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THE PREVENTIVE PRIORITY PLAN BASED ON THE CAUSALITY ANALYSIS OF THE CONSTRUCTION ACCIDENT A CASE STUDY: CONSTRUCTION PROJECT OF KENTUNGAN UNDERPASS

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ABSTRACT

The case of construction accident that occurred mid-2019 and seized a lot of attention in the surrounding community is a construction accident on the implementation of underpass construction project located in Yogyakarta. The underpass excavation wall in this project collapsed then led two vehicles are fall. Although the types of accidents are almost identical to each project, it does not mean that the same reason causes the accidents. Various methods can carry out efforts to prevent work accidents, one of which is with assessment method and risk analysis using Analytical Hierarchy Process (AHP) which sub indicators are determined using Fault Tree Analysis (FTA). The method conducted with a review in the site by referring to Ministerial Regulation No. 21 year 2019 about the SMKK (Construction Safety Management System) guidelines. This research was conducted to identify the factors and indicators of management of thesupervisory consultant and the contractor. They had a significant influence and contribution to the implementation of the Yogyakarta Kentungan Underpass construction project. The results of this early-stage study served into two outcomes. First, the accuracy of the implementation of construction safety management system based on the assessment of the contractor is 85.938% and the percentage level of accuracy of the supervisory consultant is 97.29%. Both percentages fall into the category of Satisfactory Implementation Assessment because the valuation range is included between 85% to 100%. Second, after analyzing the risk using AHP method, the indicator that is used as a reference priority for the construction safety system of underpass construction projects and has the highest risk level that can causean underpass project construction accident from the contractor's point of view is the sub-indicator of supporting facilities and infrastructure with a risk level value of 0.042 whereas from the supervisory consultant' perspective is the sub-indicator about to measuring the dimensions of the road building installed in the site with a risk level value of 0.052.

Keywords: *Assessment, FTA, Causality, Construction Accident, AHP.*

INTRODUCTION

Based on empirical facts in 2019, there have been cases of construction accidents which not only caused losses of workers (people) such as severe injuries to death, but also losses of the community (public), property (prosperity), economic and the environment. One of the cases that occurred was an accident in the implementation of the Underpass construction project located in Yogyakarta. The underpass excavation wall in this projectcollapsed and lead 2 vehicles are fall. The wall collapsed caused by the failure of slope stability. Although the types of accidents that occur are almost identical to each project, it does not mean that the accidents are caused by the same reason.

Efforts to prevent work accidents can be carried out by various methods, one of which is with assessment conducted with a review at construction sites. This activity can bedone when the project is in preparation, implementation, or when the project has been completed as described in Government Regulation Number 50 of 2012 concerning SMK3

(Occupational Safety and Health Management System) Construction in the Public Works Sector. More details about the implementation of construction work are also explained in guidelines.

Developed a model of risk factors for accidents in construction operations, distinguished between problems with workers' actions, site conditions and construction practices (proximalcauses), and linked these to project, contractor and process management influences, data derived from existing accident reporting schemes and caused bias. To get perspectives from the contractor and the consultant are required the perspectives are guidelines by Government regulation Number 50 of 2012.

The analysis used are refers to the method presented by Government Regulation Number 50 of 2012. In addition, the data can be used to determine the level of performance priority of contractors and supervisory consultantson the project. If the results did not conform with what has happened at sites, then it should continue by another analysis to further about the causality on the risk of construction accidents using fault tree analysis method. This analysis aims to find the basic event and its risk control.

RESEARCH METHOD

Data processed based on the results of site assessments with reference to PP No. 50 of 2012 concerning Occupational Safety and Health, further causality review is carried out with Fault Tree Analysis (FTA) approach which is used to determine the chances of the most important event appearing in a system and to obtain the root cause of the problem. In addition, the root of the problem is used to correct the priority of the problem in the system which lead the analysis by using the Analytical Hierarchy Process (AHP) method finding out the highest to lowest risk indicators that caused construction accidents in Kentungan Underpass construction projects. Furthermore, in the Fault Tree Analysis (FTA) approach, the enumeration graph will illustrate how problems can occur using Boolean symbols as shown in Figure 1. The variable is used on the analysis describes from Regulation, discussion with experts also adapted from sites condition.

RESULT AND DISCUSSION

The average of implementation assessmentlevel of Occupational Safety Management System which is integratedwith the ISO 45001: 2018 and the PP No. 50 year 2012 standard regarding SMK3. The regulations implemented by Kentungan Yogyakarta Underpass Construction Project according to the point of view of contractor and supervisory consultant successively is 85.938% and 97.29% where these values are included in the level of Satisfactory Implementation.
After obtaining the assessment value from the evaluation of the performance achievement of contractors and supervisory consultants, where shows satisfactory results but construction accidents still occur, then the thing that can be done is to carry out further analysis in the form of causality analysis to find the main cause of the problem that has occurred using fault tree analysis method.

Fault Tree Analysis (FTA) Method of Underpass Kentungan Construction Accident

The Fault Tree Analysis method is a deductive analysis and a technique to identify failure of the system and it is often used to identify potential failure and loss for analyzing the possible source of risk before the losses occur.

The peak event equation obtained by substitution using Boolen's Algebra.

Basic Event of Fault Tree Analysis (FTA) of Underpass Construction Accident of Contractor's Point of View

Based on causality analysis using FTA method that continued basic event search using a combination of Boolen's Algebra theorem 1a and definition 1a obtained basic events where the results cannot be described and simplified again. The basic event from the contractor's point of view canbe seen in Table 1 and while for the results of the combination of Boolen's Algebra is as follows:
A = (C1+C2+C3+C4+C8+C18+ C20 +C48+C60+C61+C62+C63+C64+D1 +D2+ D3+D4+D5+D6+D7)

Basic Event of Fault Tree Analysis (FTA) Underpass Construction Accident of Supervisory Consultant's Point of View

Based on causality analysis using FTA method that continued basic event search using a combination of Boolen's Algebra theorem 1a and definition 1a obtained basic events where the results cannot be described and simplified again. The basic event from the supervisory consultant points of view can be seen in Table 2 and while for the results of the combination of Boolen's Algebra, as follows:
A = (D1+D2+D3+D4+D5+D6+D7+D8)

Basic Event of Fault Tree Analysis (FTA) of Underpass Construction Accident of Contractor's Point of View

Based on causality analysis using FTA method that continued basic event search using a combination of Booelan's Algebra theorem 1a and definition 1a obtained basic events where the results cannot be described and simplified again. The basic event from the contractor's point of view canbe seen in Table 1 and while for the results of the combination of Boolen's Algebra is as follows:
A = (C1+C2+C3+C4+C8+C18+ C20 +C48+C60+C61+C62+C63+C64+D1 +D2+ D3+D4+D5+D6+D7)

Basic Event of Fault Tree Analysis (FTA) Underpass Construction Accident of Supervisory Consultant's Point of View

Based on causality analysis using FTA method that continued basic event search using a combination of Boolen's Algebra theorem 1a and definition 1a obtained basic events where the results cannot be described and simplified again. The basic event from the supervisory consultant points of view can be seen in Table 2 and while for the results of the combination of Boolen's Algebra, as follows:
A = (D1+D2+D3+D4+D5+D6+D7+D8)

Risk Analysis Using the Analytical Hierarchy Process (AHP) Method from the Contractor and Supervisory Consultant Points of View

In conducting a data analysis using the AHP method, the first action to do is to compare between a pair of objects, so that if there are (n) objects, a comparison will be made. For comparison between a pair of objects, the AHP method providesa standard value for comparison betweentwo objects in the form of value data, where the data are a form of quantitative and comparative syntax starting from thehighest value (9: highly preferred) to the lowest value (1: equivalent). The following data values are in accordance with table 3.

The first step of analyzing the data is to create a paired matrix that is obtained based on the assessment of each of its criteria specified in accordance with table 3. The result of filling the matrix value of the comparison is based on the results of Focus Group Discussion (FGD) and include the probability value and impact value that will be used to find risk level value and risk rank. The paired matrix table of risk indicators from the contractor's point of view can be seen in table 4 and the paired matrix table of risk indicators from the perspective of the supervisory consultant can be seen in table 5.

The next step after making a paired comparison matrix table is to determine the matrix weighting. The matrix weighting result is obtained from the priority value of each matrix element. After gaining the weight of each element, calculate its priority value by dividing the number of element weights per row by the number of elements. Do the same thing to the next row so that the matrix weighting can be seen in table 6 for the contractor's point of view and table 7 for the supervisory consultant's point of view.

To find out the consistency level of the user's fill, the AHP method must be equipped with a Consistency Index calculation. After obtaining Consistency Index, the results are compared with the Random Consistency Index (RI) for every n objects. Table 8 shows the RI values for each object (2 <= n <= 10). Prof. Saaty compiled the RI Table obtained from an average consistency index of 500 matrices. CR (Consistency Ratio) is the result of a comparison between the Consistency Index (CI) and the Random Index (RI). If CR <= 0.10 (10%), it means that the user's answer is consistent so that the resultingsolution is optimal. For the contractor points of view, the Index Ratio (RI) value is used because the number n = 10 is 1.49, then the Consistency Index (CI) value is as follows:

CI = (λ maks-n)/(n-1) CI
= 0.049

After obtaining the Consistency Index (CI) value, the next step is to calculatethe Random Consistency Index (CR) value.

CR = CI/RI
CR = 0.046/1.49
= 0.03108
= 3.1 %

Because the CR value obtained is 3.1

% less than 10% then the hierarchy is considered consistence and has a high accuracy.

For the supervisory consultant's perspective, the index ratio value (RI) is used because the number n = 9 is 1.45, then the value of Consistency Index (CI) is as follows:

CI = (λ maks-n)/(n-1) CI
= 0.011

After obtaining the Consistency Index (CI) value, the next step is to calculatethe Random Consistency Index (CR) value.

CR = CI/RI
CR = 0,00682/1.45
= 0.0047
= 0.47 %

Because the CR value obtained is 0.47% and less than 10% then the hierarchy is considered consistent and has a high accuracy.

After analyzing the data of each sub-performance indicator from the contractor's point of view using the Analytical Hierarchy Process method and it concluded that the hierarchy obtained is consistent and has a high level of accuracy, then the next step is to perform risk level analysis and risk rank of each sub indicator. The value of this risk level is obtained by multiplying the probability and impact values. The probability value is obtained from the existing quotient value and the impact value is obtained from the weightvalue of each sub-indicator. The risk ranking value is obtained by sortingthe value of the risk level from the smallest to the largest. The highest risk level value of sub-indicator has the highest risk level of causing construction accident at the underpass construction project. Furthermore, it is also used as an indicator of priority reference for the construction safety system of the Underpass construction project.

From the contractors' perspective, the indicator that has the highest risklevel value is the sub-indicator of the availability of supporting facilities and infrastructure with a risk level value of 0.042 and the indicator that has the lowest risk level value is the sub-indicator of design change based on the results of subgrade or basic soil investigation with a risk level value of 0.0024, while from the supervisory consultant points of view of, the indicator that has the highest risk level value is the sub-indicator of measuring the dimensions of the road building installed in the site with a risk level value of 0.052 and the indicator that has the lowest risk level is the sub indicator of material for internal supervisory meetings with a risk level value of 0.0015.

CONCLUSION

The achievement rate of the contractors and the supervisory consultant's performance assessment on the Kentungan Underpass construction project of the occupies the figures of 85.938% and 97.29% in which this value is included in the level of Satisfactory Implementation Assessment. The level of satisfactory does not indicate the cause of the accident. It could be the accident occurred due to other variables that have not included in theanalysis.

Through analysis using the Fault Tree Analysis method, it is found that several basic events that have the potential to cause construction accidents on the Yogyakarta Kentungan Underpass project accident are basic events caused by personal and administrative factors, such as limited work experience, negligence of archiving, carelessness of labor, disobeying work procedures, negligence of the workforce, lack of knowledge order the workforce, lack of workforce skills, and the refusal of related parties. Indicator that is used as a reference priority for the construction safety system of underpass construction projects andhave the highest risk level that can cause an underpass project construction accident from the road contractor's point of view is the sub-indicator of supporting facilities and infrastructure with a risk level value of 0.042, while the Indicator that is used as a reference priority for the construction safety system of underpass construction projects and have the highest risk level that can cause an underpass project construction accident from the supervisory consultant's perspective of is the sub-indicator measuring the dimensions of the road building installed in the site with a risk level value of 0.0548.

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