

Lean Construction Approach to Material Waste in the Construction Project of Elementary School Building 6 Kajarharjo Banyuwangi

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Article Information	ABSTRACT
Article History Received : March 28, 2025 Revised : April 12, 2025 Published : April 18, 2025	Lean Construction is a method that focuses on minimizing waste and increasing added value in the construction process. This research aims to identify and analyze material waste that occurs in the SDN 6 Kajarharjo building construction project, Banyuwangi, by applying the Lean Construction approach. Material waste is one of the significant factors in reducing efficiency and increasing project costs. The research method used is field observation, interviews with related parties, and data analysis based on the principles of Lean Construction, especially in identifying material waste based on the main work done in the building construction project. The results showed that the waste materials that occurred in this project were 19.44 m² of red brick material, 0.34 kg of plain iron 8, 74 kg of plain iron 10, 14 kg of plain iron 12, 79.60 kg of screw iron 13, 34.90 kg of formwork, 6 m³ of split stone and 3 m³ of ready mix concrete. With the implementation of the Lean Construction approach, it is expected that the SDN 6 Kajarharjo building project can achieve better material efficiency, reduce costs, and improve overall construction quality.
Keywords: <i>Lean construction; Materials waste; Construction project.</i>	

INTRODUCTION

Construction development plays an important role in infrastructure development. This is due to its crucial role in supporting the economic, social, and environmental development of a country. Construction projects cannot be separated from the use of human resources, materials, equipment, and also the utilization of technology to complete the work (Widayat, 2019). Infrastructure construction involves building and maintaining transportation networks, such as roads, bridges, and airports, which are the basis of mobility and connectivity within a region (Setiawan, 2023). Construction projects are a series of planned and organized activities to build, repair, or renovate infrastructure or physical buildings, are non-routine in nature, have limitations on time, budget, resources, and have their own specifications for the products to be produced (Lolomsait, 2024). Until now, the organization of construction in Indonesia is still struggling with the inefficiency of construction implementation (Andika et al., 2022). In its development, a project will always there will always be positive and negative impacts (Nuciferani & Firmansyah, 2022). Successfully implementing a construction project on time is one of the most important goals, both for the owner and the contractor as the executor (Andika et al., 2022). However, every construction project usually has a specific implementation plan and schedule, when the implementation of the project must be started, when it must be completed, how the project will be carried out and how to provide resources (Mudzakir et al., 2017).

Common issues faced in the construction industry include low productivity levels, sub-optimal working environment conditions, inadequate quality, inefficient use of time and budget, and safety deficiencies. In the world of construction, wastage is one of the factors that must be eliminated (Jasri et al., 2020). All of these have a significant impact on the success and efficacy of construction projects, making the importance of selecting an appropriate project management approach crucial. In the implementation of building construction projects, material waste or Construction Waste cannot be avoided (Yuniar et al., 2023). This can be seen from the fact that there is still material waste, inappropriate work stages and construction methods, waiting time, repair, and rework, which leads to a low understanding of efficient and effective construction implementation. This waste certainly cannot be left unchecked because it can interfere with the overall development implementation process (Kusuma, 2019). Answering these problems, the Government through the Directorate General of Construction Development (DJBK) of the Ministry of Public Works and Public Housing (PUPR) is present to provide solutions by introducing lean construction (Andika et al., 2022). In today's modern technological era, there have been many innovations and new management approaches that continue to develop and be applied in the construction industry, one of which is being applied in this industry is the concept of lean construction (Allo & Bhaskara, 2022).

Lean construction is an adaptation of lean production, a method developed by Taichi Ohno, a Toyota engineer, to optimize production systems by minimizing waste, both in terms of time, materials, and other resources, and increasing the value provided to customers (Lolomsait & Setiawan, 2024). The goal is to avoid excess material which is waste (Herliandre & Suryani, 2018). The efficient use of resources in construction projects is an important issue given its impact on various aspects, including economy, environment, and sustainability. One of the main challenges is the proper management of construction materials, including their procurement, use, and recycling (Nuciferani et al., 2022). Many construction projects still experience waste of resources, such as inefficient material selection, waste of energy during construction, and poorly managed waste management (Saputra, 2023).

The implementation of lean construction is expected to provide several benefits, such as increasing productivity, reducing costs, improving quality, and completing projects on time (Liman & Sulistio, 2020). However, despite the various benefits provided, there are also several factors that can hinder the application of lean construction in construction projects including financial barriers, lack of government support and lack of understanding (Hermina et al., 2014). So far, most studies tend to focus on the economic aspects of the construction sector, neglecting other aspect (Triandini et al., 2019). In construction activities, materials are used from the beginning to the end of implementation (Hendrik Sulistio & Mega Waty, 2021). However, in its implementation there is often material waste. This material waste can occur if there are materials, time or resources that have no added value or progress in construction project activities (Sugiyanto, 2020). Construction project materials hold 40-60% of the cost of a construction project. This is because indirectly, materials have an important role in supporting the success of construction projects (Angguningtyas & Beatrix, 2024).

The research gap is in analyzing the causes of problems from waste materials that occur using the five whys method accompanied by an improvement plan (action plan) to anticipate waste materials and achieve more targeted and efficient goals. This research was conducted on the SDN 6 Kajarharjo building construction project in Banyuwangi Regency. The purpose of this research is to identify activities or activities that have the potential to cause material waste in the SDN 6 Kajarharjo building construction project.

RESEARCH METHODS

The research was conducted on the SDN 6 Kajarharjo Building Construction project in Banyuwangi Regency. The materials studied in are materials that enter the critical trajectory. The list of work items for the SDN 6 Kajarharjo Building Construction project in Banyuwangi Regency

is as follows: earthwork, foundation work, concrete work, masonry and plastering work, window frame work, floor covering work, electrical installation work, painting work. The data used in this study are Budget Cost Design (RAB) data, material price data, material order data in the field. These data will be used for material identification, so that it can be seen what materials can cause waste in the field.

The identification of materials in the Draft Budget Cost (RAB) refers to HSPK 2024 so that it can be known what materials are needed in these construction activities. Materials that have been known will then be subjected to pareto analysis. Pareto analysis is carried out to find out what materials have the potential to cause material waste in the SDN 6 Kajarharjo Building construction project. The material results of the pareto analysis will identify the volume that has been installed in the field. Identification of installed material is done by calculating the volume of material used in the implementation of the construction work of the Building Development. The results of the identification of the installed volume in the field, then the volume waste analysis will be carried out. The waste volume analysis is carried out by subtracting the volume of material orders in the field from the volume of material that has been installed in the field so that it can be seen the large volume of material waste in the SDN 6 Kajarharjo Building Construction project, Banyuwangi Regency.

RESULTS AND DISCUSSION

The first time that needs to be done in this waste material research is to identify the volume of work on the RAB.

Calculating the Volume of Material

Calculating the volume of material has the aim of obtaining the volume of material based on the RAB of the SDN 6 kajarharjo building as presented in the table below:

Table 1. Material Volume based on RAB

No	Job Description	Volume	Unit
1	Earthwork	144.96	m ³
2	Foundation Work	41.8	m ³
3	Concrete work	60.73	m ³
4	Masonry and plastering work	1097.37	m ²
5	Window frame work	299.07	m ²
6	Floor covering work	255.02	m ²
7	Electrical installation work	55	point
8	Painting Work	1173.87	bh

From the results of identifying the volume of work studied based on the Draft Budget Cost (RAB), it is then necessary to analyze the material requirements for each job using the reference of the Basic Unit Price of Activities (HSPK). From the HSPK, it can be seen what materials are needed for each job that has been identified by multiplying the volume of work with the coefficient value of each material needed. Table 2 presents the results of material identification based on the Draft Budget Cost (RAB).

Table 2. Material Identification Results Based on the Draft Cost Budget

No	Materials	Needs	Unit
1	Red Brick	168.48	m ²
2	Plain Iron 8	1,362.90	kg
3	Plain Iron 10	3,148.08	kg
4	Plain Iron 12	730.15	kg
5	Thread Iron 13	3,925.46	kg
6	Formwork	619.48	m ²
7	Split Stone	41.80	m ³
8	Ready Mix Concrete	63.32	m ³

Based on the data results in Table. 2 can then be done pareto analysis. The initial stage in pareto analysis is to know the weight of each material. In this analysis requires the unit price of each material. Material unit prices in Table. 2 is obtained from material price data owned by the construction contractor. The total price is obtained from multiplying the material unit price by the volume required for each material. The following are the results of the total price for each material.

Table 3. Total Material Price

No	Materials	Volume	Unit	Unit Price (Rp)	Total Price (Rp)
1	Red Brick	168.48	m ²	700.00	117,936.00
2	Plain Iron 8	1,362.90	kg	10,875.00	14,821,537.50
3	Plain Iron 10	3,148.08	kg	10,875.00	34,235,370.00
4	Plain Iron 12	730.15	kg	10,875.00	7,940,381.25
5	Thread Iron 13	3,925.46	kg	13,103.00	51,435,302.38
6	Formwork	619.48	m ²	152,250.00	94,315,830.00
7	Split Stone	41.80	m ³	180,000.00	7,524,000.00
8	Ready Mix Concrete	63.32	m ³	686,704.00	43,482,097.28
Total					253,872,454.41

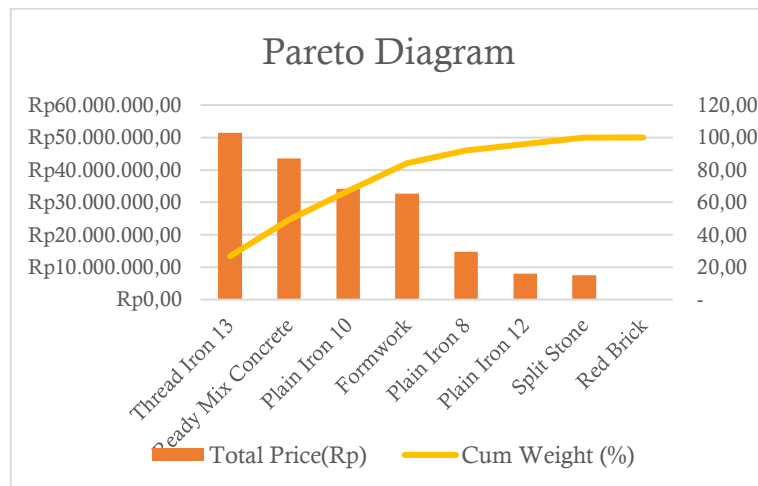
Based on the results of Table 3, the total price of each material has been found, then it is necessary to sort the total price of the material from the highest price to the lowest price. The total price that has been sorted, then the weight can be calculated. The calculation of material weight is done in the following way:

$$\begin{aligned}
 \text{Plain iron material weight 8} &= \frac{\text{Total Price of Each Material}}{\text{Total price}} \times 100 \% \\
 &= \frac{\text{Rp } 14.821.537,50}{192.305.599,41} \times 100\% \\
 &= 7.71 \%
 \end{aligned}$$

Table 4. Material Weight

No	Materials	Unit Price (Rp)	Total Price (Rp)	Weight (%)	Cum Weight (%)
1	Threaded Iron 13	13,103.00	51,435,302.38	26.75	26.75
2	Ready Mix Concrete	686,704.00	43,482,097.28	22.61	49.36
3	Plain Iron 10	10,875.00	34,235,370.00	17.80	67.16
4	Formwork	152,250.00	32,748,975.00	17.03	84.19
5	Plain Iron 8	10,875.00	14,821,537.50	7.71	91.90
6	Plain Iron 12	10,875.00	7,940,381.25	4.13	96.03
7	Split Stone	180,000.00	7,524,000.00	3.91	99.94
8	Red Brick	700.00	117,936.00	0.06	100.00
Total			192,305,599.41		

The results of the analysis in Table.4 will then be made a pareto diagram. This diagram shows the graph formed due to the large number of events. In this diagram, it is shown in the form of a bar chart and a line diagram, where the bar chart illustrates the total price of each material item and a graph illustrating the cumulative weight of each material.

**Figure 1.** Pareto diagram

Based on the results of the Pareto diagram graph in Figure 1, it can be seen that the materials on the left are 20% of the materials that cause 80% of the materials in construction work, so the materials selected as materials that have the potential to waste materials are the following materials:

Table 5. Total Volume Of Installed Materials

No	Materials	Unit	Installed Volume
1	Red Brick	m ²	12,131
2	Plain Iron 8	kg	1,379
3	Plain Iron 10	kg	3,256
4	Plain Iron 12	kg	735
5	Thread Iron 13	kg	4,127
6	Formwork	m ²	215.10
7	Split Stone	m ³	42
8	Ready Mix Concrete	m ³	63

The volume of installed materials in Table.5 is obtained from the results of material calculations on each work item in building construction. The calculation of the volume of installed materials is carried out using a direct review reference in the field. Material order volume is obtained from incoming material data at the construction project site, the following are the results of identifying the order volume for each material studied:

Table 6. Material Order Volume

No	Materials	Unit	Available
1	Red Brick	m ²	12150.00
2	Plain Iron 8	kg	1379.34
3	Plain Iron 10	kg	3330.00
4	Plain Iron 12	kg	749.00
5	Thread Iron 13	kg	4206.60
6	Formwork	m ²	250.00
7	Split Stone	m ³	48.00
8	Ready Mix Concrete	m ³	66.00

Based on the results of the material order volume in Table.6, the waste volume can be calculated by subtracting the material order volume from the installed material volume, so the following results are obtained:

Table 7. Waste Material Volume

No	Materials	Unit	Order Volume	Installed Volume	Waste
1	Red Brick	m ²	12150.00	12130.56	19.44
2	Plain Iron 8	kg	1379.34	1379.00	0.34
3	Plain Iron 10	kg	3330.00	3256.00	74.00
4	Plain Iron 12	kg	749.00	735.00	14.00
5	Thread Iron 13	kg	4206.60	4127.00	79.60
6	Formwork	m ²	250.00	215.10	34.90
7	Split Stone	m ³	48.00	42.00	6.00
8	Ready Mix Concrete	m ³	66.00	63.00	3.00

Problem Cause Analysis:

Analyze the cause of the problem by using the five whys on waste material threaded iron 13 which is the most significant material. Problem statement: there is an excess volume of Thread Iron order 13 with the installed volume?

Whys 1: mismatch calculation between the volume installed in the field and the purchase volume.

Whys 2: lack of coordination between field supervisors and the logistics or purchasing department

Whys 3: there is no joint meeting between the field and logistics department.

The improvement plan (Action plan) for Thread Iron 13 is:

1. It is necessary to hold a coordination meeting between the field section and the logistics section which is held regularly.
2. Need periodic supervision that also involves the field supervisor and logistics department
3. So that calculations are more accurate, which have been using manual calculations are transferred with applications The use of technology such as bar bending applications.
4. Develop a sustainable mindset in order to anticipate the occurrence of waste material in the next project.

CONCLUSION

Based on the results of the research on the construction project of SDN 6 Kajarharjo Banyuwangi Building, the conclusion that can be drawn is that the materials that have the potential to cause waste in this project are red brick material as much as 19.44 m², Plain Iron 8 as much as 0.34 kg, plain iron 10 as much as 74 kg, plain iron 12 as much as 14 kg, screw iron 13 as much as 79.60 kg, formwork as much as 34.90 kg, split stone as much as 6 m³ and ready mix concrete as much as 3 m³. Practical implications of the lean construction approach to reduce construction costs, reduce waste by purchasing materials according to field needs, improve collaboration between design personnel and construction employees including with other parties and create a safer and healthier work environment.

The suggestion that can be given is that the company can carry out inventory control on material purchases to anticipate the occurrence of material waste in the next project project. by applying Lean Construction principles, such as Just-in-Time (JIT), improving quality control and optimizing logistics management to reduce waste so that the project can achieve better material efficiency. The implementation of this approach not only reduces material waste, but also increases productivity, reduces costs, and ensures better construction quality.

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