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Analysis of the Causes of Waste with the Lean Construction Method on the 1700 Units Apartment Algeria Project

Novika Candra Fertilia, Dian Andaka
Faculty of Engineering, Mercu Buana University, Jakarta, Indonesia
dianandaka@yahoo.co.id

Abstract

The construction industry is currently experiencing various problems such as time and cost overruns. One of the causes is waste. In the construction work of the 1700 apartment unit project in Algeria, it was found that waste was found in materials, tools, and time. One of the ways to control waste is lean construction. The purpose of this study is to determine the causes that have a high influence on the presence of waste in the 1700 unit Algerian apartment project and to know the strategies to manage it through the lean construction approach. This research method was conducted with a 4-stage questionnaire. The results obtained in this study are the causes that have a high effect on the presence of waste in the 1700 apartment unit construction project in Algeria: a. Last Planner System (poor planning and scheduling), b. First Run Studies (bad weather in winter), c. 5S Process (Visual Work Place) (a place where the material is easily disturbed and unsafe, and d. Fail-safe for Quality and Safety (repair work). Strategies that can be applied: a. Last Planner System: making an appropriate master schedule and evaluation daily, b.First Run Studies: evaluating the anticipation of bad weather, and claiming lost time, c. 5S Process: grouping materials and moving materials, d. Fail-safe for Quality and Safety: conducting routine daily meetings and using appropriate repair methods .

Keywords:
Apartment, Lean Construction, Waste

1. Introduction

The construction industry is currently experiencing various problems such as time and cost overruns, poor safety and health, bad environmental influences, managerial problems, inefficiency in the construction process. Building construction is often classified under the order of the lowest in production management efficiency.

One of the causes of inefficiency in the construction process is waste of waste. Waste in the construction process is a loss that results in losses in terms of cost, quality, and time. This form of waste can be generated from materials, tools, human resources, time, and so on. . Based on data from the Lean Construction Institute (LCI), waste in the construction industry is 57% (oleh Ir. H. Muh. nur Sahid, M.M., 2017).

During the construction of the 1700 apartment unit construction project in Algeria, it was found that there was waste in materials, tools, and time which could cause costs and project schedule not to be achieved. Waste cannot be avoided but can be controlled, one of which is with lean construction. For this reason, construction companies need to carry out good construction management in order to find out what are the causes of waste in construction projects so that they can be managed properly with a lean construction approach.

Figure 1. Project of 1700 units apartment Algeria

The aim of this research is:

a. Knowing the causes that have a high effect on the existence of waste in the 1700 units apartment Algeria project.
b. Knowing the strategies that can be applied to manage high-impact waste through the lean construction approach in the 1700 units apartment Algeria project.

2. Literatur Review

2.1 Waste

Waste is all kinds of loss resulting from an activity that generates costs, either directly or indirectly, but does not add to the benefits/value of a product from the client's point of view.(Ahmad Chasan Mudzakir, 2017). In general, waste is not just wasted materials, but also other resources such as time, energy (manpower), and tools that do not provide added value (sapitri, 2019).

2.2 Waste Identification

The waste referred to the seven types of waste that Ohno identified as part of the Toyota Production System, known as lean manufacturing. The definition for each waste is as follows (Lubis, 2016) :

a. Overproduction

Overproduction is the most dangerous waste, which will lead to production problems where too much of this waste is produced or obtaining goods before they are really needs.

b. Defect

Defect can occur due to various things, namely; man, machine, method, material, etc. This waste causes more costs for collateral and rework to repair the defective product.

c. Excessive Transportation

This waste occurs as a result of inefficient worksite layouts where the materials needed are transferred from one process to another. This will result in the risk of being damaged, lost, delayed, etc.

d. Waiting

Waiting refers to the waiting time between activities. Workers must wait for the material to be sent or wait for the machine to be processed.

e. Unnecessary Inventory

Unnecessary inventory occurs due to excess storage and delay of product or material information which causes increased costs and decreased service to customers.

f. Unnecessary Motion

It can be defined as a symptom related to the use of the time that does not add value to the product or process. This type of waste is common in workforce activities in factories or projects, occurs due to the unreliable conditions of the work environment and equipment, which can disrupt production lead times and information flow.

g. Inappropriate Processing

This waste refers to unnecessary operations (to do more than the customer wants). This may also lead to extra transportation due to poor communication.

2.3 Waste In Construction Projects

Waste generated during the construction process affects project productivity and also negatively affects the environment, or in other words, it has a bad impact on the surrounding environment. (Asih Triandini, 2019).

Waste in the construction sector is often equated with nonvalue-added costs, which can be interpreted as the loss or loss of various resources, namely material, time, and capita, which are caused by activities that require direct or indirect costs but do not add value to the final product for the construction service user.

The problem that is often faced in construction projects is that no matter how well the planning has been done, at the implementation stage there are always changes that result in delays in completion. (Julisa, 2019). Waste is a major problem in a construction project because this has an impact on the environment around the project (Cintya Puput Zulaida, 2019).

2.4 Lean Construction

The term "lean construction" was first coined by the International group for lean construction in 1983. Then Glenn Ballard and Greg Howell founded the Lean Construction Institute (LCI) in August 1997. Lean construction is a way to design a production system to minimize waste, both materials and time, human power with the aim of producing maximum value. This system is to identify the root causes of waste, eliminate the causes and prevent the waste (Jamil Sarhan, 2017).

The philosophy of Lean Manufacturing is taken from the Toyota culture, namely the Toyota Production System (TPS) where TPS became the first model of worldwide lean management developed by Japanese companies after the second world war. The philosophy of lean construction is adapted from the philosophy of lean manufacturing with the characteristics and limitations of the construction industry.

Unlike lean manufacturing, lean construction focuses on the production process of the project. Lean construction has links to project progress in all dimensions of construction and the environment, including design, implementation of activities, maintenance, safety, and recycling. The concept of this approach tries to regulate and improve the construction process by obtaining maximum value with minimum costs related to customer needs (Lubis, 2016).

2.5 Lean Construction Principles and Models

There are several main principles in lean construction, namely: (Mohamed Saad Bajjou, 2019).

a. Focus on the customer : Customer relations, customer involvement, flexible resources, value optimization / value identification.
b. Employee involvement : Employee involvement, top management involvement / contractor involvement, training, Health Safety Environment (HSE).
c. Supply : Supply Chain Management (SCM), on time, supplier involvement, pull system.
d. Standardization : Job optimization, job definition.
e. Quality : Total Quality Management (TQM), error checking, reaction to error / problem source analysis, fail-safe for quality.
f. Waste elimination : Reducing process cycle time, waste awareness, value stream mapping, product system optimization.
g. Planning and scheduling : Last planning system, Percent Plan Complete (PPC) chart, planning collaboration.
h. Continuous improvement : Matrices (productivity, quality, safety), organizational learning, first run studies / PDCA, huddle meetings.
i. Transparency : Visual management, workplace organization.

2.6 Lean Construction Tools

In the book Lean Construction Management - The Toyota Way, Salem and his friends discuss the transferability of lean manufacturing techniques to the world of construction. Assessment tools are developed to evaluate the impact of lean construction tools on construction project performance. Salem only focuses on the feasibility of lean production tools in the construction industry, these tools include :

a. Last Planner System

Last Planner System (LPS) is a method in the form of a workflow and maps various activities in construction projects. In the LPS there is a sequence of implementation, namely; master schedule, Reverse Phase Schedule (RPS), six week lookahead, Weekly Work Plan (WWP), Percent Plan Complete (PPC). (Ahmad Chasan Mudzakir, 2017).

b. Increased Visualization

Increased Visualization is a means of communicating effectively to employees through the installation of various signs, signs, and labels around construction sites. (Ahmad Chasan Mudzakir, 2017).

c. Daily Huddle Meetings

Two-way communication is the key to the daily team meeting in order to make employees participate. This concept is similar to employee involvement in lean manufacture, which empowers workers by observing reactions when facing problems, and opens communication intensively through the meeting tool box. (Ahmad Chasan Mudzakir, 2017).

d. First Run Studies

These activities usually use media such as videos, photos, or graphics to show a construction project process or illustration. A PDCA cycle (plan, do, check, action) is suggested as a basis for enhancing learning. (Ahmad Chasan Mudzakir, 2017).

e. 5S Process (Visual Work Place)

5S Process is "a location for everything and everything is found at that location". 5S process has five stages of improvement that can help minimize waste (Kobayashi, 1995; Hirano, 1996), namely; Seiri (sort), Seiton (straighten), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain). (Ahmad Chasan Mudzakir, 2017).

f. Fail-safe for Quality and Safety

Fail-safe for quality relies on ideas being aware of the potential for flaws. It is the same as virtual inspection (poka-yoke) on lean manufacturing. (Ahmad Chasan Mudzakir, 2017).

2.7 Benefits of Lean Construction

Based on research from Aftab Hameed Memon, Muhammad Akram Akhund, Abdul Nasir Laghari, Hafiz Usama Imad, and Shadab Noor Bhangwar in 2018, there are several benefits of lean construction, including;

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reduce project duration, reduce waste, streamline workflow, visual control, improve safety, improve project quality, customer satisfaction, increase flexibility, good scheduling, reduce breakdowns, standardize work, simplify work, reduce costs, good estimation, and profit / more profit.

3. Methodology

The method used in this study used a questionnaire instrument. The questionnaire consists of 4 stages and is processed with the help of SPSS and Importance Index (IMPI). The 4-stage questionnaire includes:

a. Questionnaire of validation phase 1
b. Questionnaire of pilot survey
c. Questionnaire of respondents
d. Questionnaire of final expert validation

3.1 Questionnaire of Validation Phase 1

This questionnaire is a questionnaire with expert validation. Show whether the variables are relevant to the indicators in this study. Initial expert validation was carried out by giving a questionnaire to the expert containing the variables from the results of the literature study. These variables must be validated by an expert before they are put into the respondent's questionnaire so that the variables issued in the respondent's questionnaire are in accordance with the expected research objectives. Experts in this stage also help to add or subtract variables to be used in research.

3.2 Questionnaire of Pilot Survey

The pilot survey questionnaire is a questionnaire that aims to make adjustments to the delivery or language used in the questionnaire so that the research objectives are achieved.

3.3 Questionnaire of Respondents

Respondent's questionnaire is a questionnaire given to respondents after validation phase 1 and a pilot survey to determine the causes of construction waste which aims to collect information from respondents about this research.

From a specified number of populations, samples were taken to conduct research using random sampling techniques because the population was homogeneous and because any element selected as the sample could represent the population. The calculation of the number of samples taken based on the Slovin formula is as follows:

$$n = \frac{N}{N\,x\,(d)^2 + 1}$$

$$n = \frac{45}{45\,x\,(0.1)^2 + 1}$$

$$n = 31.0344$$

$$n = 31\,person\,(rounded)$$

Note :
n = sample
N = population = 45
d = 0.1 if precision 90%

At this stage of the questionnaire, validity and reliability tests were carried out using SPSS software. The Pearson moment validity test uses the principle of correlating each questionnaire item score with the total score of respondents' answers. The instrument test is said to be valid if the pearson correlation (r count) output on SPSS is greater than the r table and vice versa. This reliability test aims to determine the level of consistency or reliability of the research instrument itself if measurements are carried out using the questionnaire repeatedly. To determine the reliability level of an instrument, look at the alpha of the test results and compare it with Cronbach's alpha with a minimum of 0.6.

After the data has been tested and produces reliable results, then the variables are calculated the Frequency Index (FI), Severity Index (SI), and Importance Index (IMPI) to determine the variables that have a high influence in this study. Frequency Index (FI) is the percentage of the probability score or frequency of events calculated based on the respondent's answer. FI can be calculated by the following formula:

$$FI\,(\%) = \frac{\sum_1^5 ai\,ni}{5\,N} x\,100$$

Note :
FI = Frequency Index
ai = The weight given by the respondent with a score of i; ai = 1,2,3,4, and 5

ni = The number of respondents who answered the score of i
N = The total number of respondents

Severity Index (SI) is the percentage score of the severity or impact of an event in terms of time, cost, and quality which is calculated based on the respondent's answer. SI can be calculated in the formula below :

$$SI\ (\%) = \frac{\sum_{1}^{5} ai\ ni}{5\ N} x\ 100$$

Note :
SI = Severity Index
ai = The weight given by the respondent with a score of i; ai = 1,2,3,4, and 5
ni = The number of respondents who answered with a score of i
N = The total number of respondents

IMPI is used to show importance index from the multiplication of frequency and severity. IMPI can be calculated by the formula :

$$IMPI\ (\%) = \frac{FI\ (\%)\ x\ SI\ (\%)}{100}$$

Note :
FI = Frequency Index
SI = Severity Index
IMPI = Importance Index

In the IMPI results, high influencing variables can be classified according to the following score ranges :

Table 1. Classification of IMPI score ranges

Number	Scale	Information
1	Index 0% - 20%	Low
2	Index 21% - 40%	Moderate
3	Index 41% - 60%	Significant
4	Index 61% - 100%	High

3.4 Questionnaire of Final Expert Validation

The final expert validation questionnaire is the result of the validation of the respondent's questionnaire that has been approved by the experts. At this stage, previously the IMPI score was taken which could be categorized as having a high influence (significant and high). Filling the questionnaire by experts aims to validate the end to find out the results of the respondents' questionnaire so that it fits the purpose of this study and to provide a way to control the causes of waste based on the experience of experts

4. Result and Discussion

4.1 Questionnaire of Validation Phase 1

The following is expert education data, amounting to 3 people in this study:

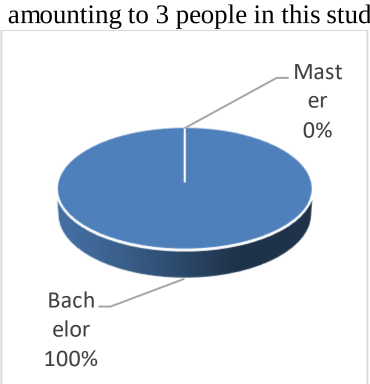

Figure 2. Percentage of expert education

Whereas for the expert work experience is as follows:

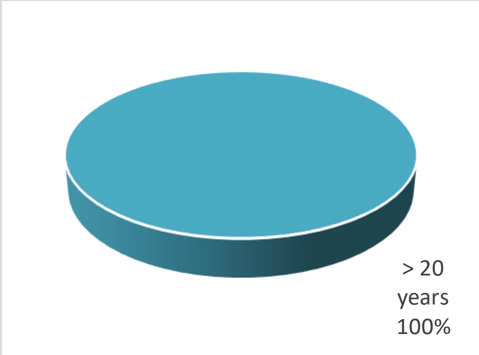

Figure 3. Percentage of expert experience

The results of the stage 1 expert validation questionnaire can be seen in table 2 :

Table 2.The results of the stage 1 expert questionnaire

The Cause of Waste	Code	Expert Approval 1	Expert Approval 2	Expert Approval 3	Conclusion
Last Planner System					
Time waiting for material to come	X1.1	Yes	No	Yes	Yes
Time waiting for tools to come	X1.2	Yes	Yes	Yes	Yes
Poor planning and scheduling	X1.3	Yes	Yes	Yes	Yes
Lack of measuring tools for achieving weekly targets	X1.4	Yes	Yes	Yes	Yes
Increased Visualization					
Lack of safety signs	X2.1	Yes	Yes	Yes	Yes
Daily Huddle Meetings					
Job instruction error	X3.1	Yes	Yes	Yes	Yes
Poor coordination	X3.2	Yes	Yes	Yes	Yes
Unemployed workforce	X3.3	Yes	Yes	Yes	Yes
Slow / ineffective worker	X3.4	Yes	Yes	Yes	Yes
Solidless teamwork	X3.5	Yes	Yes	Yes	Yes
Time waiting for instructions	X3.6	Yes	Yes	Yes	Yes
First Run Studies					
Work accident	X4.1	Yes	Yes	Yes	Yes
Lack of adjustment of work methods to the conditions and constraints found	X4.2	Yes	Yes	Yes	Yes
Bad weather in winter	X4.3	Yes	Yes	Yes	Yes
There was a complaint from the public	X4.4	Yes	Yes	Yes	Yes
5S Process (Visual Work Place)					
Loss of material on site	X5.1	Yes	Yes	Yes	Yes
Losing tools on site	X5.2	Yes	Yes	Yes	Yes
The material storage area is easily disturbed and unsafe	X5.3	Yes	Yes	Yes	Yes
The absence of the implementation of the 5S (Sort, Straighten, Shine, Standardize, Sustain)	X5.4	Yes	Yes	Yes	Yes
Material damage on site	X5.5	Yes	Yes	Yes	Yes
Fail-safe for Quality and Safety					
Late surveillance	X6.1	Yes	Yes	Yes	Yes
Rework	X6.2	Yes	Yes	Yes	Yes
Repair	X6.3	Yes	Yes	Yes	Yes

Of all these variables, there are conclusions of 23 variables that are approved by the expert, so that these 23 variables will be continued at the pilot survey questionnaire stage.

4.2 Questionnaire of Pilot Survey

The following is the educational data for the pilot survey respondent, totaling 5 people in this study:

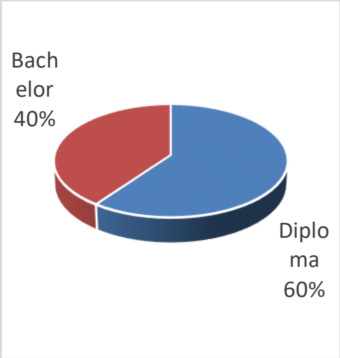

Figure 4. Percentage of education pilot survey respondent

Meanwhile, the experiences of the survey pilot respondents are as follows:

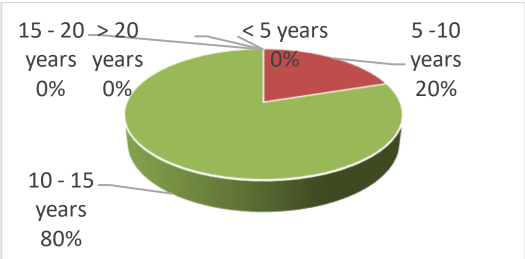

Figure 5. Percentage of work experience pilot survey respondent

The results on the survey pilot questionnaire can be seen in the following table :

Table 3. Results of the pilot survey questionnaire

Variable	Code	Easy to Understand Statement					Conclusion
		1	2	3	4	5	
Last Planner System							
Time waiting for material to come	X1.1	Yes	Yes	Yes	Yes	Yes	Yes
Time waiting for tools to come	X1.2	Yes	Yes	Yes	Yes	Yes	Yes
Poor planning and scheduling	X1.3	Yes	Yes	Yes	Yes	Yes	Yes
Lack of measuring tools for achieving weekly targets	X1.4	Yes	Yes	Yes	Yes	Yes	Yes
Increased Visualization							
Lack of safety signs	X2.1	Yes	Yes	Yes	Yes	Yes	Yes
Daily Huddle Meetings							
Job instruction error	X3.1	Yes	Yes	Yes	Yes	Yes	Yes
Poor coordination	X3.2	Yes	Yes	Yes	Yes	Yes	Yes
Unemployed workforce	X3.3	Yes	Yes	Yes	Yes	Yes	Yes
Slow / ineffective worker	X3.4	Yes	Yes	Yes	Yes	Yes	Yes
Solidless teamwork	X3.5	Yes	Yes	Yes	Yes	Yes	Yes
Time waiting for instructions	X3.6	Yes	Yes	Yes	Yes	Yes	Yes
First Run Studies							
Work accident	X4.1	Yes	Yes	Yes	Yes	Yes	Yes
Lack of adjustment of work methods to the conditions and constraints found	X4.2	Yes	Yes	Yes	Yes	Yes	Yes
Bad weather in winter	X4.3	Yes	Yes	Yes	Yes	Yes	Yes
There was a complaint from the public	X4.4	Yes	Yes	Yes	Yes	Yes	Yes
5S Process (Visual Work Place)							
Loss of material on site	X5.1	Yes	Yes	Yes	Yes	Yes	Yes
Losing tools on site	X5.2	Yes	Yes	Yes	Yes	Yes	Yes
The material storage area is easily disturbed and unsafe	X5.3	Yes	Yes	Yes	Yes	Yes	Yes
The absence of the implementation of the 5S (Sort, Straighten, Shine, Standardize, Sustain)	X5.4	Yes	Yes	Yes	Yes	Yes	Yes
Material damage on site	X5.5	Yes	Yes	Yes	Yes	Yes	Yes
Fail-safe for Quality and Safety							
Late surveillance	X6.1	Yes	Yes	Yes	Yes	Yes	Yes
Rework	X6.2	Yes	Yes	Yes	Yes	Yes	Yes
Repair	X6.3	Yes	Yes	Yes	Yes	Yes	Yes

From all variables, there are conclusions that 23 variables have passed the pilot survey stage, so that 23 variables will be continued at the responsive questionnaire stage.

4.3 Questionnaire of Respondents

The following is the education data of respondents, which amounted to 31 people in this study :

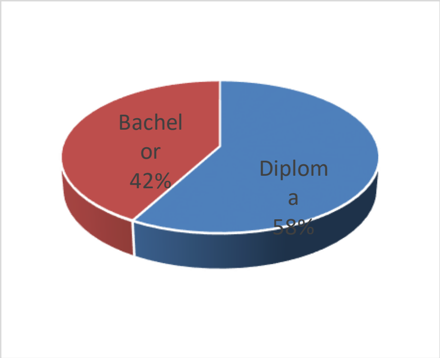

Figure 6. Percentage of respondent education

Meanwhile, the respondents' experiences are as follows :

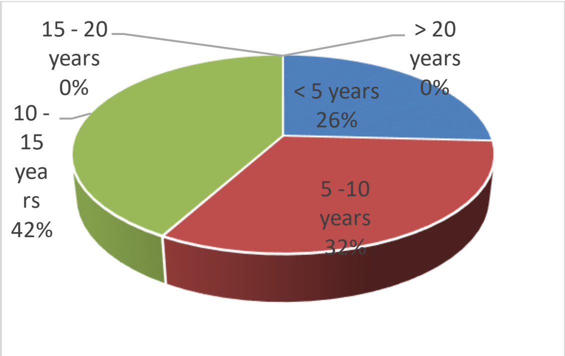

Figure 7. Percentage of respondent's work experience

The results on the respondent's questionnaire can be seen in the following table :

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Table 4. Results of the respondent's questionnaire

Variable	Code	Frequency					Severity				
		1	2	3	4	5	1	2	3	4	5
Last Planner System											
Time waiting for material to come	X1.1	0	6	18	7	0	0	12	13	6	0
Time waiting for tools to come	X1.2	0	9	12	10	0	0	9	16	6	0
Poor planning and scheduling	X1.3	0	5	14	11	1	0	6	10	13	2
Lack of measuring tools for achieving weekly targets	X1.4	0	8	16	6	1	0	12	14	5	0
Increased Visualization											
Lack of safety signs	X2.1	4	11	10	6	0	2	11	14	4	0
Daily Huddle Meetings											
Job instruction error	X3.1	2	10	12	7	0	1	8	16	6	0
Poor coordination	X3.2	1	10	11	7	2	2	11	14	3	1
Unemployed workforce	X3.3	1	6	15	9	0	2	11	11	7	0
Slow / ineffective worker	X3.4	1	4	18	8	0	1	8	13	7	2
Solidless teamwork	X3.5	2	6	15	8	0	1	8	17	4	1
Time waiting for instructions	X3.6	1	9	14	7	0	1	11	16	3	0
First Run Studies											
Work accident	X4.1	2	10	16	3	0	2	11	14	4	0
Lack of adjustment of work methods to the conditions and constraints found	X4.2	1	11	9	10	0	2	6	17	6	0
Bad weather in winter	X4.3	1	2	12	12	4	1	3	13	12	2
There was a complaint from the public	X4.4	1	12	12	5	1	1	11	12	6	1
5S Process (Visual Work Place)											
Loss of material on site	X5.1	1	9	15	5	1	1	12	11	5	2
Losing tools on site	X5.2	1	11	13	5	1	1	16	12	0	2
The material storage area is easily disturbed and unsafe	X5.3	1	5	14	8	3	1	6	11	9	4
The absence of the implementation of the 5S (Sort, Straighten, Shine, Standardize, Sustain)	X5.4	3	12	13	3	0	2	9	16	4	0
Material damage on site	X5.5	1	6	17	7	0	1	9	13	8	0
Fail-safe for Quality and Safety											
Late surveillance	X6.1	1	10	12	8	0	1	10	14	6	0
Rework	X6.2	1	7	14	7	2	1	4	15	10	1
Repair	X6.3	1	5	15	4	6	1	5	9	12	4

Several tests were conducted on the results of the respondent's questionnaire, namely by testing the validity and reliability testing with the help of SPSS software. The results of the validity test are as follows :

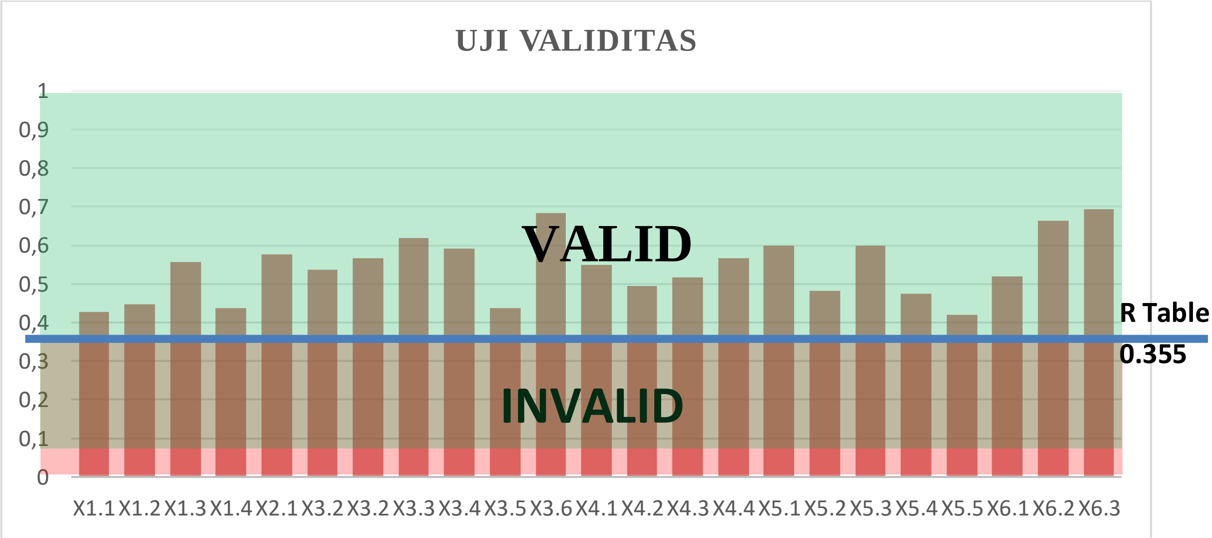

Figure 8. The results of the validity test

After the validity test is carried out, it is known that the score of r count for all variables is declared valid so that it can be continued with the next test stage. The next test is the reliability test, which is to determine the reliability level of an instrument which can be seen in alpha and compared with the cronbach alpha score. The results of the reliability test in this study are as follows:

Table 5. Reliability test results

Cronbach Alpha	N of Items
0,892	23

From the table above, it is obtained that the Cronbach alpha score is 0.892 which can be seen in the range 0.80 to 1, it can be concluded that the instrument data used is very reliable.

After being declared valid and reliable, the calculation of FI, SI and IMPI is then carried out to determine the level of a variable. The following is the FI score based on the results of the respondent's questionnaire :

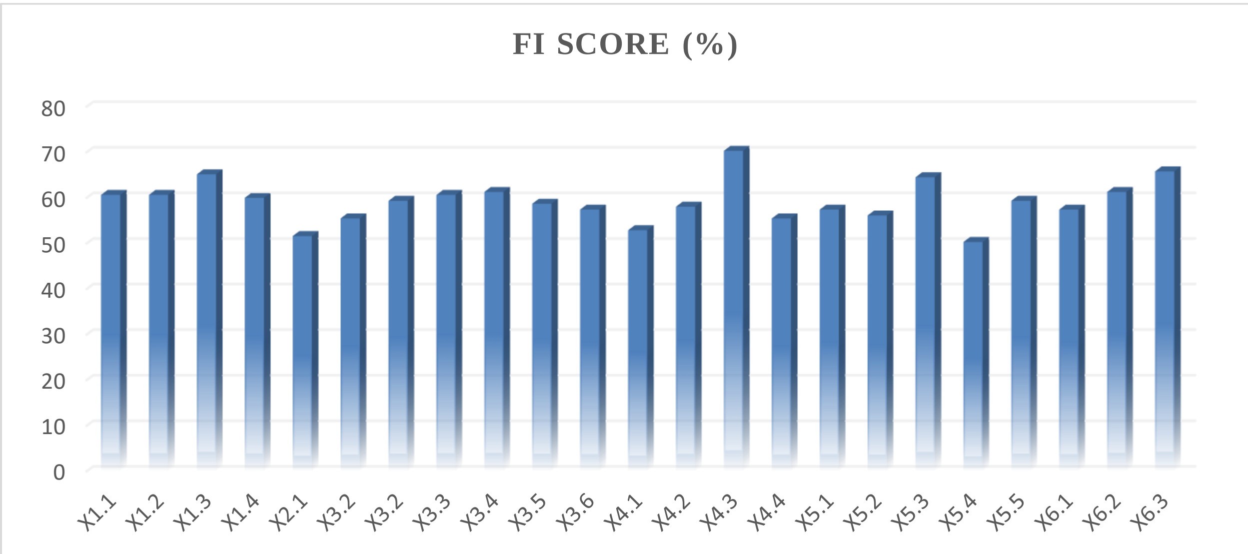

Figure 9. Bar chart of score Frequency Index (FI) %

After calculating the FI, proceed with calculating the SI. The following is the SI score based on the respondent's questionnaire :

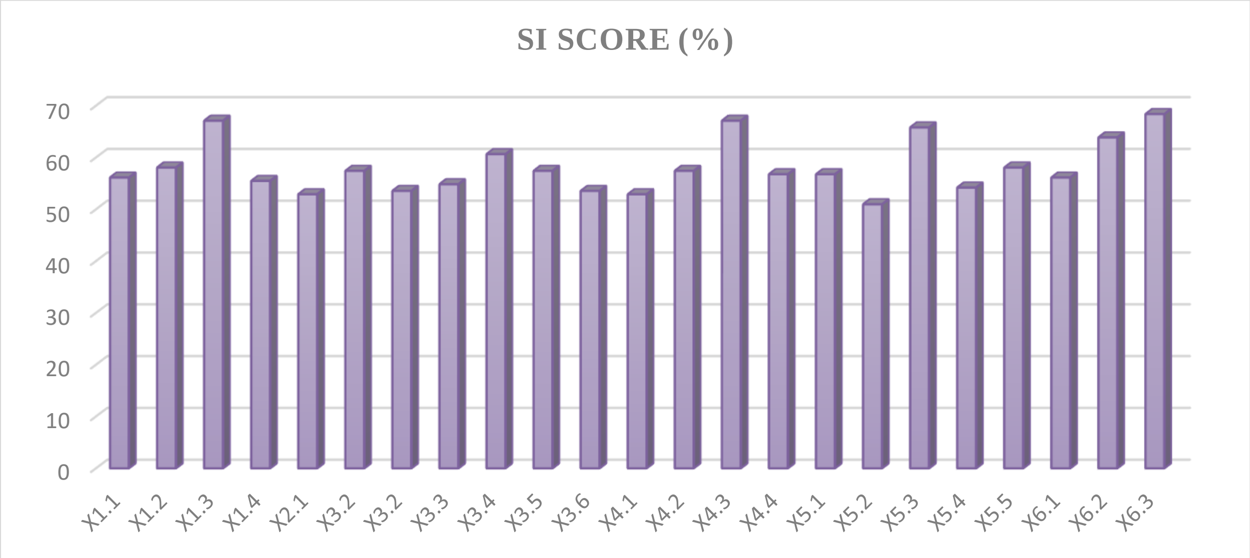

Figure 10. Bar chart of score Severity Index (SI) %

Furthermore, the IMPI can be calculated with the following results :

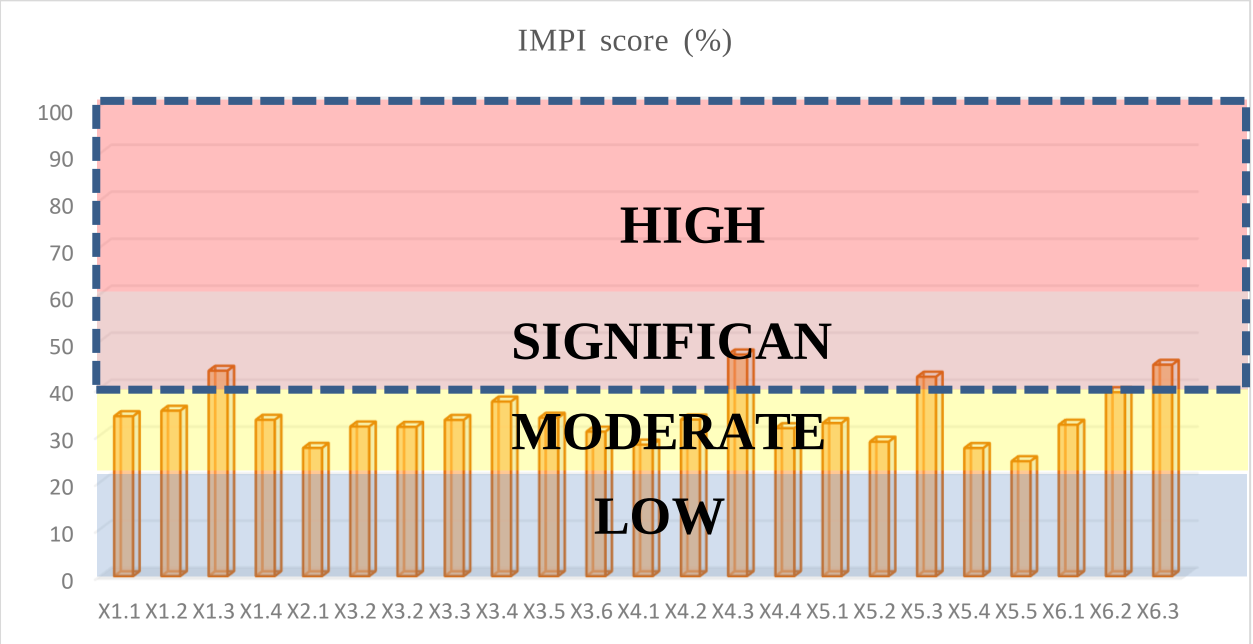

Figure 11. Bar chart of score Importance Index (IMPI) %

From the IMPI results, there are 4 variables which are categorized as "significant". Variables that have a significant category are found in the last planner system tools, first run studies, 5S process (visual work place), and fail-safe for quality and safety. Some of these variables have the code X1.3 - Poor planning and scheduling (IMPI 43.72%), X4.3 - Bad weather in winter (IMPI 47.18%), X5.3 - The material storage area is easily disturbed and unsafe (42.46%), and X6.3 – Repair (IMPI 45.00%).

4.4 Questionnaire of Final Expert Validation

Following are the results of the final expert validation agreement :

Table 6. Results of final approval of the final expert validation questionnaire

Variables Affecting Project Performance Due to Waste	Code	Expert 1		Expert 2		Expert 3	
		Yes	No	Yes	No	Yes	No
Last Planner System							
Poor planning and scheduling	X1.3	✓		✓		✓	
First Run Studies							
Bad weather in winter	X4.3	✓		✓		✓	
5S Process (Visual Work Place)							
The material storage area is easily disturbed and unsafe	X5.3	✓		✓		✓	
Fail-safe for Quality and Safety							
Repair	X6.3	✓		✓		✓	

All variables were approved by the expert, as for the results of preventive and corrective actions from the final expert validation questionnaire:

Table 7. Results of preventive and corrective action final expert validation questionnaire

Variables Affecting Project Performance Due to Waste	Code	Expert	Preventive	Corrective
Last Planner System				
Poor planning and scheduling	X1.3	1	Daily evaluation and monitoring is held.	Make changes to methods based on daily evaluation and monitoring.
		2	Create a master schedule with the most appropriate critical path.	Perform schedule evaluation, especially on critical paths that have gone out of time.
		3	Scheduling that is integrated directly with materials, tools, and time.	Carry out daily schedule control through daily reports
First Run Studies				
Bad weather in winter	X4.3	1	Carrying out new innovations in order to reduce the risk of increased waste.	The work method was created to increase the hot temperature to speed up the drying of the concrete so that the formwork unloading cycle can be achieved and the strength of the concrete is achieved.
		2	Conducting continuous evaluation of the anticipation of bad weather.	Do over time (claim) to make up for lost time due to cold weather.
		3	Conducting studies on other similar projects in anticipation of the impact of waste in winter.	A large warehouse is made, if there are already rooms in the building it can be used for the warehouse, it will be better, prepare covers and tool boxes in the field.
5S Process (Visual Work Place)				
The material storage area is easily disturbed and unsafe	X5.3	1	Made closed which is safe from weather disturbances.	Making data collection and grouping of material types and material stock containers, which are weather resistant and not weather resistant
		2	Improve the quality and quantity of security officers (security).	Perform patrols and shift changes 24 hours by security officers (security).
		3	Choosing and sorting storage places or warehouses according to the type of material or equipment when	Regularly moving disturbed and unsafe materials, especially those with large waste, such as iron.

			you first arrive at the site.	
Fail-safe for Quality and Safety				
Repair	X6.3	1	The implementation plan is carried out carefully, and is applied with a master schedule	The repair method is carried out in the event of irregularities and evaluated so that there are no re-deviations.
		2	Hold weekly meetings and monitor daily implementation according to the master schedule.	Create a more efficient method based on evaluation and close weekly.
		3	Creating a master schedule includes materials, tools, labor and time.	Doing repairs with the consideration of minimizing waste, especially material and time.

5. Conclussion

a. The causes that have a high influence on the existence of waste on the 1700 units apartment Algeria construction project :
   1. Last Planner System : Poor planning and scheduling
   2. First Run Studies : Bad weather in winter
   3. 5S Process (visual work place) : The material storage area is easily disturbed and unsafe
   4. Fail-safe for Quality and Safety : Repair

b. Strategies that can be applied to manage high-impact causes of waste through the lean construction approach on the 1700 units apartment Algeria project:
   1) Poor planning and scheduling
      Preventive : Making the right master schedule integrated with tools and people as well as daily monitoring.
      Corrective : Perform daily routine evaluation and monitoring and control on the critical path.
   2) Bad weather in winter
      Preventive : Conduct bad weather anticipation evaluations and studies of other projects.
      Corrective : File weather lost time claims, set up an all-weather warehouse, and apply special winter methods.
   3) The material storage area is easily disturbed and unsafe
      Preventive : Grouping the use of good and closed storage and evaluation of security officers.
      Corrective : The removal of the wrong material parallel based on the location list of material types, increased security guards.
   4) Repair
      Preventive : Routinely conduct daily and weekly meetings referring to the master schedule.
      Corrective : Perform the repair method with good consideration and re-evaluate it.

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Biography

Novika Candra Fertilia, born in Belitang on November 12, 1989. She earned her Engineer title in Civil Engineering in Lampung University in 2012 with the title of her thesis is Project Planning Using Primavera Project Planner. She earned her Master of Civil Engineering with concentration in Construction Management from University of Indonesia in 2016 with the title of her thesis is Development of Planning Process on EPC Project Based on PMBOK to Improve Time Performance at PT. KE. Now she is a Lecturer in Faculty of Engineering at Mercu Buana University with several courses such as Construction Management, Survey and Spatial Information, Physics, and Mechanical of Material.

Dian Andaka, born in Jakarta on June 19, 1995. He earned his Diploma 3 in Civil Engineering degree with concentration in Building Construction Engineering from Jakarta State Polytechnic in 2016 with the title of Final Project is Formwork Implementation Methods in the Medical Education and Research Centre Project, Faculty of Medical, University of Indonesia . Now, he is continuing his studies to earn a Bachelor's degree in Civil Engineering at Mercu Buana University.