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Identification of the Causes of Waste Material in the Railway Bridge Construction Project

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ABSTRACT

Material is one of the important components that has a close influence on the cost of a project, so with a large amount of construction material waste, it can be said that there is an overrun in the financing sector. In addition, the remaining construction materials can produce a high percentage of environmental pollution. Residual material or construction waste is something that is never separated from a project development. The existence of leftover materials can have a negative effect on the environment around the construction project. The remaining material can be interpreted as part of the material that has not been used resulting from the process of construction, repair, change or any item produced from the process, or an accident that cannot be directly used in that place without any further treatment. The railway bridge construction project certainly requires various types of materials, when viewed from the concept for the use of large materials, the more the remaining materials that exist or become construction waste. This research aims to determine the quantity of material waste generated from the construction of the railway bridge and analyze the factors that cause material waste in the railway bridge construction project. This research method uses observation and interview techniques and is supported by data obtained from the research location. The results of this study show that the largest percentage of waste cost during the railway bridge construction project came from K300 concrete material for retaining walls in the amount of 16.714% or Rp. 6,283,720.00. The source of the cause of the remaining material where the factors are generated from project actors, design, measurement/calculation, management, implementation and procurement/handling of materials.

Keywords: materials; waste materials; construction project; railway bridge.

INTRODUCTION

In the process of developing transport facilities, a large number of materials are required, which are important elements and have a significant impact on project costs. If there is a large amount of leftover construction material, project finances can increase significantly. In addition, construction material waste is also a significant contributor to environmental pollution. Construction waste or leftover building materials are an ever-present part of any development project. The process of developing transport infrastructure requires a significant amount of materials. These materials are important elements that can have a major impact on the cost of a project. Therefore, if there is a large amount of construction material residue, the possibility of increased costs in the project financing sector will be greater. Not only that, residual building materials can also be one of the materials that have no value and have a negative impact on environmental damage.

Construction waste is an ever-present part of any building project. Residual material refers to a portion of material that is no longer used resulting from construction, repair, alteration, or production of goods, it can also occur as a result of an accidental event and cannot be directly used without additional treatment. Research conducted by Hartono in 2016 states that most project costs are absorbed by the materials used, this shows that the use of materials has a crucial role in supporting the completion of construction projects. In other words, without materials, construction projects cannot be completed and it is important to know that there are limits to the use of materials. The materials to be used are adjusted to the needs that exist in the project. If there is an increase in the number of orders, it results in increased costs and causes waste, which ultimately results in unused material waste. The railway bridge construction project certainly requires various types of materials, and with the increasing use of materials, the amount of construction waste generated is also increasing. From the above problems, the purpose of this study is to determine the quantity of residual material generated from the construction of the railway bridge and analyse the factors that cause residual material in the railway bridge construction project.

RESEARCH METHODS

In this step, observations are made at the project that is used as the object of research to find out the conditions, problems that occur in the field, collect data and analyze information. This is contained in the research method where there are stages of research described in the flow chart, as follows:

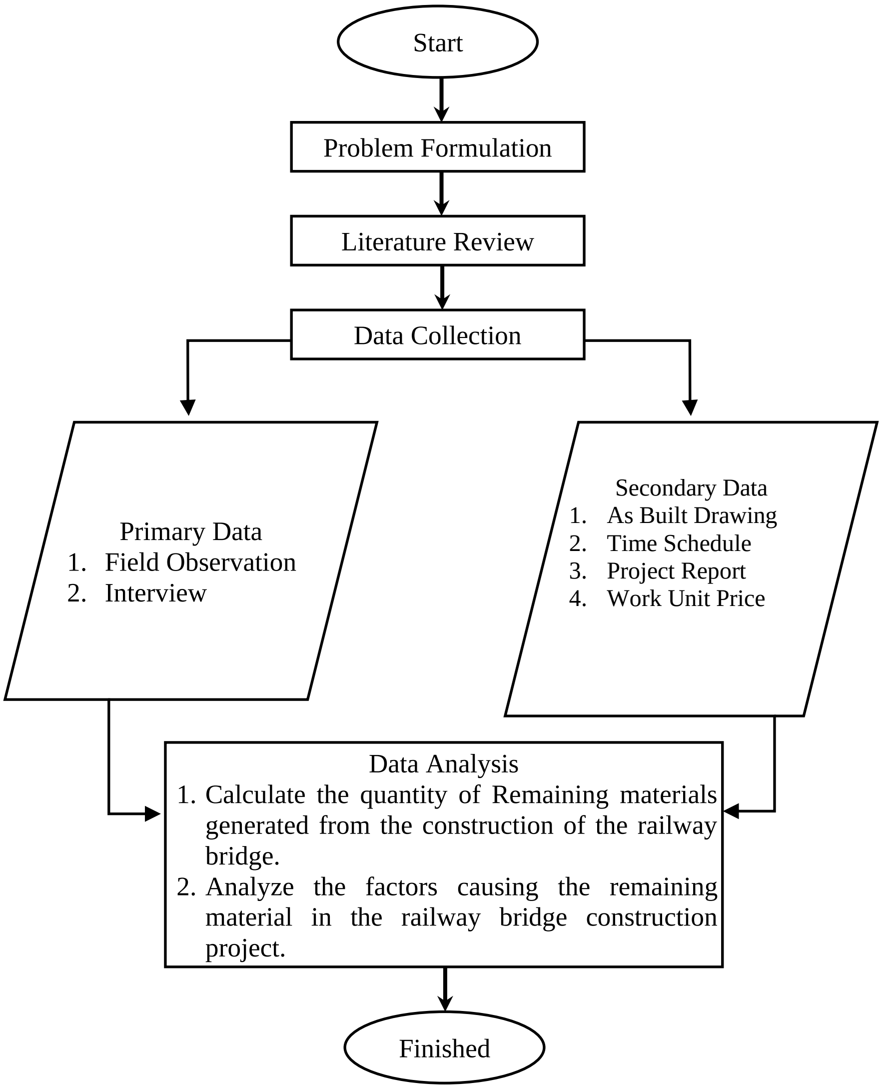

Figure 1. Flow chart

This research method uses a quantitative method which is a method to be able to help calculate and analyze the quantity and cost of leftover materials on construction projects.

RESEARCH METHODS

The research location used as a case study object is the Railway Bridge Construction Project between Mojokerto-Jombang. This railway bridge construction project is a WTP (Welded Through Plate) bridge with a span of 32 metres constructed of steel material designed to receive train loads.

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Identification of Materials

The first stage needed to analyze the quantity and cost of leftover materials is to identify materials that have the potential to become leftover materials. In this stage, it is determined what materials are used during the project, sourced from interviews with project actors, in this case the project contractor and secondary data, namely the project time schedule. From these results, the volume and cost of the waste materials will be calculated as stated in Table 1.

Table 1. Result of Recapitulation Material Used

No.	Materials
1.	Concrete
2.	Formwork
3.	Reinforced Bar
4.	Sand Fill
5.	Strauss pile
6.	Bore Pile
7.	Steel

Recapitulation of Material Quantity

The next step is to record the volume of material used based on Table 1 where the material used is the main constituent material of the railway bridge construction. The following is a recapitulation of the results of the design material volume for each work item.

Table 2. Recapitulation of Material Quantity

No.	Material	Type/Size	Volume	Satuan
1.	**Retaining Wall**			
	- Concrete	K300	3.150	m^3
	- Lean Concrete	K175	315	m^3
	Box Culvert			
	- Concrete	K300	413,75	m^3
	- Lean Concrete	K175	12,03	m^3
	Bridge			
	- Concrete	K300	207,57	m^3
	- Concrete	K350	7,49	m^3
	- Lean Concrete	K175	11,05	m^3
2.	**Retaining Wall**			
	- Formwork	Wall	12.600	m^2
	- Formwork	Foundation	1,890	m^2
	Box Culvert			
	- Formwork	Wall, Wingwall, Parapet	312,20	m^2
	- Formwork	Floor	163,80	m^2
	- Formwork	Foundation	83,50	m^2
	Bridge			
	- Formwork	Wall	553,52	m^2
	- Formwork	Foundation	115,34	m^2
3.	Reinforced Bar	Retaining Wall	535.500	kg
		Box Culvert	61.259,68	kg
		BJTD 40 (Bridge)	20.125,85	kg
4.	Sand (Retaining Wall)	Sand Fill	631,89	m^3
	Sand (Box Culvert)	Sand Fill	24,06	m^3
5.	Strauss pile	Ø35-K300	6.297	m’
6.	Bore Pile	Ø80cm-K300	304	m
7.	Steel	JIS	88.050	kg

Calculation of Waste Materials

Material quantity is obtained from daily report data or weekly project reports. The daily report or weekly report contains the type and amount of material used during the implementation of the construction project including the stored material stock. The calculation of field material quantity is presented in Table 3.

Table 3. Calculation of Waste Materials

No	Materials	Purchase Material	Need Material	Waste Materials	Waste Material Cost (Rp)	Percentage of Waste Material Cost (%)
1.	**Retaining wall**					
	Concrete K300	3.150 m^3	3145 m^3	5 m^3	6,283,720.00	16,714
	Lean Concrete K175	315 m^3	310 m^3	5 m^3	5,178,720.00	13,774
	Box Culvert					
	Concrete K300	413,75 m^3	411 m^3	2.75 m^3	3,456,046.00	9,192
	Lean Concrete K175	12,03 m^3	11 m^3	1.03 m^3	1,066,816.32	2,838
	Bridge					
	Concrete K300	207,57 m^3	206 m^3	1.57 m^3	1,973,088.08	5,248
	Concrete K350	7,49 m^3	7 m^3	0.49 m^3	725,819.36	1,931
	Lean Concrete K175	11,05 m^3	10 m^3	1.05 m^3	1,087,531.20	2,893
2.	**Retaining wall**					
	Wall Formwork	12.600 m^2	12587 m^2	13 m^2	4,146,649.39	11,029
	Foundation Formwork	1,890 m^2	1884 m^2	6 m^2	1,275,030.60	3,391
	Box Culvert					
	Wall Formwork, Wingwall, Parapet	312,20 m^2	311 m^2	1.2 m^2	382,767.64	1,018
	Floor Formwork	163,80 m^2	162 m^2	1.8 m^2	985,945.10	2,622
	Foundation Formwork	83,50 m^2	83 m^2	0.5 m^2	106,252.55	0,283
	Bridge					
	Wall Formwork	553,52 m^2	552 m^2	1.52 m^2	484,839.01	1,290
	Foundation Formwork	115,34 m^2	114 m^2	1.34 m^2	284,756.83	0,757
3.	Retaining Wall Reinforced Bar	535.500 kg	535490 kg	10 kg	136,720.00	0,364
	Box Culvert Reinforced Bar	61.259,68 kg	61256 kg	3.68 kg	53,354.48	0,142
	Iron BJTD 40 (Bridge)	20.125,85 kg	20122 kg	3.85 kg	55,819.22	0,148
4.	Sand Fill (Retaining Wall)	631,89 m^3	629 m^3	2.89 m^3	526,586.90	1,401
	Sand Fill (Box Culvert)	24,06 m^3	22 m^3	2.06 m^3	357,352.60	0,998
5.	Strauss pile Ø35-K300	6.297 m	6290 m	7 m	2,414,735.26	6,423
6.	Bore Pile Ø80cm-K300	304 m	320 kg	2 m	6,069,401.72	16,143
7.	Steel	88.050 kg	88036 kg	14 kg	526,681.68	1,401

Table 3 explains that to calculate the waste material is obtained from the purchase of materials minus the stock of materials and reduced again by the material requirements. Material purchase is data obtained from the As Built Drawing where the amount of material that should be used in the

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building. Material requirements are data on material expenditures (attached to the physical building) recorded in the daily report or weekly project report during project implementation. The remaining material is data on the amount of excess material installed so that it becomes unused waste.

To determine the amount of residual material costs obtained from the calculation of the waste material multiplied by the unit price of each material. The percentage of residual material costs can be known from the results of the remaining material costs divided by the total material costs and multiplied by one hundred (100) percent. Determination of the calculation of the percentage of total residual material costs to the total project cost is obtained from the total residual material costs divided by the total project cost and multiplied by one hundred (100) percent so that the value is 0.575%.

Factors Causing Waste Material

In any construction project implementation, the possibility of leftover materials exists. Therefore, it is important to understand the factors that cause the remaining materials. To understand this, it is necessary to investigate the consequences that can occur due to the remaining materials by analysing the factors that have a recurring influence and will then be connected to the logic gate. The causes of the remaining material are presented in Table 4.

Table 4. Causes of Waste Material

No.	Factor	Description
1.	Project actor	a. Lack of experience in work b. Not focused at work c. Undisciplined workers d. Not carrying out work according to procedures (SOP) e. No training
2.	Design	a. Error in understanding working drawings b. Image information is not detailed c. Design changes
3.	Measurement/calculation	a. Inaccurate in calculations b. Field measurements do not match the calculation
4.	Management	a. Instructions not clear from superiors b. Less intensive supervision c. Lack of coordination between departments d. Inconsistent working methods
5.	Implementation	a. Waiting for instructions from the field leader b. Control over implementation is lacking c. Equipment not working properly d. Lost equipment stolen e. The rest of the material cannot be used f. Cutting material that is not in accordance with the plan g. Location conditions are not good h. Unfavorable weather i. Coordination between shift workers (worker turnover) is lacking j. Unequal distribution of work shifts k. Lack of safety signs l. Inappropriate material delivery schedule
6.	Material	a. The material supplier delivers out of specification b. The work location is far from the material supplier c. Cement material spilled during installation or mixed with soil d. Material damage in the course of transportation both to and from the project site

No.	Factor	Description
		e. Poor material placement f. Materials piled up in the warehouse g. Improper material handling h. Supervision of material quality is lacking i. Sand material is reduced because it is washed away by rainwater runoff j. Residual concrete is still left in the mixer truck

CONCLUSION

Based on the results of the analysis and discussion, the conclusions are as follows: The largest percentage of waste cost (remaining material costs) during the railway bridge construction project came from concrete material K300 for retaining walls of 16.714% or Rp. 6,283,720,000. The source of the cause of the remaining material is obtained from interviews with stakeholders, contractors and direct observation in the field where the resulting factors are from project actors, design, measurement/calculation, management, implementation and procurement/material handling.

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