Implementation of the Failure Mode and Effects Analysis (FMEA) Method to Determine Project Risk Priority

by Sufa atin

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S Atin[1], R Lubis[2]
[1,2,] Program Studi Teknik Informatika, Universitas Komputer Indonesia, Indonesia

Email: sufaatin@email.unikom.ac.id

Abstact. The purpose of this research is to determine the priorities of risks that might occur so that the implementation of project work can run smoothly and later can be used as a basis for making decisions in handling the project being worked on. One method that can be used to determine the priority of risks that arise in a project is the Failure Mode and Effects Analysis (FMEA). FMEA is one of the methods used to prevent project failures caused by project risks that arise. The results of this study are FMEA can be used to handle and determine the priority of risks that arise in the project and can be used by the person in charge of the project in making decisions in handling risks that arise in the project. By using FMEA project risks can be prevented and completed so that the project can be completed on time.

1. Introduction

The project is a combination of labor (human), material, equipment, facilities, and supporting services (capital / cost) in a temporary organization that is used to achieve the goals and objectives that have been determined [1]. Project risk is the cumulative effect of the chance of an uncertain event that affects project goals and objectives that can result in late completion of the project [2]. Risk refers to the uncertainty and severity of events and results of an activity in connection with something that human's value [3]. Identification of risks in the project will be divided into several project risks [4]. To identify and take action on the project risks that arise can use several methods, one of the methods used is Failure Mode and Effects Analysis (FMEA) [5]. FMEA is a structured method that can be used to identify, prioritize failure modes and then prevent them as much as possible and be able to trace the sources of the causes of failure [6]. FMEA is an analytical technique that combines technology and experience in identifying the failure of the production process and planning to prevent it from happening again [5]. FMEA was originally created by Aerospace Industry in the 1960s. FMEA began to be used by Ford in the 1980s, AIAG (Automotive Industry Action Group) and the American Society for Quality Control (ASQC) set it as a standard in 1993. Currently FMEA is one of the core tools in ISO / TS 16949: 2022 (Technical Specifications for Automotive Industry) [7]. Previous studies that used FMEA were research conducted by Teng and Ho in 1996 [5], Santoso in 2007 [8] and Ahsen in 2008 [9] FMEA was used to identify failures in the production process that resulted in risks that appeared to be proven failures the production process does not repeat itself.

The purpose of this research is to apply the FMEA method to find out the risks that arise in the project and to determine which risk priorities must be addressed first so that the risks that arise in the project can be immediately addressed and the project can be completed on time.

2. Method

The research methodology in this study uses descriptive methods. Descriptive method is a method used to find facts with the right interpretation and try to describe a symptom, events that occur at the moment or an actual problem [10]. The research methodology in this study begins with a review of the FMEA literature study together with secondary data collection. The next step is to identify risks, followed by calculating the severity, occurrence and detection. After that, calculating the value of the Risk Priority Number (RPN) is continued to calculate the critical value and the last is managing risks that are used to assist the Responsible Person in identifying project risks at the beginning of the project implementation so that if these risks arise when project implementation can be dealt with quickly [11].

3. Results and Discussion

3.1 Secondary Data Collection

The data used in this research is the installation of paving in the Mandala project. In this project, the project implementation time is 200 days starting from December 27, 2018 until July 15, 2019. There are five steps in determining risk priorities using FMEA [11]. The step starts from identifying risks, then continues with calculating the severity, occurrence and detection. After that, calculate the value of the Risk Priority Number (RPN) and proceed to calculate the critical value and the last is risk management.

3.2 Project Risk Identification

Risk identification process aims to create a list of risks that have occurred in the previous project work and that will probably occur in the next projects. This risk identification process is carried out using an interview approach with the person in charge of the project. The identification of risks in this study can be seen in Table 1.

Table 1. Identification of Project Risk

No.	Name of Activities	Risk Code	Obstacle
1.	Land Leveling and Compaction Land Work with Tamping Rammer	R1	Bad weather
		R2	Material prices have risen
		R3	Material delivery delays
		R4	Damage to project tools
		R5	Labor is absent
		R6	Labor accident
2.	Paving Alignment Work with Ash Stone and Paving Block Installation	R1	Bad weather
		R2	Material prices have risen
		R3	Material delivery delays
		R4	Damage to project tools
		R5	Labor is absent
		R6	Labor accident
3.	Casting filler work	R1	Bad weather
		R2	Material prices have risen
		R3	Material delivery delays
		R4	Damage to project tools
		R5	Labor is absent
		R6	Labor accident
4.	Paving Block Leveling Work With a Baby Roller	R1	Bad weather
		R2	Material prices have risen
		R3	Material delivery delays
		R4	Damage to project tools
		R5	Labor is absent
		R6	Labor accident

3.3 Determining the Severity Value, Occurrence Value and Detection Value

Determine the severity, Occurrence and detection values based on the identification of risks that have been carried out in the previous stage. The severity, occurrence, and detection values were obtained from interviews with the project managers and can be seen in Table 2.

Table 2. Value of Severity, Event, and Detection

Risk Code	Risks	Severity Value	Occurrence Value	Detection Value
Land Leveling and Compaction Land Work with Tamping Rammer				
R1	Bad weather	5	7	5
R2	Material prices have risen	2	5	4
R3	Material delivery delays	3	4	5
R4	Damage to project tools	6	4	6
R5	Labor is absent	3	2	7
R6	Labor accident	3	2	7
Paving Alignment Work with Ash Stone and Paving Block Installation				
R1	Bad weather	5	7	5
R2	Material prices have risen	3	6	4
R3	Material delivery delays	4	4	3
R4	Damage to project tools	6	4	5
R5	Labor is absent	4	2	6
R6	Labor accident	3	2	7
Casting Filler Work				
R1	Bad weather	5	7	5
R2	Material prices have risen	3	6	4
R3	Material delivery delays	4	4	4
R4	Damage to project tools	3	3	5
R5	Labor is absent	3	4	3
R6	Labor accident	3	3	6
Paving Block Leveling Work with a Baby Roller				
R1	Bad weather	4	7	5
R2	Material prices have risen	1	5	4
R3	Material delivery delays	1	3	4
R4	Damage to project tools	4	3	4
R5	Labor is absent	3	5	3
R6	Labor accident	1	3	3

4 Determine the Value of The Risk Priority Number (RPN)

The next step is to calculate the Risk Priority Number (RPN) is an overall danger score calculated by multiplying Severity, Occurrence, and Detection. Higher RPNs are design priorities. [11].

RPN = Severity Value X Occurrence Value X Detection Value ..... (1)

The results of the calculation of the RPN value can be seen in Table 3.

Table 3. Result of RPN Value Calculation

Risk Code	Risks	Severity Value	Occurrence Value	Detection Value	RPN Value
Land Leveling and Compaction Land Work With Tamping Rammer					
R1	Bad weather	5	7	5	175
R2	Material prices have risen	2	5	4	40
R3	Material delivery delays	3	4	5	60
R4	Damage to project tools	6	4	6	144
R5	Labor is absent	3	2	7	42
R6	Labor accident	3	2	7	42
Paving Alignment Work with Ash Stone and Paving Block Installation					
R1	Bad weather	5	7	5	175
R2	Material prices have risen	3	6	4	72
R3	Material delivery delays	4	4	3	48
R4	Damage to project tools	6	4	5	120
R5	Labor is absent	4	2	6	48
R6	Labor accident	3	2	7	42
Casting Filler Work					
R1	Bad weather	5	7	5	175
R2	Material prices have risen	3	6	4	72
R3	Material delivery delays	4	4	4	64
R4	Damage to project tools	3	3	5	45
R5	Labor is absent	3	4	3	36
R6	Labor accident	3	3	6	54
Paving Block Leveling Work With a Baby Roller					
R1	Bad weather	4	7	5	140
R2	Material prices have risen	1	5	4	20
R3	Material delivery delays	1	3	4	12
R4	Damage to project tools	4	3	4	48
R5	Labor is absent	3	5	3	45
R6	Labor accident	1	3	3	9

3.5 Determine Critical Value

After getting the RPN value for each risk, the next step is to calculate the Critical Value. This critical value is used to determine what risks are included in the high-risk category. Risks included in the high category is a risk that has an RPN value greater or equal to the critical value (RPN critical value). Critical values are calculated using the formula: Total RPN / Total risk [12]. Calculation of critical values in this study can be seen in Table 4.

Table 4. Critical Value and Risk Categories

Risk Code	Risks	RPN Value	Critical Value	Risk Category
Land Leveling and Compaction Land Work with Tamping Rammer				
R1	Bad weather	175	83.83 ≈ 84	High
R2	Material prices have risen	40		Low
R3	Material delivery delays	60		Low
R4	Damage to project tools	144		High
R5	Labor is absent	42		Low
R6	Labor accident	42		Low
Paving Alignment Work with Ash Stone and Paving Block Installation				
R1	Bad weather	175	84.17 ≈ 85	High
R2	Material prices have risen	72		Low
R3	Material delivery delays	48		Low
R4	Damage to project tools	120		High
R5	Labor is absent	48		Low
R6	Labor accident	42		Low
Casting Filler Work				
R1	Bad weather	175	74.33 ≈ 75	High
R2	Material prices have risen	72		Low
R3	Material delivery delays	64		Low
R4	Damage to project tools	45		Low
R5	Labor is absent	36		Low
R6	Labor accident	54		Low
Paving Block Leveling Work with a Baby Roller				
R1	Bad weather	140	45.67 ≈ 46	High
R2	Material prices have risen	20		Low
R3	Material delivery delays	12		Low
R4	Damage to project tools	48		High
R5	Labor is absent	45		Low
R6	Labor accident	9		Low

From Table 4, it can be seen that there are 2 risk categories, namely High and Low, which is going to be used by the person in charge of the project to find out which risks must be addressed first.

3.6 Risk Handling

Table 4 can be used as a reference for the person in charge of the project in handling risks that arise in the project. The risk management in the project in this study can be seen in Table 5.

From the risk categories obtained in Table 4, the person in charge of the project can see which risks have a major impact on the project and which risks have a small impact on the sustainability of the project and the person in charge of the project can see risk priorities from R1 to R6 which risks will be resolved first if they occur risk at the same time so that the project can be completed on time.

In addition, the person in charge of the project can also make the handling of risks that arise, while the risk management in this study can be seen in Table 5.

Table 5. Risk Handling Scenario

Risk Code	Risks	RPN Value	Risk Category	Risk Handling Action
Land Leveling and Compaction Land Work With Tamping Rammer				
R1	Bad weather	175	High	Increase worked hours (overtime)
R2	Material prices have risen	40	Low	Agreement with suppliers regarding the prices of materials
R3	Material delivery delays	60	Low	Communicating with suppliers of materials
R4	Damage to project tools	144	High	Immediately replace damaged equipment and increase supervision of work equipment
R5	Labor is absent	42	Low	Replacing with other workers
R6	Labor accident	42	Low	Directing the workforce to prioritize safety
Paving Alignment Work with Ash Stone and Paving Block Installation				
R1	Bad weather	175	High	Increase worked hours (overtime)
R2	Material prices have risen	72	Low	Agreement with suppliers regarding the prices of materials
R3	Material delivery delays	48	Low	Communicating with suppliers of materials
R4	Damage to project tools	120	High	Immediately replace damaged equipment and increase supervision of work equipment
R5	Labor is absent	48	Low	Replacing with other workers
R6	Labor accident	42	Low	Directing the workforce to prioritize safety
Casting Filler Work				
R1	Bad weather	175	High	Increase worked hours (overtime)
R2	Material prices have risen	72	Low	Agreement with suppliers regarding the prices of materials
R3	Material delivery delays	64	Low	Communicating with suppliers of materials
R4	Damage to project tools	45	Low	Immediately replace damaged equipment and increase supervision of work equipment
R5	Labor is absent	36	Low	Replacing with other workers
R6	Labor accident	54	Low	Directing the workforce to prioritize safety
Paving Block Leveling Work With a Baby Roller				
R1	Bad weather	140	High	Increase worked hours (overtime)
R2	Material prices have risen	20	Low	Agreement with suppliers regarding the prices of materials
R3	Material delivery delays	12	Low	Communicating with suppliers of materials
R4	Damage to project tools	48	High	Immediately replace damaged equipment and increase supervision of work equipment
R5	Labor is absent	45	Low	Replacing with other workers
R6	Labor accident	9	Low	Directing the workforce to prioritize safety

In this study, it can be concluded that the use of FMEA in project implementation can not only be used to identify project failures caused by emerging risks developed by Teng and Ho in 1996 [5] but can also be used to choose which risk priorities must be resolved first if there are several risks that arise simultaneously and can also be used to deal with risks that arise so that project failure can be minimized and the project can be completed on time.

4. Conclusion

The conclusion of this research is that FMEA can be used to help the project person in charge, to determine the risks, risk categories and treatment measures so that if risks arise in the project, they can be overcome immediately and the project can be completed on time.

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