi, Hidayat, & Nugroho, 2016). So the quality of the planning will be better. Modeling methods in BIM can also produce 4D, 5D, 6D, and 7D models in addition to 2D and 3D. BIM provides facilities such as 3D for object-based parametric modeling, 4D to provide scheduling information or it can be called a time element, 5D to provide integrated cost estimates from 3D design, 6D to be able to analyze energy in a building, up to the top BIM level, namely 7D, 7D is facility management in a building, this 7D BIM level is for the maintenance stage, and these facilities are already integrated with accurate data (Rizqy, Martina, & Purwanto, 2021; Suasira, Tapayasa, & Santiana, 2021). One of the software based on BIM is Autodesk Revit. Autodesk Revit is software for modeling architectural, structural, mechanical, electrical, and plumbing (MEP) projects (Pratama & Witjaksana, 2022). In addition to presenting 2D design working drawings, users can build a building by modeling each component in 3D. Users can also simulate planning for scheduling or assigning execution phases for each building component while providing schedule details and being able to provide cost estimates (Marizan, 2019; Pratiwi & Wirawan, 2022). Therefore, in this study, image modeling was carried out up to the cost estimation stage using Autodesk Revit software.

4. CONCLUSION

Based on the results and discussion above, it can be concluded that the use of Autodesk Revit software can optimize the 2D modeling process into the 3D form so that the quantity take-off calculations can be more detailed and accurate and can reduce material waste and already supports BIM 5D to help calculate estimated costs. The results of calculating estimated costs using Autodesk Revit software are 3.45% smaller than conventional calculations. It is because the conventional method is calculated manually based on 2D images, allowing for differences due to lack of detail.

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