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International Journal of Physical Sciences and Engineering Available online at www.scienceschola r.us Vol. 5 No. 3, December 2021, pages: 52-60 e-ISSN : 2550-6943, p-ISSN : 2550-6951 https://doi.org/10.53730/ijpse.v5n3.2942 52 Work Accident Risk Analysis with FMEA (Failure Mode and Effect Analysis) Method on Steel Frame Bridge Project

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Abstract

Risk is the possibility of the occurrence of an event outside of which every activity that is likely to be detrimental is carried out by humans. In the Nangarasong Steel Frame construction project in Flores district, there is uncertainty which will create a risk that can encourage the project and can affect the potential for work accidents. Uncertainty factors can cause risk in an activity that has an impact on decreasing labor productivity, risk of cost, time, and damage to design or technology. To reduce these adverse impacts, a risk management system is needed, which includes analysis, analysis, and monitoring of risks that may occur. Risk management makes an integrated effort to manage the risk of work accidents by using the FMEA (Failure Mode And Effect Analysis) method. All construction projects that may experience accident risks are identified and analyzed for the severity with FMEA, from the results of which the causes and impacts of the work accident risks will be sought. After knowing and the impact of the risk of work accidents, the next action on the risk of work accidents that result.

Keywords FMEA method; identification; impact; risk analysis; work accident;

Contents Abstract

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1 Introduction

Construction projects are jobs that have a high risk of work accidents with the possibility of serious work accidents. 1 The number of work accidents in Indonesia is still very high. If the risk of an accident occurs it will have an impact on the disruption of the overall project performance so that it can cause losses in costs, time, and quality of work. 2 A bridge is a structure made to cross a ravine or obstacle such as a river, railroad, or highway. Bridges are built for crossing pedestrians,

vehicles, or trains over obstacles. Bridges are also part of land transportation infrastructure which is very vital in traffic flows (Adzim, 2013; Endroyo & Tugino, 2009; Gita, 2015). The Nangarasong Steel Frame Bridge construction project, which is one of the construction projects that has a high risk of work accidents. In addition to using a steel frame whose installation process can cause various potential work accidents, the construction of this bridge is also close to residential areas, heavy equipment and project vehicles used must require correct procedures. This research will be carried out by identifying and analyzing the risks that occur in the project and then providing control over the risk of work accidents (Harms-Ringdahl, 2004; Marhavilas et al., 2011). The method used in this research is FMEA (Failure Mode Effect Analysis). Failure Mode Effect Analysis method is a method of evaluating the possibility of a system, design, process, or service to take steps to handle it. Prevention of work accidents can be done by controlling the occurrence of work accidents that have a high risk both in terms of consequences, the possibility of occurrence, and ease of detection (Ismail, 2018; Suraji & Duff, 2000; Suraji et al., 2001). This method is expected to be able to see the risks that may occur in the Steel Frame Bridge construction project along with their impacts and how to control them. Thus, in this study, the analysis of the risk factors for work accidents that occurred in the Steel Frame Bridge construction project was studied, assessed the risks from the lowest to the highest, and determined the proposed strategy in risk control (Zhang et al., 2014; Chen & Leu, 2014; Adar et al., 2017). 2 Materials and Methods In this study, the research design used is descriptive qualitative, namely a research method that utilizes qualitative data and is described descriptively. In this study, in order to obtain the required data, the authors used data collected through primary and secondary data sources (Melchior & Zanini, 2019; Brody et al., 1990; Rodriguez et al., 2018). The primary data source used in this research is the method of distributing questionnaires. The population is 20 employees of the Nangarasong Bridge construction project in Flores. 3 Results and Discussions Identify potential failure modes To find out the potential risk factors for work accidents in the project, the stage of identifying the risk of work accidents begins with

conducting field surveys and direct interviews at the project. Table 1 Identify failure mode NO. Type of work Job description Failure Mode

e-ISSN : 2550-6943 □ p-ISSN : 2550-6951 IJPSE Vol. 5 No. 3, December 2021, pages: 52-60 54 1 Preparatory Work 1. Measurement and Benchmarking a. Slipped due to a steep project site a. Hit by a passing vehicle (active road) 1. 1. Working Electrical Installation a. Electrocution / leakage current a. b. Stumbling on cables while working b. c. Cable damaged due to being run over by heavy equipment/vehicles 2. Equipment Mobilization a. Accident when mobilizing heavy equipment b. Heavy vehicles can't walk 2 Foundation work 1. Foundation work a. a. Accident when mobilizing heavy equipment b. b. Hit by excavator while digging c. c. Hit by a dump truck d. d. Slip e. e. Buried by avalanche f. f. Inhaled dust 2. 2. Wells a. a. Hit by a pit while transporting b. b. Slipped into the river due to slab soil c. c. Falling and slipping into the dug hole 3. 3. Ironing a. a. Hand blisters due to direct contact with iron b. b. Stuck when transporting iron c. c. Stumbled on iron while transporting d. d. Falls during installation at height e. e. Injured during the welding process f. f. Injured during the iron binding process 4. 4. Foundry a. a. Mixer movement, dangerous CP b. b. Hit/sprayed by concrete material c. c. Falls while casting at a height 3 Steel Frame Bridge Works 1. 1. Steel Frame Mobilization a. Struck by a broken crane a. b. Hit by steel frame b. c. Material late date 2. 2. Steel Frame Installation a. a. The reinforcing steel was crushed during installation b. b. Crane overturned/slipped during installation

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a. a. Hand blisters due to direct contact with iron b. b. Stuck when lifting iron c. c. Stumbled on iron while transporting d. d. Falls during installation at height e. e. Slipping when installing iron 4. 1. Formwork a. a. Slips during installation b. b. Punctured by sharp objects during installation/disassembly c. c. Struck by formwork material d. d. Falls during unloading at a height 5. 5. Concrete Floor Plate a. a. Falls while casting at a height b. b. Inhalation of dust and cement material 4 Masonry/Stone Work 1. Excavation a. a. Accident when mobilizing heavy equipment b. b. Hit by excavator while digging c. c. Hit by a dump truck d. d. Slip e. e. Buried by avalanche f. f. Inhaled dust 2. 2. Stone Laying a. a. Injured during masonry b. b. Injured due to small equipment used c. c. Falling slip Sumber: Wawancara dan Pengamatan Lapangan,2021 Table 2 Most critical risk interest Type of work Job description Failure Mode Risk Assesment RPN RPN TOTAL Severity Occurance Detection Steel Frame Bridge Works 1. Steel Frame Mobilization a. Struck by a broken crane 2.25 1.7 1.8 6.89 7.95 b. Hit by steel frame 2.2 2.05 2 9.02 2. Steel Frame Installation a. The reinforcing steel was crushed during installation 2.3 2.05 2.65 12.49 32.48 b. Clamped steel when laying 2.8 2.65 2.4 17.81 c. Exposure to radiation during welding 3.1 3.7 3.4 39.00 d. Falls during installation at height 4.05 4.1 3.65 60.61 3. Ironing a. Stuck when lifting iron 2.7 3.1 3.2 26.78 28.79 b. Stumbled on iron while 3.1 2.6 3.15 25.39

 transporting c. Falls during installation at height 2.9 2.7 3.25 25.45 d. Slipping when installing iron 3.2 3.45 3.4 37.54 4. Formwork a. Slips during installation 3.2 3.45 3.4 37.54 24.46 b. Punctured by sharp objects during installation/disassembly 3.1 3.15 3.4 33.20 c. Struck by formwork material 2.2 2.3 2.4 12.14 d. Falls during unloading at a height 2.3 2.55 2.55 14.96 5. Concrete Floor slab a. Falls while casting at a height 2.6 2.35 2.85 17.41 19.99 b. Inhalation of dust and cement material 3.2 2.35 3 22.56 Based on the value of the risk priority results above, the priority order for repairs that must be carried out is obtained from the mode of the Steel Frame Bridgework accident (Sepang et

al., 2013; Sinaga et al., 2014; Sudiarsa et al., 2018). The order of priority starts with Steel Frame Installation work with the highest RPN value of 32.48, then Steelwork work with an RPN value of 28.79, Formwork work with an RPN value of 24.46, Floor Plate Concrete work with an RPN value of 19.99, and the lowest RPN value in the Steel Frame Mobilization work is 7.95. Control of work accident risk Risk control is the most important stage as whole risk management. Risk control is the efforts made to anticipate the occurrence of risks that arise as a result of work accidents on the project (Boral et al., 2020; Mutlu & Altuntas, 2019; Efe, 2019). The following is the control of the work sub-items with the highest RPN value Table 3 Risk control analysis Type of work Job description Risk Control Steel Frame Bridge Works 1. Steel Frame Mobilization a. Struck by a broken crane - Make sure the machine is in good condition before operating - Using the right PPE - Ensure that the distance between workers and heavy equipment being operated is a safe distance b. Hit by steel frame - Inspection of lifting equipment before operating - Presence of supervisor during the steel frame transportation process - Using the right PPE 2. Steel Frame Installation a. The reinforcing steel was crushed during installation - Inspection of lifting equipment before operating - Presence of supervisor during the steel frame transportation process - Using the right PPE b. Clamped steel when laying - Use gloves c. Exposure to radiation during welding - Pay attention to welding SOPs - Using welding glasses

 d. Falls during installation at height - Use of safety belts - Blue sheet installation 3. Ironing a. Stuck when lifting iron - Use gloves b. Stumbled on iron while transporting - Use the right PPE c. Falls during installation at height - Use of safety belts - Blue sheet installation d. Slipping when installing iron - Use

proper PPE (safety helmet, shoes) 4. Formwork a. Slips during installation - Use proper PPE (safety helmet, shoes) b. Punctured by sharp objects during installation/disassembly - Pay attention to work SOPs - Using the right PPE c. Struck by formwork material - Use proper PPE (safety helmet) - Ensure proper placement of the formwork d. Falls during unloading at a height - Use of safety belts - Blue sheet installation 5. Concrete Floor slab a. Falls while casting at a height - Use of safety belts - Using the right PPE - Blue sheet installation b. Inhalation of dust and cement material - Use proper PPE (masks) - Using materials that comply with health standards 4 Conclusion Based on the results of data processing, some conclusions can be drawn as follows: 1) 14 The results of the study, identified 33 risk variables that may occur in the construction of the Nangarasong Steel Truss Bridge in Flores, NTT which is divided into 4 types of work with 14 sub-items of ongoing work on the project, namely preparatory work, foundation work, framework steel, and masonry work. 2) The level of risk importance (RPN) or the dominant failure mode that occurs in the construction of the Nangarasong Steel Frame Bridge is the preparatory work of 18.83; foundation work of 21.83; steel frame bridgework of 24.92; and masonry work of 24.80. Priority risk from steel truss bridgework as the work item with the largest RPN value. And the lowest RPN value in preparatory work is 18.83. 3) The source causes of work accidents are caused by 4 factors, namely; human factors, management factors, environmental factors, and technical factors. 4) Work accidents have an impact on the workers themselves, the workers' families, and the company. Work accidents cause minor injuries, serious injuries, to death for workers, not only that, losses will also be experienced by various parties. So that work accidents have an impact on the workers themselves, their families, and the company. Acknowledgments We are grateful to two anonymous reviewers for their valuable comments on the earlier version of this paper.

e-ISSN : 2550-6943 □ p-ISSN : 2550-6951 IJPSE Vol. 5 No. 3, December 2021, pages: 52-60 58 References Adar, 4 E., Ince, M., Karatop, B., & Bilgili, M. S. (2017). The risk analysis by failure mode and effect analysis (FMEA) and fuzzy-FMEA of supercritical

water gasification system used in the sewage sludge treatment. 23 Journal of Environmental Chemical Engineering, 5(1), 1261-1268. https://doi.org/10.1016/j.jece.2017.02.006 Adzim, H. I. (2013). Pengertian dan Elemen Sistem Manajemen K3 (Keselamatan dan Kesehatan Kerja). Ahli K3 Umum. Diakses, 2. Boral, S., Howard, I., Chaturvedi, S. K., McKee, K., & Naikan, V. N. A. (2020). A novel hybrid multi-criteria group decision making approach for failure mode and effect analysis: An essential requirement for sustainable manufacturing. Sustainable Production and Consumption, 21, 14-32. https://doi.org/10.1016/j.spc.2019.10.005 Brody, 6 B., Létourneau, Y., & Poirier, A. (1990). An indirect cost theory of work accident prevention. Journal of Occupational Accidents, 13(4), 255-270. https://doi.org/10.1016/0376-6349(90)90033-R Chen, T. T., & Leu, S. S. (2014). Fall risk assessment of cantilever bridge projects using Bayesian network. Safety science, 70, 161-171. https://doi.org/10.1016/j.ssci.2014.05.011 Efe, B. (2019). Analysis of operational safety risks in shipbuilding using failure mode and effect analysis approach. Ocean Engineering, 187, 106214. https://doi.org/10.1016/j.oceaneng.2019.106214 Endroyo, B., & Tugino, T. (2009). 20 Analisis faktor-faktor penyebab kecelakaan kerja konstruksi. Jurnal Teknik Sipil dan Perencanaan, 9(1), pp-21. Gita, M. A. (2015). Analisa Risiko Kecelakaan Kerja Proyek Marvell City Linden Tower Surabaya Menggunakan Metode FMEA (Failure Mode And Effect Analysis) Dan FTA (Fault Tree Analysis) (Doctoral dissertation, Institut Teknology Sepuluh Nopember). Harms-Ringdahl, L. (2004). 13 Relationships between accident investigations, risk analysis, and safety management. Journal of Hazardous materials, 111(1-3), 13-19. https://doi.org/10.1016/j.jhazmat.2004.02.003 Ismail, H. F. (2018). 17 Statistika untuk penelitian pendidikan dan ilmu-ilmu sosial. Kencana. Marhavilas, P. K., Koulouriotis, D., & Gemeni, V. (2011). Risk analysis and assessment methodologies in the work sites: On a review, classification and comparative study of the scientific literature of the period 2000– 2009. Journal of Loss Prevention in the Process Industries, 24(5), 477-523. https://doi.org/10.1016/j.jlp.2011.03.004 Melchior, C., & Zanini, R. R. (2019). 18 Mortality per work accident: A literature mapping. Safety science, 114,

7278. https://doi.org/10.1016/j.ssci.2019.01.001 Mutlu, N. G., & Altuntas, S. (2019). Risk analysis for occupational safety and health in the textile industry: Integration of FMEA, FTA, and BIFPET methods. International Journal of Industrial Ergonomics, 72, 222240. https://doi.org/10.1016/j.ergon.2019.05.013 Rodriguez, A. C. Z., Gamez, M. R., & Faure, L. G. (2018). Design, construction, and energy of sustainable solar dryers in Jipijapa Canton. International Journal of Physical Sciences and Engineering, 2(2), 88-100. https://doi.org/10.29332/ijpse.v2n2.170 Sepang, B. A. W., Tjakra, J., Langi, J. E. C., & Walangitan, D. R. O. (2013). Manajemen risiko keselamatan dan kesehatan kerja (K3) pada proyek pembangunan ruko Orlens Fashion Manado. Jurnal Sipil Statik, 1(4). Sinaga, Y. Y., Bintang, C. N., & Adi, T. W. (2014). Identifikasi Dan Analisa Risiko Kecelakaan Kerja Dengan Metode FMEA (Failure Mode And Effect Analysis) Dan FTA (Fault Tree Analysis) Di Proyek Jalan Tol Surabaya-Mojokerto. Jurnal Teknik Pomits, 1(1), 1-5. Sudiarsa, M., Sudiasa, W., & Sutapa, K. (2018). Value engineering approach for construction materials selection of irrigation drainage: Case study on project of DAS irrigation drainage improvement at Cengcengan River in Gianyar. International Journal of Physical Sciences and Engineering, 2(1), 35-46. https://doi.org/10.29332/ijpse.v2n1.89 Suraji, A., & Duff, A. R. (2000, September). Construction management actions: a stimulant of construction accident causation. In Proceedings of the 16th Annual ARCOM Conference (pp. 6-8). Suraji, A., Duff, A. R., & Peckitt, S. J. (2001). Development of causal model of construction accident causation. Journal of construction engineering and management, 127(4), 337-344.

 Sutapa, I. K., Kader, I. M. S., Santiana, I. M. A., Wibawa, I. G. S., Yasa, I. M. T., & Suasira, I. W. (2021). Work accident risk analysis with FMEA (failure mode and effect analysis) method on steel frame bridge project. International Journal of Physical Sciences and Engineering, 5(3), 52-60. https://doi.org/10.53730/ijpse.v5n3.2942 59 Zhang, L., Wu, X., Skibniewski, M. J., Zhong, J., & Lu, Y. (2014). Bayesian-network-based safety risk analysis in construction projects.

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