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Analysis Effect Severity and Occurrence Work Accident Risk Detection With Failure Mode and Effect Analysis Method on Continuing Development Project for The Bali Tourism Polytechnic Practice Hotel Building

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Abstract

Risk is inherent in every activity. The risk of accidents occurring in construction projects is high, but programs on work safety are not receiving much attention. In practice, there are many risks of accidents that cause damage to equipment or buildings and potentially detrimental effects on employees' strength after returning to work. K3 is an essential factor in work safety that can affect the risk of accidents if K3 does not work well. This study aims to determine the most dominant work accidents and the effect of severity and incidence on the detection of work accidents. Our method is to use one case study with direct observation of building construction projects. The data obtained were analyzed by FMEA (Failure Mode and Effect Analysis) method and multiple linear regression. FMEA is a structured procedure to identify and prevent as many failure modes as possible (Failure Mode). This method determines the RPN value of the most dominant work in the field. The most dominant risk of work accidents is found in floor plate work, with a total RPN value of 601.145. Severity and incidence simultaneously positively and significantly affect project cost overruns. The proportion of the effect of severity and incidence on cost overruns is 72%.

Keywords: Work Accidents Risk, Failure Mode, Effect Analysis, Building Projects.

1. INTRODUCTION

Work accidents often occur in construction projects. There is a need for specific steps and handling to reduce the high risk of work

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accidents on construction projects. A unique program is needed to reduce the level of risk of work accidents, and special attention is required so that the program can be successful.

Several things hinder the success of work safety programs, including poor job planning, improper work safety training, inadequate budget for work safety, and lack of investigations and evaluations procedure for work accidents [10].

Based on the facts above, work safety management is an important part that needs to be looked into deeper in the construction industry, including Indonesia. Work safety management functions to prevent work accidents. It can be done by controlling the high risk from its consequences, possibility of occurrence, and ease of detection [1].

Work safety management is also a part of the study of ergonomics. One of the principles of implementing an ergonomic building construction project is to enable workers to work comfortably, safely, healthily, and productively. Safety and comforts are essential to work in industry or on a task [9]. Work safety management also discusses risk management. Risk management is an effort to systematically implement regulatory policies and practical management efforts to analyze the use and control of risk to protect workers, society, and the environment [5].

In continuing the building of a hotel for practical purposes, the Continuing Development Project for the Bali Tourism Polytechnic Practice Hotel Building, work safety management is applied to overcome various possible work accidents. Different methods have been introduced to identify potential work accidents, measure the level of risk of work accidents and evaluate work accidents. These methods include: a checklist, hazops, what if, FMEA, audits, CIA (Confidentiality, Integrity, and Availability), FTA (Fault Tree Analysis), and ETA (Event Tree Analysis). Among these methods, FMEA is the most appropriate method to fulfill the objectives described above. Therefore this study focuses on the FMEA method to identify potential hazards of work accidents and measure the level of risk.

FMEA is a structured procedure to identify and prevent as many failure modes as possible. A failure mode includes a defect, a condition outside the specified specifications, or a change in the product that causes the effect to malfunction [3]. The method is used to identify the sources and causes of a problem that occurred in each work process.

In this study, FMEA was conducted to see the risks that might occur in maintenance operations and company operational activities. Three things help determine the disturbance, among others [2]: (1) Frequency of occurrence; in determining this occurrence, it can be determined how many disturbances can cause a failure in maintenance operations and factory operational activities, (2) the level of severity, in determining the level of severity it can be determined how serious the occurrence of process failures causes the damage in terms of maintenance operations and factory operational activities, (3) the ease of detection, in determining the ease of detection can be determined how FMEA PENE Detection can predict the frequency, severity dan ease of detection to be known before it occurs. The detection rate can also be influenced by the number of controls that govern the process [13]. The more rules and procedures that regulate the maintenance management system and factory operational activities, the better the detection rate of failure will be achieved.

Besides using the FMEA method to determine the dominant risk, it is also necessary to analyze the effect of severity and frequency of occurrence on work accident detection to see how significant the influence of severity and detection on work accident detection is.

This study aims to determine the most dominant work accidents that occur and the effect of severity and occurrence on the detection of work accidents in the building of a hotel for practical purposes by Continuing Development Project for the Bali Tourism Polytechnic Practice Hotel Building.

2. METHODS

The research is designed as one case study type, conducted by observation, to analyze the effect of severity and frequency of occurrence of work accident risks on detection using the FMEA method on building projects. The analysis was carried out on Continuing Development Project for the Bali Tourism Polytechnic Practice Hotel Building. The failure analysis method was carried out using the FMEA method, designed to identify potential failure modes for a product or process before a problem occurs to assess the risk. In the FMEA method, a single point of failure is determined, which is very important. It ranks each failure according to the criticality of the failure effect and the probability of its occurrence.

The data obtained were then analyzed to find the most dominant occupational risk factor in the continuation of the construction project Continuing Development Project for the Bali Tourism Polytechnic Practice Hotel Building using the FMEA method. A multiple regression test and a coefficient of determination test (R2) were carried out to find this factor. The selection of this project as the object of study is based on the fact that the project has activity criteria that match the research title and has a large scale of work, so it is interesting to review, especially regarding the risk of work accidents.

To calculate risk with the FMEA method, the three risk components are multiplied by each other, resulting in Risk Priority Number (RPN) [13]. They are:

1. Severity (S): Severity is described on a 10-point scale where ten is the highest.

2. Occurrence (O): Occurrence is described on a 10-point scale where ten is the highest.

3. Detection (D): Detection is described on a 10-point scale where ten is the highest.

RPN= S*O*D. [2] RPN_{min}= 1 while RPN_{max} = 1000

3. RESULTS AND DISCUSSION

3.1 FMEA Methods Analysis

The FMEA method was analyzed to determine the most dominant occupational accident factor in constructing a hotel building for the Continuing Development Project for the Bali Tourism Polytechnic Practice Hotel Building. The results of the analysis are shown in the following table:

Table 1. FMEA Method RPN Value Test Results

No	Work Items	Function	Failure Mode	SEVERITY (SI%)	OCCURANCE (SI%)	DETECTION (SI%)	RPN
1	Soil Excavation & Backfill	Excavation of	The groundwater level is higher than the river	46.25	40.00	51.25	94,813
			Soft soil conditions	45.00	42.50	47.50	90,844
			Soft soil conditions	48.75	48.75	37.50	89,121
			Heavy equipment accident	43.75	45.00	47.50	93,516
			The project environment is not clean	37.50	45.00	47.50	80,156
2	Foundry work	The casting work is with a floor plate	Workers not concentratin g	56.25	47.50	42.50	113,555

No	Work Items	Function	Failure Mode	SEVERITY (SI%)	OCCURANCE (SI%)	DETECTION (SI%)	RPN
		thickness of ±12cm and a floor area of 742.56 m2. So the volume of cast concrete 36 floors = 3.207.86 m3.	Workers not concentratin g	36.25	62.50	60.00	135,938
			Workers not concentratin g	61.25	56.25	45.00	155,039
			Heavy equipment that doesn't work well	53.75	27.50	57.50	84,992
			Workers are not careful	47.50	56.25	42.50	113,555
3	Formwork or print work	Manufacture and installation of formwork with mobile cranes, vibrators which function to compact the concrete in the formwork	Disturbing project environment	43.75	43.75	47.50	90,918
			Workers not concentratin g	41.25	41.25	55.00	93,586
			Improper implementat ion method	35.00	35.00	47.50	58,188
			Workers are not careful	38.75	38.75	52.50	78,832
4	Rebar and fabrication work	Production and cutting of iron with plain and threaded iron with diameters of 10,12,16.	Workers not concentratin g	43.75	45.00	42.50	83,672
		In its implementatio	Workers are not careful	41.25	42.50	55.00	96,422

No	Work Items	Function	Failure Mode	SEVERITY (SI%)	OCCURANCE (SI%)	DETECTION (SI%)	RPN
		n, the heavy equipment used is an iron cutting machine	Workers not concentrating	35.00	41.25	48.75	70,383
		Rebar installation at the location of the cast	Workers are not careful	40.00	40.00	50.00	80,000
			Workers are not careful	45.00	45.00	32.50	65,813
5	Light brick work	Transportation of materials used in the installation of lightweight bricks	Heavy equipment / stairs that don't work	48.75	33.75	51.25	84,322
			Mortar mixing machine is not in place	41.25	40.00	55.00	90,750
			Workers are not careful	35.00	51.25	40.00	71,750
			Unclean project environment	38.75	37.50	46.25	67,207
				45.00	45.00	42.50	86,063

Based on the value of the Risk Priority Number above, it is found that repairs need to be prioritized from the many types of the accident that occurred was foundry work, specifically with a floor plate thickness of ±12cm and a floor area of 742.56 m2. This is because the highest RPN value for each of the five types of work is obtained in the floor plate casting job, specifically in the failure mode of scratched by objects, sharp/blunt, slipped, bumped, squeezed by the formwork with an RPN value of 155.039.

The priority of repairs that must be carried out first is the work of casting floor plates with a floor plate thickness of ±12cm and a floor area of 742.56 m2; because the floor plate casting work has the highest RPN value, the way to improve it is to look for factors causing the risk of work accidents by interview and literature study.

The occurrence of this failure mode is due to several things. Failure Mode occurs when an item or operation has the potential to fail to fulfill or deliver its intended function and associated requirements. These failure modes include failure to perform tasks within prescribed limits, the inadequate or poor performance of functions, intermittent performance of parts, and performing undesired or undesired operations [4]. Work accident control and risk level control must be controlled in occupational safety and health management to reduce accidents [6].

3.2 Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to determine the influence of severity and occurrence on the detection of work accidents. Before the multiple linear regression test is performed, it is necessary to test the reliability of the regression model or have conditions that a multiple linear regression model must meet. If the value of sig. F arithmetic is smaller than the error rate (α) of 5% (sig. F < 5%), then it can be said that the multiple linear regression model that is calculated is feasible. The following are the results of the regression model reliability test on the processed data:

Table 2. Simultaneous Significance Test Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	106.859	2	53.429	28.461	0.000
Residual	41.301	22	1.877		
Total	148.160	24			

Based on the table above, the calculated F significant value is 0.000, much smaller than the 0.05 significance level requirement. Therefore, it can be ascertained that the estimated multiple linear regression model is feasible to use to explain the effect of severity and occurrence on work accident detection.

In addition, it is necessary to test the influence of each variable using the t-test. The t-test in multiple linear regression aims to test the parameters in the form of regression coefficients and constants suspected in estimating the multiple linear regression model, which is the proper parameter. This t-test is used to determine how far the influence of the independent variables (Severity and Occurance) was used in this study individually in explaining the dependent variable partially. In this t-test, only the slope parameter (regression coefficient) will be focused. The following table presents the coefficients, which are the results of the regression coefficient test:

Table 3. Coefficient of Multiple Regression Model

	Model	Unstandardized Coefficients		standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.36	3.01		0.45	0.65

Severity (X1)	0.53	0.13	0.55	4.04	0.00
Occurance (X2)	0.44	0.15	0.40	2.96	0.01

From the results of the t-statistic test, it can be seen that the coefficients of the independent variables that are included in the regression model, severity, and occurrence variables have a significant effect on the detection of continued development of the hotel building aimed for practical class at the Continuing Development Project for the Bali Tourism Polytechnic Practice Hotel Building.

Table 3 above presents the results of calculating the multiple linear regression coefficients. Shown the respective values of the constants and coefficients of the independent variables, the coefficient value of the constant is 1.36, the coefficient value of the severity variable is 0.53, and the coefficient value of the occurrence variable is 0.44. Based on the calculations in the table, the multiple linear regression equation of severity (X1) and occurrence (X2) of Detection (Y) is Y = 1.36 + 0.53 X1 + 0.44 X2.

The constant value of 1.36 in the equation states the severity and safety of the project manager. If the variable is continuous or has a value of 0, then the project detection value is 1.36 units.

The value of 0.53 contained in the severity regression coefficient states that severity with detection has an influence. Every increase in one unit of severity will cause an increase of 0.53 in detection, assuming the occurrence variable coefficient is constant. Likewise, the value of 0.44 contained in the occurrence regression coefficient states that occurrence with detection has an influence. Every increase of one unit of occurrence coefficient will cause an increase of 0.44 in detection, catering to Paribus.

3.3 Coefficient of Determination Test (R2)

The coefficient of determination test (R2) was carried out to measure how much the model can explain the independent variables' variation (Severity and occurrence). The coefficient of determination describes the variation in the effect of the independent variable on the dependent variable (detection). In addition, the coefficient of determination can also be said as the proportion of the influence of the independent variable on the dependent variable. The calculation of the coefficient of judgment in this study uses the value of R-square to represent the coefficient of self-determination.

The following table is presented, which results from the coefficient of determination of all independent variables on the dependent variable.

Table 4. Results of the Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. An error in the Estimate
1	0.85	0.72	0.70	1.37

Based on the table of determination coefficient test results above, it is found that the value of R square is 0.72 indicating that the proportion of severity and occurrence on detection for development is 72%. In comparison, other factors do not influence the remaining 28% in the regression model. Linear.

Prevention or control of one or more fault mechanisms is the only way to reduce the severity and occurrence level. Eliminating or reducing the cause or mechanism of each hazard will reduce the number of severity and Occurrence probability values [8].

4. Conclusion

The most dominant work accident risk was found in the floor plate casting work, with a total RPN value of 601.145. Severity and occurrence simultaneously positively and significantly affect project cost overruns. The proportion of the effect of severity and occurrence on cost overruns is 72%. Risks with a high RPN value must receive better attention to reduce the impact caused by these risks. In planning costs, both the cost budget and its implementation plan should pay attention to every aspect of the cost, especially considering the definition of the scope of project implementation. Also, in implementing those, contractors should be able to place project managers who have high competency and experience to minimize disputes in the field and can create good relations between stakeholders in the project.

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