Research Inventy: International Journal of Engineering and Science
Vol.16, Issue 6 (June 2026), PP 45-51
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

Analysis of Factors Affecting Waste Material in The Teuku Umar University Building Construction Project U2 Segment C

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Abstract: *A construction project is an activity in which there is a long process, One thing that must be considered is waste material or residual material. This waste material is greatly influenced by the material management implemented in a construction project. Waste material occurs due to the misalignment between the planned volume and the volume of work carried out, especially in reinforcing steel materials. The use of reinforcing steel often results in an uncertain amount of waste. This study aims to determine the factors causing waste material and the most dominant factor causing waste material on reinforcing steel. This research was conducted on the Teuku Umar U2 University Building Construction project Segment C which consists of 4 floors including the basement floor. The research method used is qualitative and quantitative (mix method) with data collection through distributing questionnaires and a Descriptive Analysis approach to obtain the average value (mean) while for data processing using the Likert Scale method with the help of the SPSS application. The sources consist of site managers, contractors, foremen, and other project structures. The results of this study indicate that there are 8 factors causing waste material, namely Design Factors, Procurement and Purchasing Factors, Material Handling Factors, Worker Factors, Construction Management Factors, Material Residue Management Factors, Site Condition Factors, and External Condition Factors. Furthermore, based on the answers from respondents through the distribution of questionnaires in the field, it was identified that the most dominant factor causing waste material is the Worker Factor with the highest mean value of 2.53, followed by the factor Construction Management with a mean value of 2.28, factor Material Handling with a mean value of 2.13, factor Procurement and Purchasing with a mean value of 1.91, the factor Management of Remaining Materials with a mean value of 1.86, factor Location Conditions with a mean value of 1.85, factor External Conditions with a mean value of 1.84, and the factors Design with a mean value of 1.82.*

Keywords: *Management, Waste, Material, Reinforcement, Project, Building.*

Date of Submission: 14-06-2026 Date of Acceptance: 27-06-2026

I. INTRODUCTION

A construction project is an activity in which there is a long process, often in this process many problems and obstacles are found. The success of a construction project is very dependent on the role of resources, one of the resources in a construction project that has a very vital role is the material or materials that will be used in the project, this material has different types and specifications depending on its function in the work, of course in this condition it is very important for contractors to pay close attention to the specifications needed in the project they will work on, in addition to paying attention to the specifications, one thing that is also very important to pay attention to is the volume of work to be done, from the volume of work it will be known how much material is needed. Waste material is any material that is not used in a construction project and does not become part of the building. Therefore, the more waste material there is, the less efficient the material use in the project.(Abdurrahman, 2012).

Reinforcing steel is a steel rod in the form of a round cross-section with a smooth or finned surface used for concrete reinforcement, which is produced from billet raw materials by hot rolling (SNI 2847:2019). According to Kim (1987., 2004), the amount of lost/remaining/waste material can reach 3-10% of the total material at the bidding stage, in countries that have not used reinforcement in the form of coils. The level of loss of reinforcing steel from a construction project is greater than in buildings that tend to use the same length and size of reinforcement repeatedly. The construction project of the Teuku Umar University U2 segment C building consists of 4 floors including the basement floor. Therefore, it is necessary to carry out careful and precise calculations in determining how much material needs will be used in the project and to evaluate the use of these materials, so that waste material can be minimized. Many factors are the source of waste material, including design, material procurement, material handling, implementation, residues and others. So that with the existence of a large enough remaining construction material, it can be ensured that there will be an increase in the financing sector.

II. EXPERIMENTAL PROCEDURE

According to Sugiyono (2016) population is a generalization area of objects/subjects that have certain qualities and characteristics determined by researchers to be studied and then drawn conclusions. Determining the population is an important stage in research because the population can provide useful information or data for a study. According to Arikunto (2006) states, if the population subject is less than 100 it is better to take all of them, whereas if the subject is more than 100 then 10% to 15% of the population is taken. This study uses samples obtained from the population, namely Site Managers, Contractors, Foremen and other Project Structures in the continued construction project of the Teuku Umar U2 University Building Segment C, only 30 people.

Sugiyono (2016) states that the Likert scale is used to express the attitudes, opinions, and perceptions of an individual or group of people regarding social phenomena. The variables to be measured are broken down into variable indicators. These indicators are then used as a starting point for compiling instrument items that use a Likert scale with gradations ranging from very positive to negative. To measure the variables above, a five-level Likert scale is used as follows:

Table 2.1 Percentage Value

Category	Score
Strongly Disagree (STS)	1
Disagree (TS)	2
Doubt (RR)	3
Agree (S)	4
Strongly Agree (SS)	5

Arikunto (2006) argues that a questionnaire is a series of written questions used to obtain information from respondents in the form of reports about their personality or things they know. In this case, there are two types of questionnaires based on the way they answer, namely as follows.

1. Open questionnaire
   An open-ended questionnaire is a research questionnaire that allows respondents to write their personal opinions on a list of questions or statements. However, researchers need to ensure that the list of statements or questions in a research questionnaire is easy to understand.
2. Closed questionnaire
   A closed-ended questionnaire is a research questionnaire containing a list of questions or statements with pre-defined answer options. Generally, closed-ended questionnaires use multiple-choice answers, such as "yes" or "no." Research using closed-ended questionnaires is quite effective because respondents can simply check the box provided, reflecting their choice.
3. Mixed questionnaire
   A mixed questionnaire is a research questionnaire that combines open-ended and closed-ended questions. This research method is used to explore topics in greater depth. Researchers generally use mixed questionnaires to obtain a series of numerical data.

Sudjana (2005) argues that SPSS (Statistical Analysis of Product and Service Solutions) is a statistical computer program capable of processing statistical data accurately and quickly into various desired outputs. The SPSS program is widely used in various market research, quality control and improvement, and scientific research. The SPSS program data processing process varies in the presentation of input and output data. Entered data must go through the data editor menu and be processed. The processed data results then appear in the navigator output in various forms such as text, tables, and graphs.

According to Iswinarno (2017), waste in construction projects can originate from several factors as follows.

Table 2.2 Factors Causing Construction Waste Materials

Variable	Reason
Design	* Incomplete documents at the time of commencement of construction * Design changes * Incomplete design information * Changes to material specifications after implementation
Procurement and Purchasing	* Error in ordering (excess or shortage of what is required)

	* The item ordered does not match the specifications * Purchases that cannot be made in small quantities * Supplier goods transportation/delivery procedures to the project location (warehouse)
Material Handling	* Improper storage of materials * Damage due to transportation methods from the warehouse to the work location * Less efficient dismantling method * Using low quality materials * The tools used are inadequate * Using defective materials * Poor material handling (e.g. inefficient cutting)
Worker	* Work method errors during the project * Inexperienced workers * Shortage of skilled workers * Ineffective working hours * Bad attitude of workers
Construction Management	* Poor planning and scheduling * Poor location management * Lack of worker supervision * Inappropriate construction methods * Lack of communication * Lack of waste prevention measures * Poor material control
Waste Material Management	* Unused remaining cutting results * Excessive mixing of wet materials * The amount of waste from the application process
Location Conditions	* Poor work site conditions * Unnatural project site conditions
External Conditions	* Weather effects * Criminal waste causes damage and theft

Priyatno (2010) argues that validity is often used to measure the accuracy of an item in a questionnaire, whether the items in the questionnaire are appropriate in what is intended to be measured. The calculation is done by correlating the item scores with the total item score. From the results of the correlation calculation, a correlation coefficient will be obtained which is used to measure the level of validity of an item and determine whether an item is suitable for use or not. To determine whether an item is valid or not, the following assessment criteria are used.

$$rxy = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}} \qquad (2.1)$$

Where :

rxy = The correlation coefficient between variable X and variable Y, the two variables that are correlated;

$\sum X$ = Total item scores;

$\sum Y$ = Total score (all items); and

N = Number of samples.

1. If R count ≥ R tabel then the instrument or question item is significantly correlated with the total score (declared valid).
2. If R count ≤ R tabel then the instrument or question item does not correlate significantly with the total score (declared invalid).

Ghozali (2007) argues that significance is determined by comparing the calculated R count with the R table for degree of freedom (df) = n-2, in this case n is the number of samples with a significance level of 0.01 or 1% and 0.05 or 5% in one direction and two directions.

According to Sugiyono (2016), reliability testing is the extent to which measurement results using the same object will produce the same data. The purpose of reliability testing is to determine the consistency and stability of the questionnaire. Thus, the measuring instrument will produce the same results even if used repeatedly by the same researcher or different researchers. The results of this calculation indicate that a variable is reliable if the resulting Cronbach's Alpha value is greater than 0.6.

$$ri = \left[\frac{k}{k-1}\right]\left[1-\frac{\sum \sigma b^2}{\sigma t^2}\right] \quad (2.2)$$

Where :

ri = Instrument reliability;

K = Number of questions;

$\sum \sigma b^2$ = The number of item variances; and

σt^2 = Total variance.

Narbuko and Achmadi (2004) argue that descriptive research is research that attempts to explain solutions to existing problems based on data, as well as presenting, analyzing, and interpreting the data. Descriptive analysis provides the average (mean) value and ranking of each parameter discussed, and is presented in tabular form.

$$Me = \frac{\sum x_i}{n} \quad (2.3)$$

$$Me = \frac{\sum y_i}{n} \quad (2.4)$$

Where :

Me = *Mean*(average);

n = Number of respondents;

∑ = *Sigma*(amount);

Xi = The values of X from i to n; and

Yi = The Y values from i to n.

III. RESULTS AND DISCUSSIONS

3.1 Validity test

Validity testing is conducted to determine whether a statement in the questionnaire is valid or invalid for the variables used, based on the data received from respondents. The steps for conducting this validity test are explained as follows.

1. Each question item in the research questionnaire can be calculated using the equation
2. The output produced from this equation is the calculated R value, which is then compared with the R table.
3. If the calculated R value > R table then the statement in the questionnaire filled in by the worker will be valid, whereas if the calculated R < R table then the statement in the questionnaire filled in by the worker will be invalid.
4. If there are invalid statement items, then the statement can be dropped and the reliability of the valid statement items can then be measured.

Table 3.1 Summary of Validity Test Output

Question	Variables		
	R count	R table (n=30)	Information
X1.1	0.786	0.361	Valid

X1.2	0.799	0.361	Valid
X1.3	0.828	0.361	Valid
X1.4	0.692	0.361	Valid
X2.1	0.708	0.361	Valid
X2.2	0.857	0.361	Valid
X2.3	0.659	0.361	Valid
X2.4	0.812	0.361	Valid
X3.1	0.656	0.361	Valid
X3.2	0.715	0.361	Valid
X3.3	0.810	0.361	Valid
X3.4	0.744	0.361	Valid
X3.5	0.660	0.361	Valid
X3.6	0.705	0.361	Valid
X3.7	0.397	0.361	Valid
X4.1	0.583	0.361	Valid
X4.2	0.870	0.361	Valid
X4.3	0.675	0.361	Valid
X4.4	0.747	0.361	Valid
X4.5	0.383	0.361	Valid
X5.1	0.681	0.361	Valid
X5.2	0.742	0.361	Valid
X5.3	0.861	0.361	Valid
X5.4	0.532	0.361	Valid
X5.5	0.448	0.361	Valid
X5.6	0.428	0.361	Valid
X5.7	0.787	0.361	Valid
X6.1	0.884	0.361	Valid
X6.2	0.726	0.361	Valid
X6.3	0.827	0.361	Valid
X7.1	0.826	0.361	Valid
X7.2	0.917	0.361	Valid
X8.1	0.915	0.361	Valid
X8.2	0.824	0.361	Valid

3.2 Reliability Test

This reliability test is conducted to determine whether a questionnaire is reliable against the variables used, based on the data received from respondents. The steps for conducting this test are explained below.

1. Each variable in the questionnaire is calculated using the equation
2. The output produced from the equation is the Conbranch Alpha value, which is then compared with the value of 0.6 as the fixed value in the reliability test.
3. If the Conbranch Alpha for each variable is > 0.6, then the questionnaire filled in by the worker will be reliable (can be trusted), whereas if the value obtained is < 0.6, then the questionnaire filled in by the worker is not reliable.
4. If a variable is not reliable, the steps taken are to correct the unreliable variables in the questionnaire, then redistribute it to respondents to be rescheduled.

Table 3.2 Recap of Reliability Test Output

No	Indicator	*Cronbach's Alpha*> 0.6	Information
1	X1	0, 778	*Very reliable*
2	X2	0, 731	*Very reliable*
3	X3	0, 793	*Very reliable*
4	X4	0, 691	*Very reliable*
5	X5	0, 765	*Very reliable*
6	X6	0, 746	*Very reliable*
7	X7	0, 668	*Very reliable*
8	X8	0, 663	*Very reliable*

3.3 Descriptive Analysis

This analysis is taken as a whole from all incoming data. The overall data processing shows the general results implemented in the UTU U2 Building Construction Project, segment C. Based on the descriptive analysis output in Appendix B, pages 68-69, it can be grouped as shown in table 4.9 below:

Table 3.3 Mean Factor

No	**Factors Causing Waste Materials to Occur**Reinforcing Steel	Mean
1	Incomplete documents at the time of commencement of construction	1.70
2	Design changes	1.90
3	Incomplete design information	1.80
4	Changes to material specifications after implementation	1.87
	Design Factor (X1)	**1.82**
5	Error in ordering (excess or shortage of what is required)	2.10
6	The item ordered does not match the specifications	1.63
7	Purchases that cannot be made in small quantities	2.07
8	Supplier goods transportation/delivery procedures to the project location (warehouse)	1.83
	Procurement and Purchasing Factors (X2)	**1.91**
9	Improper storage of materials	1.67
10	Damage due to transportation methods from the warehouse to the work location	1.90
11	Less efficient dismantling method	2.17
12	Using low quality materials	1.97
13	The tools used are inadequate	1.70
14	Using defective materials	1.73
15	Poor material handling (e.g. inefficient cutting)	3.80
	Material Handling Factor (X3)	**2.13**
16	Work method errors during the project	1.97
17	Inexperienced workers	2.40
18	Shortage of skilled workers	2.00
19	Ineffective working hours	2.03
20	Bad attitude of workers	4.23
	Worker Factor (X4)	**2.53**
21	Poor planning and scheduling	2.00
22	Poor location management	2.03
23	Lack of worker supervision	2.40
24	Inappropriate construction methods	1.80
25	Lack of communication	2.97
26	Lack of waste prevention measures	2.60

27	Poor material control	2.13
	Construction Management Factor (X5)	**2.28**
28	Unused remaining cutting results	1.90
29	Excessive mixing of wet materials	1.87
30	The amount of waste from the application process	1.80
	Material Residue Management Factor (X6)	**1.86**
31	Poor work site conditions	1.63
32	Unnatural project site conditions	2.07
	Location Condition Factor (X7)	**1.85**
33	Weather effects	2.03
34	Criminal waste causes damage and theft	1.66
	External Condition Factors (X8)	**1.84**

Table 3.4 Summary of Mean Values

No.	Variables	*Mean*	Ranking
1	Design Factors	1.82	8
2	Procurement and Purchasing Factors	1.91	4
3	Material Handling Factors	2.13	3
4	Worker Factors	2.53	1
5	Construction Management Factors	2.28	2
6	Material Residue Management Factors	1.86	5
7	Location Condition Factors	1.85	6
8	External Condition Factors	1.84	7

IV. CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the analysis of the factors causing waste material in the Teuku Umar University U2 Building Construction Project Segment C is as follows:
1. In this study, the sample data used is N = 30 and a significance value of 5% with a value of r = 0.361. After the validity test, it shows that all statements are declared valid because Rhitung>Rtabel, and then for the reliability test, it shows that all outputs from the variables are declared reliable because the Cronbach Alpha value is greater than 0.6. The causal factors that influence the emergence of waste material in the reinforcing steel are Design Factors (X1), Procurement and Purchasing Factors (X2), Material Handling Factors (X3), Worker Factors (X4), Construction Management Factors (X5), Material Residue Management Factors (X6), Location Condition Factors (X7), and External Condition Factors (X8).

2. The most dominant factor causing waste material in the Teuku Umar U2 University Building Construction Project Segment C is the Worker Factor with the largest mean value of the 8 variables, namely 2.53.

ACKNOWLEDGEMENT

On this occasion, the author would also like to express his gratitude to all those who have helped the author with all their efforts and endeavors from the beginning to the completion of this article.

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