

Risk Control of Construction Worker Hazards at Heights

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Abstract: An occupational accident is an unexpected and unplanned occurrence, including acts of violence, arising out of or in connection with work, which results in one or more workers incurring a personal injury, disease, or death. Based on data from the ILO, every year, 2.78 million workers die due to occupational accidents and occupational diseases, of which 2.4 million (86.3%) are related to both occupational accidents and diseases. In comparison, the other 380,000 workers (13.7%) are due to occupational diseases only. The purpose of this study is to determine the risk control of hazards in high-altitude workers. The research method used is descriptive observational research that focuses on events that occur and is described in the form of a narrative. The results of this study indicate that there are still many workers who have not implemented hazard risk control at height and still do not use PPE when working at height. Controls that can be carried out are control through administrative work procedures, work safety analysis, making PPE completeness standards in the project area that are more tightened, and control of using PPE at height.

Keywords: Construction, PPE, JSA, Risk Control

INTRODUCTION

Work at height carries a very high risk of danger. In the United States, falls due to construction height work cause 50% of accidents each year (Khan et al., 2023). According to Minister of Manpower Regulation 09/2016, work at height is an activity or work activity carried out by workers at workplaces on land or water surfaces with differences in height and has the potential to fall, which can cause labor or other people in the workplace to be injured, die or cause property damage.

Working at height carries a high risk of hazards that can cause death and injury (Li et al., n.d.). Risk is an expectation that workers may suffer injury or health problems due to potential hazards (Seng Hansen, 2022). Hazard is anything that causes occupational injury and illness based on ISO 45001 (Purwanto et al., 2021). Thus, the risk of working at height is the cause of workplace accidents and fatalities (Oliveira et al., 2023).

According to the International Labour Organization, an occupational accident is an unexpected, unplanned event, including an act of violence, that occurs out of or in connection with work and causes physical injury, illness, or death to one or more workers (International Labour Organization (ILOSTAT), n.d.). Based on data from the ILO, every year, 2.78 million workers die due to occupational accidents and occupational diseases, of which 2.4 million (86.3%) die related to occupational accidents and occupational diseases) and 380,000 workers (13.7%) die due to occupational diseases (International Labour Office, 2019). Construction has a very high accident rate ((ILO), n.d.). Construction sites are workplaces that enclose a variety of risks to worker safety and health, and many of the activities that take place during the execution phase of a construction project are potentially hazardous (Sousa et al., 2014). Research conducted in Italy shows that construction is the occupation with more fatalities (Perotti & Russo, 2018).

Falls from height are one of the most common causes of serious occupational accidents and deaths in the construction industry, according to a study by Dong et al (Muhamad Zaini et al., 2020). In the city of Jeddah, the most common accident and injury to the construction industry is workers who fall from a height (Abukhashabah et al.,

2020). The study identifies three main causes of FFH accidents: human factors, management factors, and environmental factors. Human factors include misjudgment, poor attitude, unsafe behavior and carelessness, obliviousness, negligence, and failure to wear personal protective equipment (PPE). Management factors include insufficient monitoring, lack of training, noncompliance with safety regulations, and cost-saving. Environmental factors include poor site management and bad weather (Samad et al., 2023).

Risk identification is the process of identifying, classifying, and evaluating the initial significance of risks associated with a construction project systematically and continuously (Tadayon et al., 2012). Identifying risks helps to understand their nature and gives ideas on how to deal with them (Crispin, 2020).

Project X is one of the residential construction projects located in Gunungpati. Construction project is a dynamic field that has potential hazards and can affect the performance and quality of a project (Jannah et al., 2014). Based on observations and interviews, the construction process of Project X was assisted by fifty construction workers who had their own tasks and were supervised by one foreman on a regular basis.

Based on observations and interviews, the work at Project X is dominated by various work at heights, such as the construction of roof trusses and installation of roof tiles and ceilings, which have high potential hazards. Therefore, it is necessary to identify hazards in order to control the risk of existing hazards. According to Ramli, hazard identification is a systematic effort to determine the presence of hazards in organizational activities (Urrohmah & Riandadari, 2019). The hazard identification carried out aims to analyze, identify, and explain the risk picture in construction height work (Chen et al., 2022).

The high potential risk of hazards in high-altitude work in Project X makes researchers interested in conducting research related to controlling existing hazard risks.

METHODS

Based on the method of data collection, this research is an observational study because researchers only make observations and there are no treatments or interventions provided. Based on the analysis, this research is included in descriptive research because it explains the description of an activity objectively. Based on the place, this research is included in field research because the data was obtained by observation and interviews.

The object of this research is the height work in the House Construction Project in Gunungpati. The variables of this research include height work, hazard identification, risk assessment, and risk control. The study's participants were selected using a purposive sampling method to obtain the desired data.

RESULT AND DISCUSSION

A work accident is an unplanned, uncontrollable, and unwanted event that can occur while working (Budiyanto & Abdullah, 2018). Law No. 1 of 1970 explains the importance of paying attention to work safety in work activities carried out at heights. Work carried out at height includes trips, falls, slips, and falling objects (Nurhijrah, 2018).

Job Safety Analysis is a method that can be used to identify dangers that exist in the work environment. Through this identification, we can develop control and countermeasures to prevent work accidents and illnesses resulting from work accidents that have a risk of arising from a job (Ilmansyah et al., 2021).

From our observations, we found potential dangers in high-altitude work in Project X, which can be seen in Table 1.

| Stages of Work | Potential hazard | Reason |
|-------------------------|------------------|--|
| Roof Frame Construction | Overwritten | There was an error during installation |

| | | |
|-------------------------|-------------|--|
| | Fallen | Platform is not sturdy, slipping |
| | Wounded | Hit by a sharp object |
| Roof Tiles Installation | Overwritten | There was an error during installation |
| | Fallen | Falling from a height |
| | Wounded | Hit by a sharp object |
| Ceiling Installation | Wounded | Hit by a sharp object |
| | Fallen | Falling from a height |

The three stages of work are the stages at height. In work involving heights, there are many risks that arise. Our observation results show that not all workers use Personal Protective Equipment. Only a few workers use personal protective pieces of equipment, and do not use it in accordance with existing regulations.

According to the Minister of Public Works and Public Housing Regulation Number 10 of 2021 concerning Construction Safety Management System Guidelines Article 12, Personal Protective Equipment includes: Safety helmet, eye protection (goggles, spectacles), face shield, mask diving (breathing apparatus), ear protection (Ear Plug, Ear Muff), respiratory and mouth protection (Mask), gloves (Safety Gloves), safety shoes (Rubber Safety Shoes and Toe Cap), full body support (Full Body Harness), life jacket (Life Vest), safety vest (Safety Vest), apron (Apron/Coveralls), and fall protection (Fall Arrester).

The danger of falling can occur because workers do not use personal protective equipment such as a full suit body harness. This danger can occur in work related to heights, such as building roof frames, installing roof tiles, and installing ceilings.

Such work is carried out depending on how many floors the house is built. In housing project X, there are houses with various types and floors. Those various types and floors put workers at different risks. In installation work involving heights, workers use wooden stakes and do not use personal protective equipment specifically for heights.

In jobs such as installing roof tiles, workers also carry additional loads in the form of roof tiles manually, namely using pulleys made specifically for the job. From our observations and interviews, many workers did not use appropriate personal protective equipment; some only used boots and masks that did not meet standards. This was felt to be troublesome and hampered workers' activities. It was also said that they were used to working without complete PPE.

Risk Control

Based on observations and interviews, the most frequent accidents resulting from construction work at heights are falls, injuries, and crushes. This is because work at height has a high risk of danger, so risk control efforts must be made to reduce work-related accidents. Risk Control is a way to overcome potential dangers that exist in the work environment. These potential hazards can be controlled by determining a priority scale first, which can help in

prioritizing which can then help in selecting risk controls which is called a risk control hierarchy. Hazard control is an effort to eliminate a risk that causes loss. Risk control is an important and decisive step in overall risk management. Risk control plays a role in reducing the level of existing hazard risks to the lowest level or a tolerable level (Soputan et al., 2014). Risk control is carried out through:

The first step in hazard control is elimination, namely eliminating danger by eliminating monotonous work processes that can cause workers stress and other things. This control is carried out by eliminating sources of danger. Second, substitution, namely changing the process of work methods, operations, and equipment used to minimize the dangers that will occur, Reduces the risk of danger by changing processes and replacing inputs with lower-risk ones (Juhindra, 2023). The third one is technological engineering. Technology Engineering is an effort to separate sources of danger from workers by installing safety systems on tools or work areas and improving technological safety equipment for workers.

The fourth is administrative control, namely by controlling work permits, work method procedures, work safety analysis, and making PPE equipment standards in the project area more stringent, as well as increasing the competency of the workforce to make them more competent. Administrative control is a system of warnings, signals, signs, labels, instructions, training, education, or procedures to influence people's actions, reactions, or practices. This control includes the development of work methods and procedures, personnel selection, training, coaching, supervision, direction, planning, motivation, job rotation, change management, and changing or testing behavior, culture, or practice (Ajslev et al., 2022). Administrative control includes providing pre-employment and in-service training to all workers on covering workplace safety hazards and procedures, and most importantly, training on the importance of PPE use (Sehsah et al., 2020). Reduce the risk of danger by creating procedures and rules, installing safety signs, warning signs, training and selecting contractors, materials, and machines, handling methods, storage, and labeling. Lastly, use of Personal Protective Equipment (PPE), namely arranging and supervising the completeness of PPE that will be used when working, such as safety shoes, safety glasses, ear protectors, gloves, etc. By using PPE, the number of accidents due to working at height can be controlled (Rasouli et al., 2024).

Risk control using PPE

| Risk of Work Injury | Control using PPE |
|-----------------------|--|
| Falling from a height | Use a body harness and wear safety shoes |
| Hit by work material | Use a safety helmet |
| Wounded | Control gloves using safety shoes |

Based on the table, the Occupational Safety and Health (K3) risk that has the greatest and highest risk is the risk of workers falling from heights. To minimize the risk of workers falling from a height when working at height, there are several steps or ways that can be implemented in the workplace, namely: Look for other alternatives besides working at heights; plan for hazards, for example preparing the necessary PPE, using a safety net, paying attention to whether there are power lines around the work area, paying attention to the maximum load that can be supported by the structure where the worker is working; be more careful and aware of the surrounding, as there is a possibility of objects falling; prepare the scaffolding, pay attention to any holes or weak footings, and lastly, mark dangerous places or areas.

Carry out work according to plan and use fall protection. There are two types of fall protection, namely Collective fall protection and Individual fall protection. Collective fall protection is a device that prevents workers from falling, such as fences/guardrails, work platforms, scaffolds, etc. Additional equipment include nets (safety nets), airbags or crash decking. Meanwhile, individual fall protection is a device that protects workers if the worker falls, such as a fall arrest system. It can be used in a full-body harness and line (Koloso, 2022).

CONCLUSION

Project X is one of the residential construction projects located in Gunungpati. This project is dominated by various work at height, such as the construction of roof trusses, the installation of roof tiles and ceilings. The work at height in this project has potential hazards that can affect the performance and quality of a project. For this reason, this study was conducted to identify the hazards of working at height in Project X to control the existing hazards. The results of the study are PPE is one of the efforts used to prevent and control the hazards of working at height, but there are still many workers who do not use appropriate Personal Protective Equipment, some only use boots and masks that do not meet the standards. This condition happens because workers are accustomed to working without PPE and they feel that using PPE is troublesome and hampers activities while working. Controls that can be carried out are control through administrative work procedures, work safety analysis and making PPE completeness standards in the project area and more tightened rules for using PPE.

REFERENCES

- (ILO), I. L. O. (n.d.). *World Statistic*. Retrieved November 29, 2023, from https://www.ilo.org/moscow/areas-of-work/occupational-safety-and-health/WCMS_249278/lang-en/index.htm
- Abukhashabah, E., Summan, A., & Balkhyour, M. (2020). Occupational accidents and injuries in construction industry in Jeddah city. *Saudi Journal of Biological Sciences*, 27(8), 1993–1998. <https://doi.org/10.1016/j.sjbs.2020.06.033>
- Ajslev, J. Z. N., Møller, J. L., Andersen, M. F., Pirzadeh, P., & Lingard, H. (2022). The Hierarchy of Controls as an Approach to Visualize the Impact of Occupational Safety and Health Coordination. *International Journal of Environmental Research and Public Health*, 19(5). <https://doi.org/10.3390/ijerph19052731>
- Budiyanto, S., & Abdullah, R. (2018). Upaya Meminimalisir Kecelakaan Kerja di Area Penambangan PT. Putra Perkasa Abadi jobsite Borneo Indobara, Kabupaten Tanah Bumbu, Kalimantan Selatan. *Jurnal Bina Tambang*, 4(1), 276–286.
- Chen, Y., Sun, Z., Hou, Y., Gao, D., & Li, Z. (2022). Hazard identification & risk control in aluminum production. *Process Safety and Environmental Protection*, 165(March), 336–346. <https://doi.org/10.1016/j.psep.2022.07.017>
- Crispin, G. (2020). The Essence of Risk Identification in Project Risk Management: An Overview. *International Journal of Science and Research*, 9(2), 973–978. <https://doi.org/10.21275/SR20215023033>
- Ilmansyah, Y., Mahbubah, N. A., & Widyaningrum, D. (2021). Penerapan Job Safety Analysis Sebagai Upaya Pencegahan Kecelakaan Kerja Dan Perbaikan Keselamatan Kerja Di Pt Shell Indonesia. *Profisiensi*, 8(1), 15–22.
- International Labour Office. (2019). Safety and Health at the heart of experience. *International Labour Office Switzerland*.
- International Labour Organization (ILOSTAT). (n.d.). *Occupational Safety and Health Statistics (OSH database)*. Retrieved December 5, 2023, from <https://ilostat.ilo.org/resources/concepts-and-definitions/description-occupational-safety-and-health-statistics/>
- Jannah, M. R., Unas, S. El, & Hasyim, M. H. (2014). Pada Studi Kasus Proyek Pembangunan Menara X Di Jakarta (Risk Analysis of Occupational and Safety Using HIRADC Approach and Job Safety Analysis Method in the Case Study of Tower Project X in Jakarta). *Teknik Sipil*, 9.
- Juhindra, M. H. (2023). *TESIS M.Hary Juhindra 21914016*.
- Khan, M., Nnaji, C., Khan, M. S., Ibrahim, A., Lee, D., & Park, C. (2023). Risk factors and emerging technologies for preventing falls from heights at construction sites. *Automation in Construction*, 153.
- Koloso, A. P. (2022). Manajemen Risiko Keselamatan dan Kesehatan Kerja pada Pekerjaan Konstruksi. *Seminar Nasional Insinyur Profesional (SNIP)*, 1(1). <https://doi.org/10.23960/snip.v1i1.132>
- Li, X., Ge, F., & Yang, F. (n.d.). Human reliability assessment on building construction work at height: The case of scaffolding work. *Safety Science*, 159.
- Muhamad Zaini, N. Z., Mat Salleh, M. A., Fikri Hasmori, M., & Haslinda Abas, N. (2020). Effect of Accident Due to Fall from Height at Construction Sites in Malaysia. *IOP Conference Series: Earth and Environmental Science*, 498(1). <https://doi.org/10.1088/1755-1315/498/1/012106>
- Nurhijrah, N. (2018). Pencegahan Resiko Kecelakaan Jatuh Dari Ketinggian Pada Pekerjaan Industri Konstruksi Di Indonesia. *PENA TEKNIK: Jurnal Ilmiah Ilmu-Ilmu Teknik*, 3(1), 85. https://doi.org/10.51557/pt_jiit.v3i1.172
- Oliveira, S. S., Soares, W. de A., & Vasconcelos, B. M. (2023). Fatal fall-from-height accidents: Statistical treatment using the Human Factors Analysis and Classification System – HFACS. *Journal of Safety Research*, 86, 118–126.
- Perotti, S., & Russo, M. C. (2018). Work-related fatal injuries in Brescia County (Northern Italy), 1982 to 2015: A forensic analysis. *Journal of Forensic and Legal Medicine*, 58, 122–125. <https://doi.org/10.1016/j.jflm.2018.06.002>
- Purwanto, A., Asbari, M., Novitasari, D., Fahmi, K., Mustofa, A., Rochmad, I., & Wahyuni, I. S. (2021). Peningkatan Keselamatan Kerja Melalui Pelatihan ISO 45001:2018 Sistem Manajemen Keselamatan dan Kesehatan Kerja Pada Industri Manufaktur di Tangerang. *Journal of Community Service and Engagement (JOCOSAE)*, 01(02), 1–6. <https://jocosae.org/index.php/jocosae/article/view/8>
- Rasouli, S., Alipouri, Y., & Chamanzad, S. (2024). Smart Personal Protective Equipment (PPE) for construction safety: A literature review. *Safety Science*, 170.
- Samad, N. A., Hasmori, M. F., & Ismail, R. (2023). Identification of fall event and classification of the factors causing fall from height accidents in the construction industry. *IOP Conference Series: Earth and Environmental Science*, 1205(1).

<https://doi.org/10.1088/1755-1315/1205/1/012036>

- Sehsah, R., El-Gilany, A.-H., & Ibrahim, A. M. (2020). Personal protective equipment (PPE) use and its relation to accidents among construction workers. *La Medicina Del Lavoro*, 111(4), 285–295. <https://doi.org/10.23749/mdl.v111i4.9398>
- Seng Hansen. (2022). Identifikasi Jenis Bahaya Dan Parameter Penilaian Bahaya Pada Pekerjaan Konstruksi. *PADURAKSA: Jurnal Teknik Sipil Universitas Warmadewa*, 11(1), 94–102. <https://doi.org/10.22225/pd.11.1.4356.94-102>
- Soputan, G., Sompie, B., & Mandagi, R. (2014). Manajemen Risiko Kesehatan Dan Keselamatan Kerja (K3) (Study Kasus Pada Pembangunan Gedung Sma Eben Haezar). *Jurnal Ilmiah Media Engineering*, 4(4), 229–238.
- Sousa, V., Almeida, N. M., & Dias, L. A. (2014). Risk-based management of occupational safety and health in the construction industry – Part 1: Background knowledge. *Safety Science*, 66, 75–86.
- Tadayon, M., Jaafar, M., & Nasri, E. (2012). An Assessment of risk identification in large construction projects in Iran. *Journal of Construction in Developing Countries*, 17(SUPPL. 1), 57–69.
- Urrohmah, D. S., & Riandadari, D. (2019). Identifikasi Bahaya dengan Metode Hazard Identification, Risk Assessment and Risk Control (Hirarc) dalam Upaya Memperkecil Risiko Kecelakaan Kerja di PT. PAL Indonesia. *Jurnal Pendidikan Teknik Mesin*, 8(1), 34–35.