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EFFECTIVENESS OF APPLYING BIM BASED COST ESTIMATION IN DEVELOPMENT OF THE SYAMSUDIN NOOR AIRPORT PROJECT BANJARMASIN

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ABSTRACT

Development of The Syamsudin Noor Airport Project in Banjarmasin is one of the largest projects in Banjarmasin, South Kalimantan. This project applied BIM-based cost estimation on a steel roof structure. However, the cost estimation for this steel roof structure is applied conventionally. The BIM-based cost estimation could have been applied in collaborating a building information becomes unity in one model. This research will raise the issue of applying BIM-based cost estimation at The Syamsudin Noor Airport Project to find out the effectiveness calculation of cost estimation conventionally and BIM-based cost estimation. The report result by 3D modeling of Tekla is quantity take-offs using as a data for processing the cost analysis conventionally. Whereas the 3D model made by Tekla will be exported to Revit through the interoperability of IFC or application of extention of Tekla warehouse that is “Export to Revit Geometry” for the processing the BIM-based cost estimation analysis. The unit price for the cost calculation is acquired by list price (AHSP or subcontractor value). The result of these both cost calculation, there are large enough difference in cost of these both calculations. Difference of conventional calculations and BIM-based cost estimation using Revit worth Rp 3,690,741,474 - Rp 5,047,206,780 with a percentage of 14% - 20%. Cause of these large enough differences in cost due to the model exported is only 90% succeeded. It happened due to difference thing in the mapping of object profile and difference in shape BREP geometry conditions.

Key word: BIM-based cost estimation; Tekla; Revit; IFC; steel roof structure.

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INTRODUCTION

Development of the Syamsudin Noor Airport Project Banjarmasin is one of the largest projects in Banjarmasin, South Kalimantan, which implements the development of BIM (Building Information Modeling) technology. One of the applying of BIM in the project is applied BIM-based on quantity take off (Eastman, 2011). One of the applying of BIM-based quantity take off in this project is the steel structure (Rayendra & Soemardi, 2014). To get the quantity of steel material take-offs in this project using the Tekla Structures application. However, Tekla is unable to estimate the cost. So that the cost estimation of the steel structure for this project is applied conventionally (Kurniawan, 2018). Whereas with the implementation of BIM in this project, BIM-based cost estimation could have been implemented by utilizing one of the advantages of BIM, which is collaborating on building models or information into a single unit.

Autodesk Revit is a 3D BIM-based software used for architects, structural engineers, MEP engineers, designers and contractors (Amalia, 2011). In addition, Revit has the advantage of being able to estimate the cost by input material prices for each component made in the modeling. With the advantages of Revit application, this project should be able to implement BIM-based cost estimation on steel structures by importing 3D steel structure building models from Tekla to Revit through IFC format interoperability. Then the modeling can be processed by entering the data needed to determine the cost of each material. Whereas the take-off report quantity obtained from Tekla will be used to estimate the cost manually.

Therefore, this research will raise the issue of the applying of BIM-based cost estimation on the steel structure of the Syamsudin Noor Airport Project with the Autodesk Revit application to determine the effectiveness of cost estimation between manual cost estimation calculations and cost estimation calculations using Autodesk Revit based on BIM-based cost estimation with the conditions in Indonesia, which is currently still at a developmental stage and faces challenges in implementing BIM.

Construction costs will be determined easily whether or not the implementation of the construction section, especially construction using steel frames, requires specific activities. Costs incurred must be in accordance with correct and precise construction calculations. So that the costs incurred are relatively more efficient and economical, but the model used is very simple (N.I.Hayati, F.H.Amin, 2014); (S.Anwar, N.I.Hayati, 2013); (Syaiful.S, Sutarsa.S, 2020).

RESEARCH METHOD

Research procedure

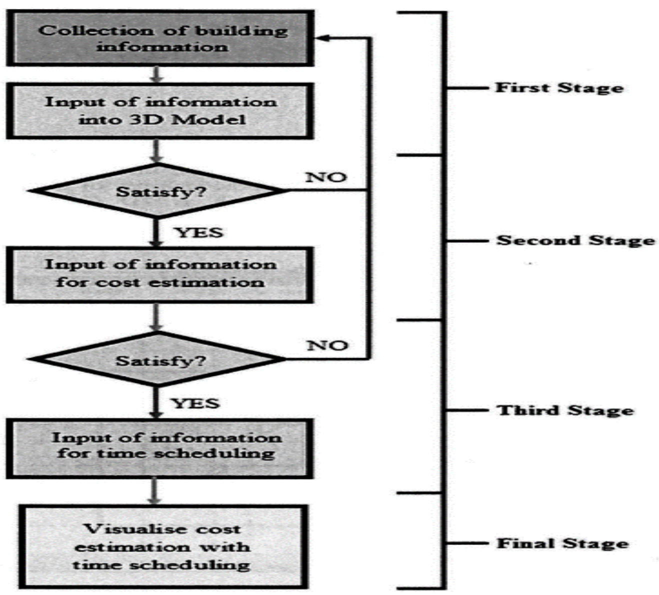

Figure 1. Research Flow 3D Model BIM

In this research, a commercial steel roof structure modeling and west wing & east wing will be carried out using Tekla Structures. The modeling will refer to Shop Drawing and standard details and use the Southeast Asian environment.

The modeling with Tekla Structures is in the form of 3D Model results in the form of commercial steel roofs west & east part steel roofs.

RESULT AND DISCUSSION

Modeling Roof

For creating a commercial roof and wing roof modeling, a database and 2D images from AutoCAD are needed. The modeling uses the South East Asia database because it matches the Indonesian

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market data. Then 2D drawings in the form of floor plans and detailed drawings will be used as reference models to create and adjust cross-sectional positions.

1. Set Grid and *Reference Model*

The function of the grid for this modeling is to coordinate references in making 3D models of steel roof structures. To model commercial roofs and wing roofs, three types of grids are needed, namely grid 1, grid 2 and grid 3. The reference model used is a 2D image from AutoCAD in the form of floor plans and detailed drawings, as shown in Figure 2 below.

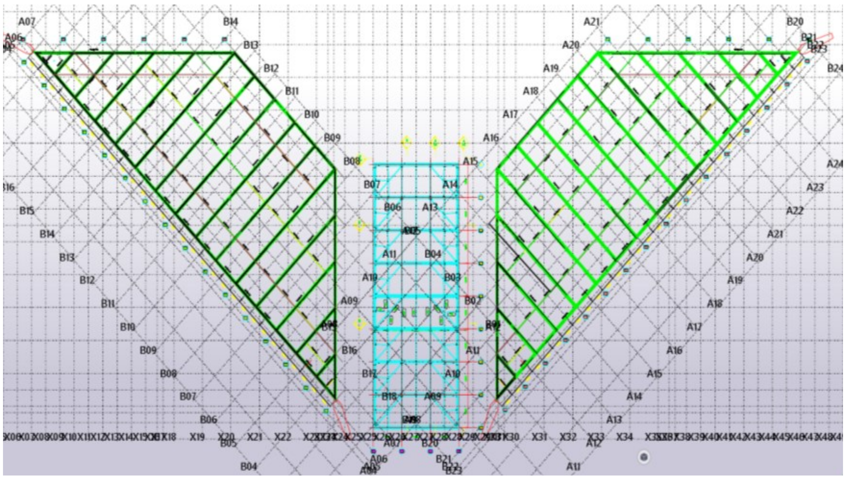


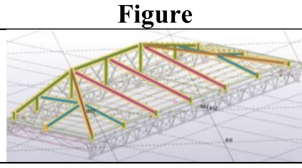
Figure 2. Grid and Reference Model Floor Plan Drawing

2. Define Profile

1) Structural Element Profile

The structural element profiles used for airport roof models are of many types. Table 4.1 presents the types of structure profiles and dimensions divided by type of structure to display the position of the structural elements.

Table 1. Profile of Structural Elements Used

Structure Type	Profile	Profile Dimensions	Figure
Rafter	HSS356x11	**d = 355,5 mm** **t = 11,13 mm**	

2) Connection Profile

The connection profile that will be used in the steel roof model on Tekla is divided into two types, namely manual connection and Tekla component connection. Manual connections will be presented in Table 2 and Tekla component connections will be presented in Table 3. Manual connections are used because the connection details described in shop drawing are many different and not available on the connection components provided by Tekla. It means by the manual connection is to make the dimensions of the connection profile using the profile plate as a connection manually according to the shape required at shop drawing.

Table 2. Connection Manual Profiles Used

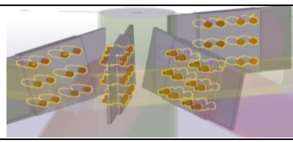
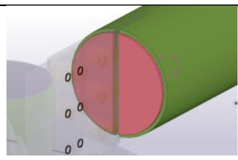
Structure Type	Profile	Profile Dimensions	Position on part	Figure
Bolt	Bolt24	d = 24 mm	*Tube Gusset Plate* (*Rafter*)	

Table 3. Component Connection of Tekla

Name of connection	Structure Type	Profile Dimensions	Position on part	Figure
Cap Plate	Rafter	**d = 10 mm**	Rafter (BP, MP, XP)	

3. Define Material

Material used for this modeling showed on this following Table 4 below.

Table 4. Material Lists Used

Material	Profiles using
SS400	• Base Plate • Gusset Plate • Cap Plate • Stiffener plate • Profil C
STK400	• Pipa (PIPE4SCH40, PIPE6SCH40, PIPE8SCH40, HSS356x11) • Sagrod12 • Sagrod16

Related to material on the bolt, bolt standard used for this connection on the roof model showed on the Table 5 below.

Table 5. Bolt Standards Used

Standard	Bolt used
4.6Fire	Bolt12
8.8XOX	• Bolt12, • Bolt20 • Bolt24
8.8Fire	• Bolt12 • Bolt24

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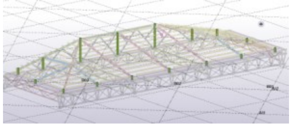
4. Define Profile Labels

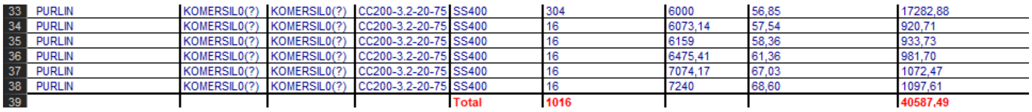
Labeling (Name, Part and Assembly) for this roof model profiles showed on the Table 6 below.

Table 6. Labeling List Used

Structure Type	Profile	Assembly	Name	Part	Model
Rafter	HSS356x11	**K-RFT**	P50	VP	

5. Report

Report from the roof model in Figure 4. and can be seen information there is information in the form: name, assembly, parts, profile, grade, quantity, length, net weight (kg) per unit and total net weight (kg). The report that will be used to calculate the estimated cost is the weight of steel (tonnage).



33	PURLIN	KOMERSIL0(?)	KOMERSIL0(?)	CC200-3.2-20-75	SS400	304	6000	56,85	17282,88
34	PURLIN	KOMERSIL0(?)	KOMERSIL0(?)	CC200-3.2-20-75	SS400	16	6073,14	57,54	920,71
35	PURLIN	KOMERSIL0(?)	KOMERSIL0(?)	CC200-3.2-20-75	SS400	16	6159	58,36	933,73
36	PURLIN	KOMERSIL0(?)	KOMERSIL0(?)	CC200-3.2-20-75	SS400	16	6475,41	61,36	981,70
37	PURLIN	KOMERSIL0(?)	KOMERSIL0(?)	CC200-3.2-20-75	SS400	16	7074,17	67,03	1072,47
38	PURLIN	KOMERSIL0(?)	KOMERSIL0(?)	CC200-3.2-20-75	SS400	16	7240	68,60	1097,61
39					Total	1016			40587,49

Figure 3. Reports

And Figure 4 is the result of modeling of commercial roofs and wing roofs that have been completed.

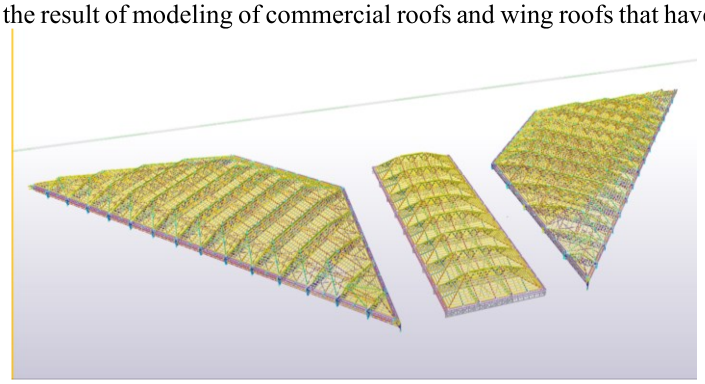


Figure 4. The 3D Model of Commercial Roofs and West & East Wing Roofs

Analysis of Export and Import IFC

The commercial roof modeling is exported to the IFC (.ifc) format from Tekla Structures, then imported into Autodesk Revit.

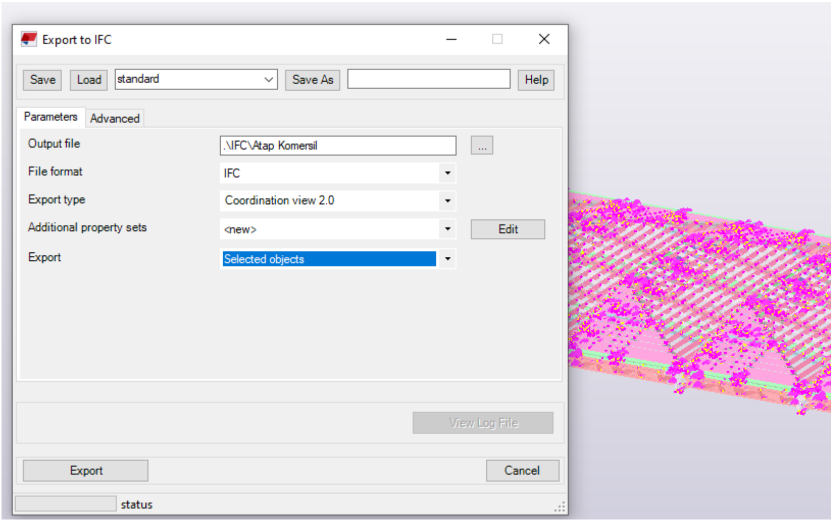


Figure 5. Export To IFC

There are several problems that occur that will cause uncertainty and error in making a schedule/quantity for the estimated cost. These constraints consist of 3 types, namely as follows:
1. Many objects are automatically grouped together.
2. Some objects are not synchronized in the profile category.
3. Several data and model information are not detected.

Evaluation of Model Results with IFC

Evaluation of model results with IFC will discuss solutions to IFC model interoperability problems. Two attempts were made regarding IFC interoperability, resulting in 3 similar problems, namely:

1. Objects that are automatically grouped into entities
2. Object categories are unclear and inconsistent.
3. Data and information of many models are not detected.

The impact of these 3 problem points is the difficulty of crosschecking between manual costs and Revit costs. And the final solution is done, namely business 3. The third attempt is to use the extension applicable from Tekla warehouse, namely Export to Revit Geometry.

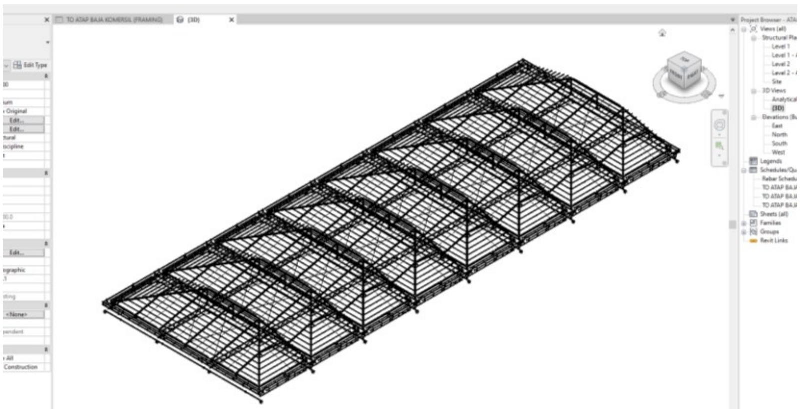


Figure 6. Commercial Roof Model After Import

After an effort was made with the application export extension application to Revit Geometry. There are several problems when the model is opened in Revit, that is:

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1. Some profile objects are missing.
2. Multiple plate connections fall into different categories. Some are structural framing and some are generic models.
3. Bolt connections are lost.

RESULT AND DISCUSSION

The first is the cause of the large cost difference from the BIM-based cost calculation using Revit with manual calculations is that the imported model is not 100% successful. There are several pipe profiles objects (PIPE4SCH40, PIPE6SCH40 and PIPE8SCH40) and all bolts cannot be read by Revit. The second is the problem in the analysis of quantity take-offs with Revit is that object models that are dimensionally the same cannot be recapitulated into a single unit but rather separated. This is most likely due to the reading of the profile objects read by Revit being imported separately because of different GUIDs.

These problems are caused by exports and imports with the extension of the application extension from Tekla warehouse "Export to Revit Geometry". Most likely due to export and import failure of these models due to BREP quality, the Revit edge length requirement is more limited than Tekla, usually less than 1/32 inch or 0.79 mm. And the latter is the reason for the use of exports and imports with the application extension interoperability of Tekla warehouse "Export to Revit Geometry" due to IFC interoperability issues. Some IFC interoperability such as loss of data or information and errors in the presentation of object models are happened to be caused by software differences in reading profile grouping. These problems are also caused by the differences database over these both software.

CONCLUSION

Here is the following conlude of this research is: Cost estimation of the steel roof structure in Banjarmasin The Syamsudin Noor Airport Development Project using Autodesk Revit based on BIM-based cost estimation: Commercial roofs Rp 14.209.845.003, West wing roofs Rp 29.592.038.197, East wing roofs Rp 29.592.038.197. The difference in the estimated cost of the steel roof structures in the Banjarmasin The Syamsudin Noor Airport Development Project based on conventional calculations with BIM-based cost estimation using Revit worth Rp 3.690.741.471 – Rp 5.047.206.778 with a percentage of 14% - 20%.

So that concluded that is "Application of BIM (Building Information Modeling) Based Cost Estimation at the Syamsudin Noor Airport Development Project in Banjarmasin" requires further effort to be able to apply BIM-based cost estimates using Autodesk Revit. Because there are many uses of the manual method yet in implementing the BIM both in modeling and in the estimation of costs and there is non-compliance yet with the standard requirements validating in Indonesia both regulations and environments.

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