JICE Journal Innovation of Civil Engineering

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

ANALYSIS OF DELAY FACTORS IN THE CONSTRUCTION PROJECT OF THE PROMOTION CENTER BUILDING AND BATIK DERIVATIVE PRODUCTION BUILDING IN PAMEKASAN

Ahmad Fatoni[1], **Fairus Zabadi**[2], **Muhammad Saifuddin**[3]

[1,2,3]Civil Engineering, University of Madura, Pamekasan, 69371, Indonesia

e-mail: fatoni@unira.ac.id

ABSTRACT

The construction of the Promotion Center Building and Written Batik Derivative Production Building is a development project with service provider PT. Hariz Three Sons. Tree Analysis (FTA) to determine the causes and impact of risk failure and Critical Path Method (CPM) to determine the extent to which work experiences a critical path. The most dominant causal factors are factors caused by external factors, namely in the form of very high rainfall intensity in one month and unilateral blockades by village officials. The causal factor caused by the owner is the delay in submitting design changes to the field where the design is very important as a development guide. Meanwhile, delays caused by implementers are inappropriate duration determinations that result in work productivity not being properly controlled. Floor work and wall ornaments this work on the last day of the contract only produced 1.286% of the total 17.50%, which means there was a deviation of -16.211%. Floor work and wall ornaments have several work items including Install UK Polished Ceramic Floors. 60 x 60 cm, Install KM/WC Color Ceramic Floor 20 x 20 cm, Install Color Ceramic Wall 20 x 40 cm, Install 1 m ceramic plinth measuring 5 cm x 20 cm, Install 1 m2 Cutting Plate 5mm Thick Batik Motif + frame and Lettering Jobs.

Keywords: *Project Delay Factors; Fault Tree Analysis (FTA); Critical Path Method (CPM).*

1. Introduction

A project is a temporary activity that lasts for a limited period, with certain resources, and is intended to carry out tasks with clearly outlined goals and objectives [19]. In a project, there will generally be an agreement between the owner, contractor, and consultant which contains the agreed costs, specifications, and time which must be completed before or exactly at the specified time [17]. The measure of project success is stated if it meets 3 conditions, namely budget (the project must be completed at a cost that does not exceed the budget), schedule (the project must be carried out following the specified period and end date), and quality (the product or result of the project activity must meet the specifications and required criteria) [16].

The construction of the Promotion Center Building and Written Batik Derivative Production Building is a development project with service provider PT. Hariz Three Sons. The construction process for the Promotion Center Building and Written Batik Derivative Production Building began in August 2022 and was planned to be completed in December 2022, however, the realization in the field was still ongoing until completion in mid-January 2023 which resulted in project delays. Many factors cause this project to experience delays. Starting from when there were objections by other contractors when the Work Order had been started for 2 weeks to the unilateral blockade by local village officials where the project location was being built.

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

With the many factors inhibiting project development that have an impact on project delays, it is necessary to carry out an in-depth evaluation and analysis using scientific methods regarding delays in the project for the construction of the Promotion Center Building and the Handwritten Batik Derivative Production Building. This research aims to analyze the causes of delays in the construction of the Promotion Center Building and the Handwritten Batik Derivative Production Building, by examining what factors cause project delays by interviewing people who are active in this project which are then processed using the Fault method. Tree Analysis (FTA) to determine the causes and impact of risk failure and Critical Path Method (CPM) to determine the extent to which work experiences a critical path. It is hoped that this research can analyze the factors that cause delays using risk management methods and can identify the highest factors that cause project delays.

2. Material and Methods

2.1 Data Collection

The data in this research is divided into two, namely primary data and secondary data. Primary data is project data in the form of weekly reports, RAB, interviews, and Project Implementation Schedules. Meanwhile, secondary data is literature that explains the use of Fault Tree Analysis and interviews with related parties. The data collection technique is by analyzing the Time Schedule and weekly progress reports obtained from the Project Supervisory Consultant for the Construction of the Promotion Center Building and the Handwritten Batik Derivative Production Building. Observations were carried out by collecting other data such as RAB and also conducting direct interviews with several parties actively involved in project implementation.

2.2 Sample and Population

Population is a generalization area consisting of objects or subjects that have exclusive qualities & characteristics determined by researchers to be studied and then draw conclusions. Meanwhile, the sample is part of the number and characteristics of the population. The population sampled in the research were people who were actively involved in the construction of the Promotion Center Building and Handwritten Batik Derivative Production Building. Because the population of people actively involved in working on development projects is known, the sampling technique in this research is probability sampling using simple random sampling.

Because the population in this study is known, when taking the sample size you can use the Slovin formula as follows:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

With:
n = sample size
N = population size
e = Margin of error

In choosing the number of samples to be selected, the author uses a margin of error of 15%, because in every study it is impossible for the results to be 100% correct, the greater the margin of error, the smaller the number of samples used.

2.3 Research Flow Chart

Below is an illustration of the research flow starting from the research background, the methods used, to the expected results that will be obtained through this research. So that it provides an idea of how this research will proceed. The stages of this research method will be explained in the following flow chart.

JICE Journal Innovation of Civil Engineering
Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

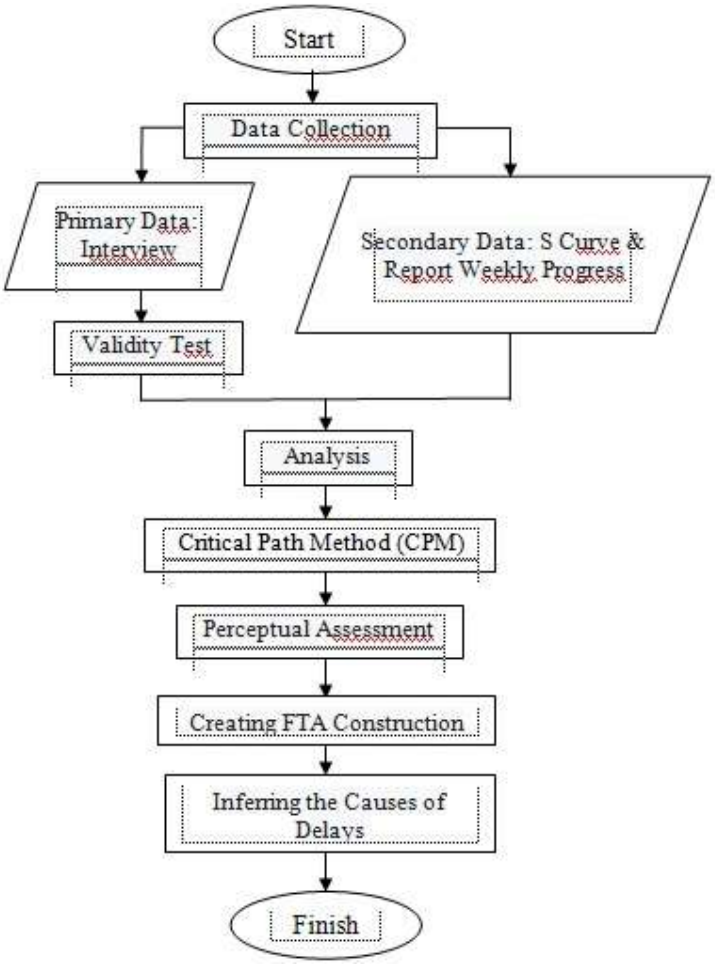

Figure 1. Research Flow Chart

3. Result and Discussion

3.1 Identify the Cause of Delay

Projects are activities that involve resources in the form of labor, construction equipment, materials, money, and implementation methods [15]. Many conflicts occurred during the construction of the Promotion Center Building and the Written Batik Derivative Production Building Project. This project aims to complete the physical construction of the building within the cost, time, and reasonable quality [2].

In the construction of the Promotion Center Building and Production Building for Written Batik Derivatives, several factors caused delays, quoted to the Contractor's Field Implementer, several problems could not be taken lightly which had an impact on the continuity of the project construction which was hampered and the target completion time was not on target, including allowing other service providers to make objections outside the time scheduled by the working group committee (POKJA) where the contractor's objections result in at least 2 weeks of work starting after the contract is signed [12]. Apart from that, there was a unilateral blockade by village officials for 1 week in the middle of the construction work calendar which resulted in materials not having access to get to the project site [18]. Apart from that, several factors cause delays, from design changes to the weather, where the intensity of rain increases in mid-November to early December, which results in work productivity being reduced and the target completion time not being achieved [7].

JICE Journal Innovation of Civil Engineering
Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

Table 1. Weekly Progress Report On End Of Contract

Weekly Work Progress Plan	10.714
Cumulative Work Progress Plan	100
Weekly Work Progress Plan	7.337
Cumulative Work Progress Plan	85.005
Deviation	-14.995

Project delays are caused by several factors originating from the Contractor, Owner, and other than both parties [13].

1. Delays due to Contractor errors, including:
   a. Delay in starting project implementation.
   b. Workers and Implementers lack experience.
   c. Late arrival of equipment.
   d. The foreman is less active.
   e. Poor work plan.
2. Delays due to Owner error
   a. Late payment of terms to the Contractor.
   b. Delay in providing land.
   c. Make a major job change.
   d.The owner assigns another contractor to work on the project.
3. Delays caused by other than the two parties above include, among others;
   a. Due to fire which is not the fault of the contractor, consultant, or owner.
   b. Due to war, earthquake, flood, or other disasters.
   c. Monetary changes

3.2 Measuring the critical path with CPM (Critical Path Method)

Secondary data in the form of project work data and weights from the S-Curve will be identified and summarized into various work groups, to obtain higher detail. The more detailed the activity, the more detailed its relationship with other activities [4]. The S curve in the figure is an estimate of the overall project schedule made by PT Hariz Tiga Putra.

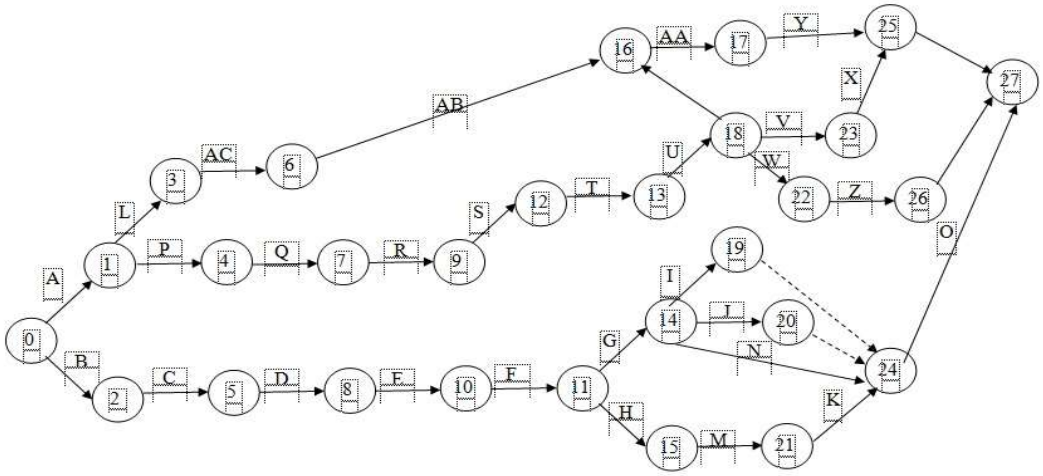

Figure 2. CPM Network Diagram

JICE Journal Innovation of Civil Engineering
Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

Critical Path Method (CPM) is the basis of a system for planning and controlling work progress which is based on a network or work network. The process in the CPM method consists of several important stages including [3]:

1. Analyze, identify describe, and solve the scope of each project work. The secondary data was obtained, namely in the form of a schedule or s curve which contains the time and weight of work broken down into simpler components to obtain higher detail.
2. After the identification stage is complete, continue with network analysis. Namely analyzing the work network as a whole.
3. Rearrange the components that have been described in the first stage, into a chain with a systematic and logical sequence that is based on literature studies of implementation methods and observations as well as direct interviews with people actively involved in the project.
4. Then provide an estimated time for each job based on worker productivity in the field.
5. Estimating work start time (LET) and end of work (EET) using the CPM algorithm to determine the project implementation time and critical path for each job.
6. Calculate work that can be postponed (float time) based on the existing critical path.

3.3 Tabulate the Probability Risk Matrix

After obtaining the critical path as a parameter causing delays, the next step is to create a risk matrix tabulation. The risk matrix is used to determine the level of risk to help solve problems that cause project delays [8].

The risk matrix can be prepared using the formula below:

$$R = P \times I \quad (2)$$

Where :
R = Risk level
I = Level of impact (Impact) of the risk that occurs
P = Possibility (Probability) of the risk occurring

Table 2. Risk Matrix

Probability	Consequence				
	Very Low	Low	Moderate	High	Very High
Almost Certain	M	H	E	E	E
Likely	M	H	H	E	E
Possible	L	M	H	H	E
Unlikely	L	M	M	H	H
Rare	L	L	M	M	H

Information :
L = Low
M = Moderate
H = High
E = Extreme

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

Table 3. Consequence Criteria

Very Low / 0.05	Low / 0.10	Moderate / 0.20	High / 0.40	Very High / 0.80
The project is running late but can be overcome with contingency planning	The project is late but contingency planning is not going well	Projects are late, manpower is not supported, and costs are increasing	Projects are abandoned and there is no definite plan. There is no significant progress	Failed projects continue
Insignificant cost increase	Cost increase <10%	Cost increase 10–20%	Cost increase 20-40%	Cost increase >40%
The time addition is not significant	Time increased <5%	Time increased <5-10%	Time increased <10-20%	Time increased >20%

Table 4. Frequency Criteria

No	Scale		Qualitative
1	Sd. 0,1	Rare	It is likely to be impossible to happen
2	>0,1 s.d 0,2	Unlikely	There is a small possibility that this could happen
3	>0,2 s.d 0,3	Possible	The probability of it happening or not happening is the same
4	>0,3 s.d 0,4	Likely	Most likely it could happen
5	>0,4	Almost Certain	It tends to happen frequently

3.4 Analysis of Factors Causing Delays with FTA

Fault tree analysis better known as fault tree analysis looks for the root of the problem or cause of failure. This method is generally used by people involved in engineering or industry [14]. Apart from that, this method is also often used in the application of project risk management by identifying and grouping factors that can become undesirable obstacles (called "top events/main risks). Furthermore, this method can further identify the best way or decision to reduce the impact of undesirable risks [5].

Factors that could become risks are analyzed deductively, and arranged logically and systematically so that a logical tree diagram can be drawn between the causal factors and the occurrence of risks [9]. This method uses a qualitative and quantitative approach, namely identifying the main causes and the probability or possibility of the risk occurring through the path to the peak of the risk in the fault tree diagram [6].

FTA has event symbols to map the analysis process of FTA, namely:

1. Circle (basic event), is a symbol to express the cause of the peak risk. In other words, it represents the root of a risk event where this symbol does not require further analysis.
2. Square (intermediate event), is a symbol that states the next event followed by logical gates. This symbol requires further analysis.
3. Diamond (undeveloped event), a symbol that means the event cannot be processed due to insufficient data and limited information.

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

4. Triangle (transfer symbol), a symbol that means it requires further analysis beyond the main risk and analysis being carried out.
5. Logic Event OR, peak risk can occur if one or more events occur.
6. Logic Even AND, peak risk can occur when all data has been input.

Here we will thoroughly explain the causes of the failure of the construction of the Promotion Center Building and Written Batik Derivative Production Building, starting from the causes of delays caused by the owner, contractor, and construction management to external factors in the Taman Melati Surabaya apartment construction project [11]. All these processes will be described in the form of a root FTA fault tree diagram so that later the basic cause of the problem and the probability of each root problem can be known [1].

a. Delay factors caused by the owner
   Delays caused by the owner are delays in taking action by the owner. There is 1 event that causes delays in taking action by the owner which are interrelated with one thing and another, including the owner being late in making decisions, the owner being late in conveying changes to the design of the space, and being late in approving the changes. ranging from design to changes in specifications and material types. These factors were obtained from the results of literature studies and questionnaires were distributed to people related to the construction project for the Promotion Center Building and Derivative Handwritten Batik Production Building [1].
b. Delay factors caused by the Executor
   Delays caused by the implementer are delays in taking action by the implementer. There is 1 event that determines the inappropriate duration of time which is related to one thing and another, including work plans that are not well structured, incomplete identification of problems with work and target control. the work is not according to plan. These factors were obtained from the results of literature studies and questionnaires were distributed to people related to apartment development projects [1].
c. Delay factors caused by external factors
   The delay caused by the implementer was the delay in taking action which was carried out by external factors. There was 1 event that was not appropriate which was related to one thing and another, including the high intensity of rainfall and the many complaints about the work space and land which can be seen. These factors were obtained from the results of literature studies and questionnaires were distributed to people related to apartment development projects [1].
d. FTA Construction
   Based on weekly reports and field observations, it was found that the work that experienced delays was electrical work, floor work, plastering work, painting, latching, and several causes of delays which can be seen in the Fault Tree Analysis (FTA) construction drawings [1].

3.5 Determining the Cut Set using the Obtain Cut Set (MOCUS) Method

After completing the FTA construction, the next step is to determine the cut set. Cut set is a combination of the formation of a fault tree, which if all of them occur can cause a peak event to occur [9]. The minimum cut set is a combination of the smallest events that bring about a delay-causing event called a Basic Event. Meanwhile, MOCUS is a method for getting cut sets and minimum cut sets. The basic event combination is obtained from the FTA diagram which is analyzed using the gate or or gate relationship [14].

A cut set is defined as a basic event that, if it occurs, will result in a top event occurring. A cut set is said to be a minimal cut set if the cut set cannot be reduced without losing its status as a cut set. The operator notation in Boolean Algebra logic for the OR gate or Boolean addition has the symbol (+). Meanwhile, the AND gate has the symbol (.) or Boolean multiplication. Boolean algebra has laws of equality. One example is the distributive law where $a . (b + c) = (a . b) + (a . c)$. The following are the results of the analysis of determining the cut set using MOCUS.

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

Table 5. Cut Set Owner

No.	Combination of Events
1	A.1.1,B.1.2,B.2.1.1
2	A.1.1,B.1.2,C.2.3.2
3	A.1.1,B.2.1.1,C.2.1.1
4	A.1.1,C.2.1.1,C.2.3.2
5	A.1.1,B.2.1.1,C.2.1.2
6	A.1.1,C.2.1.2,C.2.3.2

Table 6. Executing Cut Set

No.	Combination of Events
1	C.1.1.2
2	C.1.1.1
3	C.1.1.5
4	C.1.1.4

Table 7. Cut Set External

No.	Combination of Events
1	D.2.1
2	D.1
3	C.2.5.2.1
4	C.2.5.2.2

MOCUS is an algorithm for getting the minimum cut set. According to Clemens cut set is a form of FTA formation that occurs which will result in a peak event occurring. Cut sets are used to examine or evaluate FTA diagrams and obtain an overview of the entire failed system [12]. A combination of small events will not always become a peak event. Therefore, it is necessary to analyze the cut set to determine the peak of the event. The steps in determining the cut set method with MOCUS include [10]:

1. Modify FTA to be AND and OR gate only
2. Give each gate a name with letters
3. Give each basic event a marker with a number
4. Determine the cut set (eliminate if there are duplicates and supersets)
5. Determine the minimum cut set
6. Determination of ranking in the cut set

4. Conclusions

From the results of the analysis above, it was found that several jobs experienced delays, including: (1) Floor work and wall ornaments where this work on the last day of the contract only produced 1.286% of the total 17.50%, which means there was a deviation of -16.211%. Floor work and wall ornaments have several work items including Install UK Polished Ceramic Floors. 60 x 60 cm, Install KM/WC Color Ceramic Floor 20 x 20 cm, Install 20 x 40 cm colored Ceramic Wall, Install 1 m of 5cm x 20cm ceramic plinth, Install 1 m2 Cutting Plate 5mm Thick Batik Motif + frame and Lettering Work. (2) The most dominant causal factors are factors caused by external factors, namely in the form of very high rainfall intensity in one month and unilateral blockades by village officials. The causal factor caused by the owner is the delay in submitting design changes to

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

the field where the design is very important as a development guide. Meanwhile, delays caused by implementers are inappropriate duration determinations which result in work productivity not being properly controlled.

Acknowledgments

In this research, the author would like to express his thanks to:

1. Mr. Taurina Jemmy Irwanto, ST., MT. as Dean of the Faculty of Engineering, Madura University.
2. Mrs. Erwin Prasetyowati, ST., MT. as Deputy Dean of the Faculty of Engineering, Madura University.
3. Mr. Deddy Asmaroni, ST., MT. as the Head of the Civil Engineering Study Program, Madura University.

References

Reference to a Journal Publication:

[1] Analysa D., et al., (2019) "Evaluation of Delays in the Graha Mojokerto Service City (Gmsc) Construction Project Using the Fault Tree Analysis (Fta) Method". Scientific Journal of Civil Engineering and Chemical Engineering, 4.

[2] Amalia R., et al., (2021) "Analysis of the Causes of Delays in the Sidoarjo Town Square Development Project Using the Fault Tree Analysis (FTA) Method". Its Engineering Journal Vol. 1, No. 1, Issn: 2301-9271

[3] Heizer, J. and Render, B. (2018). Operation Management : Operations Management. Jakarta: Salemba Empat.

[4] Hosaini, et al. (2021). Project management. Bandung: Widina Bhakti Persada Bandung.

[5] Lambomban M, (2018) "Risk Management in Construction Projects" Smartek, Vol. 9.

[6] Mustika A.F (2018) "Project Delay Analysis using Fault Tree Analysis (Fta)(Case Study of a Building Construction Project for Industrial Engineering Study Program Phase II, Universitas Brawijaya Malang)" Ministry of Education and Culture, Universitas Brawijaya.

[7] Rani, Hafnidar A. (2016). Construction Project Management. Yogyakarta: Deepublish.

[8] Rosdianto M.A., (2019) "Risk Analysis of Delays in Apartment Construction Projects at Taman Melati Apartments Surabaya" Department of Technology Management Field of Project Management Expertise Faculty of Business and Technology Management Sepuluh Nopember Institute of Technology Surabaya.

[9] Salamin A & Hassan A., (2018). "The Impact Of Pricing On Consumer Behavior In Saudi Arabia: Al-Hassa Case Study". European Journal Of Business Management, Vol.8 No.12

[10] Stevenson. (2015). Operations Management. Jakarta: Salemba Empat.

[11] Sudipta I.G.K, (2019). "Project Management Study of Resources in Construction Project Implementation (Case Study: Construction of Villa Bali Air)". Scientific Journal of Civil Engineering Vol. 17, no. 10

Reference to a Book:

[12] Godfrey, P., et al., (1996). “Control Of Risk A Guide To Systematic Management Of Risk From Construction.” Westminster, London: Construction Industry Research And Information Association (Ciria).

[13] Mulyawan S., (2015). “Risk Management”. Cv Pustaka Setia.

[14] Republic of Indonesia Government Regulation number 54 of 2016 concerning the Third Amendment to Government Regulation Number 29 of 2000 concerning the Implementation of Construction Services

[15] Presidential Regulation Number 16 of 2018 concerning Government Procurement of Goods/Services

[16] Presidential Regulation of the Republic of Indonesia Number 54 of 2010 concerning Procurement of Government Goods/Services

Vol. 4, No. 2, pp. 224-233, 2023
Submit: 12-09-2023 |
Accepted: 06-12-2023 |
Publish: 06-12-2023 |

[17] Project Management Institute, (2008) “Pmbok -A Guide To The Project Management Body Of Knowledge” Newtown Square, Pa: Project Management Institute, 4th Edition.
[18] Suharto (1999). "Project Management (From Conceptual to Operational)". Erlangga Publishers.
[19] Law Number 2 of 2017 concerning Construction Services.