

Identification of Occupational Health and Safety of Formwork Using the Job Safety Analysis Method of Building Construction Projects

Regita Gustriana^{1✉}, Sely Novita Sari², Anggi Hermawan³

^{1,2,3} Civil Engineering Study Program, Faculty of Engineering and Planning, Institut Teknologi Nasional Yogyakarta, Indonesia

✉Corresponding Author : Regita Gustriana (e-mail: 1100220038@students.itny.ac.id)

Article Information	ABSTRACT
Article History Received : December 13, 2025 Revised : January 03, 2026 Published : January 10, 2026	Formwork in construction projects has a high level of risk to worker safety due to heavy material handling, equipment use, and activities at height. This study will investigate potential hazards in formwork through Job Safety Analysis (JSA) and assess the effectiveness of risk control based on the Hierarchy of Control, which includes elimination, substitution, engineering control, administrative control, and the use of personal protective equipment (PPE). Data collection was executed via on site observations, evaluation of project K3 documentation, and conversations with safety officers, supervisors, and associated workers. The results of the analysis indicated that risk control was more applied to engineering control (55.1%), administrative control (20.4%), and the use of PPE (20.4%). Meanwhile, of substitution (4.08%) and elimination (0%) are still very low. This condition shows that the control with the highest level of effectiveness has not been maximized, so the potential risk of accidents remains high. The findings emphasize the value of implementing top-level controls from the planning and design stages of the project. The use of Hierarchy of Control-based Job Safety Analysis has proven to be a systematic approach in determining risk control priorities and improving occupational safety management. Thus, the results of this study provide strategic recommendations for construction projects in minimizing accidents and building a more effective safety culture.
Keywords: <i>Job Safety Analysis;</i> <i>Hierarchy of control;</i> <i>K3;</i> <i>Formwork.</i>	

INTRODUCTION

Construction work involves a coordinated set of activities to build a physical structure, such as a building or bridge, with resource management and quality control that is technically designed to achieve planned outcomes (Servanty et al., 2025). One of the important components in construction work is formwork, which is a temporary auxiliary construction that functions as a mold to hold fresh concrete until it forms according to the design (Nasikhin, 2023). The existence of formwork has a vital role in the success of concrete structure work, so work safety in this activity must receive adequate attention.

The success of a construction project is determined not only by punctuality and budget but also by the low rate of work accidents. The implementation of the Occupational Safety and Health Management System (SMK3) is an important element in accident control through risk management policies, training, and commitments (Latupeirissa et al., 2024). Risk management itself is a process to recognize, analyze, and control hazards in every company activity to increase work effectiveness and efficiency (Tamim & Ismail, 2020). Ministerial Regulation (PUPR 10/2021) stipulates that every construction work that has a high level of risk must be accompanied

by the preparation of a Job Safety Analysis (JSA) as part of the safety control mechanism. Work that falls into the high-risk category includes activities at height, excavation, operation of heavy equipment, lifting using cranes or lifting, electrical work, installation of temporary structures such as scaffolding and formwork, and demolition work. This provision emphasizes that the implementation of JSA is an important component in ensuring construction safety in accordance with applicable national standards.

The use of Job Safety Analysis (JSA) is one of the systematic approaches in the process of identifying hazards, assessing risks, and preparing controls before work is carried out (Ghasemi et al., 2023). The implementation of JSA has been proven to improve work formalities, worker engagement, and organizational learning, making it an important tool in a sustainable safety management system (Albrechtsen et al., 2019). This analysis is more optimal when combined with the Hierarchy of Controls (HoC), which is the priority level of hazard control actions based on the highest to lowest effectiveness. The mechanism allows the determination of a more targeted control strategy to reduce the potential for accidents.

The field conditions in the Oncology Center Building Construction Project of Soeradji Tirtonegoro Hospital show incidents such as being scratched by iron, head hit by a hammer, hand pinched, and finger being cut off. The observation results identified potential additional hazards in the form of material buildup in the fabrication area, lack of safety signs, and the use of non-standard work clothes. The findings reflect that the application of K3 to formwork has not been running optimally. In fact, accidents and occupational diseases not only have an impact on workers but also cause direct or indirect losses to companies (Gelvan Laurens Tuapetel, 2019).

The challenges of implementing K3 are also seen in various construction projects in Indonesia that still face obstacles in their implementation. Practices in the field are often not up to standard, so the risk of accidents remains high (Suryani et al., 2021). Various studies show that the implementation of control in the construction and manufacturing industry is still dominated by engineering control and the use of PPE, while elimination and substitution steps are rarely carried out due to budget limitations, time pressures, and resistance to changes in working methods (Zhang et al., 2019). This imbalance in the implementation of control has the potential to reduce the effectiveness of project safety, even though K3 has an important role in maintaining the smooth running of work (Pranoto, 2024).

The mismatch between the potential hazards in the field and the effectiveness of the controls applied shows that the safety system in formwork is still not optimal in providing protection. This condition demands a more measurable evaluation to ensure that the controls chosen are truly appropriate to the level of occupational risk, especially in activities with high potential for injury. Analysis through JSA combined with the Hierarchy of Controls is important to obtain an objective picture of the adequacy of control and determine actions that should be prioritized in the field.

Through the identification of potential hazards and the analysis of the effectiveness of risk control based on the Hierarchy of Control, this study aims to prepare recommendations for priority K3 actions that are feasible to be implemented to minimize the risk of accidents in formwork work in the construction of the Oncology Center Building of Soeradji Tirtonegoro Hospital. The relevance of this study is further emphasized by the urgent need to address work accidents in formwork caused by the lack of implementation of K3 procedures and actions in the field. Suboptimal implementation of K3 in structural work can increase the risk of serious injuries, making hazard control an essential aspect of preventing work accidents (Amirah et al., 2024). Thus, the results of this study are expected to be able to make a real contribution to the company in the process of identifying and controlling the risk of work accidents in construction projects.

RESEARCH METHODS

This study is quantitative research with a descriptive design that applies the Job Safety Analysis (JSA) method. Research on the Construction Project of the Oncology Center Building of

Soeradji Tirtonegoro Hospital Formwork Works, based on consideration of field conditions that show the occurrence of various incidents of work accidents, including workers being scratched by iron, heads hit by hammers, pinched hands, and severed fingers.

To gain an understanding of potential hazards in formwork, this study applies the Job Safety Analysis (JSA) method, with risk control analyzed based on the level of effectiveness through the Hierarchy of Control. The approach is used to determine the priorities of preventive efforts, where the actions with the highest effectiveness, such as elimination and substitution, are placed as the primary choice, while administrative control and the use of personal protective equipment are at a lower level of effectiveness (Wardana et al., 2023). The research output is in the form of the percentage of control effectiveness, which is used as the basis for recommendations for controlling the risk of work accidents in formwork work.

As a first step in understanding the risks as a whole, the identification of research activities on formwork is carried out through direct observation coordinated with the K3 project administration. The K3 administration provides safety documents such as job safety analysis, permits to work, and daily inspection reports that are used as the basis for determining risky work areas. Field observations were carried out with safety officers and project supervisors to record real conditions, work behavior, use of PPE, and the implementation of risk control.

To produce data, with research instruments using observation sheets to record working conditions and K3 implementation (Bungin, 2023), the reliability and validity of data are strengthened through technical triangulation, namely by comparing the results of field observations with information obtained from interviews and project documentation, so that the credibility of the data and the accuracy of the analysis results can be guaranteed.

The study of K3 documents is a comparison of the results of field practice observations, photo or video documentation to capture dangerous conditions and the controls applied, as well as interviews with workers and supervisors to obtain information related to the implementation of occupational safety procedures. The steps of the research instrument can be seen in figure 1 and in figure 2 it can be seen that the data collection is carried out through direct observation at the project site.



Figure 1. Research Instruments



Figure 2. Direct Observation

Field data collection is carried out through direct observation at the project site to identify K3 practices, working conditions, and potential hazards at each stage of formwork (Deanggi, 2025). Each stage is analyzed using JSA to record the hazards and control measures implemented, then their effectiveness is evaluated through the Hierarchy of Control according to the order of control priorities (Suseno & Yuliarty, 2025). The steps to collect field data can be seen in figure 3.



Figure 3. Research Procedure

The data analysis process was prepared using qualitative thematic analysis techniques that were quantified through grouping based on potential hazards, work steps in the JSA, and hazard control levels. The analysis stages include data reduction, hazard description, and control evaluation. Data reduction is carried out by filtering and simplifying information from observations, interviews, and K3 documents so that only relevant data is retained. The hazard description refers to the JSA prepared by the project K3 administration as a work safety guideline, while the evaluation is focused on the suitability of risk control with JSA recommendations (Marfiana et al., 2019). Risk control is then analyzed using the Hierarchy of Control to determine the level of effectiveness, and the results are calculated in percentage form as in formula 1.

$$\text{Control Effectiveness} = \frac{\text{Number of Actions Executed by Category}}{\text{Total Number of Actions}} \times 100\% \quad (1)$$

The results of the effectiveness assessment are mapped into a hierarchy diagram, such as the pyramid Hierarchy of Controls, to illustrate the dominance of the type of control used in the formwork work. This visualization provides a comparative overview of each type of control and is the basis for the preparation of more appropriate risk control recommendations in accordance with figure 4.

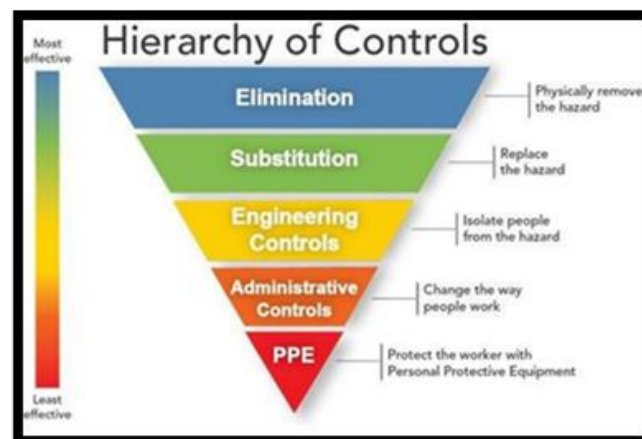


Figure 4. Hierarchy of Controls

Source: (Purwanningrum et al., 2023)

RESULTS AND DISCUSSION

Based on the results of field observations, interviews, and job safety analysis to identify steps that have and have not been implemented, nine main potential hazards in formwork work are obtained. These potential hazards include the risk of being hit by a material transport car, the use of damaged equipment, pinching or cutting equipment, falling materials, workers falling from heights, being hit by sharp objects such as iron, scratched hands, and tripping over materials in the

work area. Each of these potential hazards is further analyzed to assess the suitability and effectiveness of the form of control that has been applied based on the principle of the Hierarchy of Control. The classification of potential hazards in formwork work along with the implementation of risk control measures prepared based on the Hierarchy of Control is presented in table 1.

Table 1. Identification of the Hierarchy of Control

No	Potential Hazards	Hierarchy of Controls				
		Elimination	Substitution	Engineering Controls	Administrative Control	PPE
1	Hit by a material car			1. Traffic signs on the road must be obeyed 2. Make sure the truck is running at a maximum speed of 20 km/jam 3. Ensure safe road access. 4. Make sure the lighting is sufficient	1. Make sure the truck carries the material safely / according to the SOP 2. Make sure the warehouse team directs the truck to where the materials will be unloaded	
2	Equipment is damaged so it cannot be used		1. Make sure spare parts are available in case of damage	5. Periodic maintenance of the equipment used 6. Make sure the equipment is protected from rainy weather	3. Regular equipment inspection checklist is made 4. Use of the appliance in accordance with the established manual guidelines	
3	Pinched or cut due to the use of equipment			7. At the time of lifting the iron, it is ensured that the iron does not get stuck with the existing material 8. The rigger ensures the removal of the iron bars and pays attention to the position of the people around them as well as the correct lifting process	5. Workers must know how to lift and use the tool	1. Workers wear thick gloves during work
4	Material drops		2. Provide a special equipment	9. Not placing equipment and materials carelessly 10. Make sure		2. Material lifting pays attention to the standard of correct lifting

No	Potential Hazards	Hierarchy of Controls				
		Elimination	Substitution	Engineering Controls	Administrativ Control	PPE
5	Workers fall		place at the above time	the precast iron fastening is installed correctly 11. Check the lift sling before starting work 12. Make sure the iron binding with the bendrat is properly bonded 13. Setting up a platform and access ladder to work at height (already tagged green) 14. Make sure the railing safety system is installed 15. Pay attention to the conditions at the time of installation, whether wet or dry 16. Ensuring adequate lighting while working 17. Make sure the work area is dry and not slippery at work 18. Iron cuttings that stick out and have the potential to injure workers are given safety and danger warning signs/ bent inwards 19. The bending of the iron webbing binder of the structure is bent in such a way as not to injure workers	6. Work in a safe position at altitude 7. Ensure the condition of workers is healthy before starting work	3. Use a safety body harness at work at height and is linked to the life line 4. Provide a life line for the full body harness fasteners and must use the attached full body harness 5. Ironing workers are required to wear long-sleeved shirts and trousers 6. Use PPE, gloves, safety shoes
6	Exposure to sharp iron parts					

No	Potential Hazards	Hierarchy of Controls				
		Elimination	Substitution	Engineering Controls	Administrativ Control	PPE
7	Workers fall			20. The sharp side of the material in the work area is removed by grinding if possible 21. Set up a platform and access ladder to work in height (already tagged green) 22. Make sure the railing safety system is installed 23. Pay attention to the conditions at the time of installation, whether wet or dry 24. Ensuring adequate lighting while working 25. Make sure the work area is dry and not slippery at work	8. Work in a safe position at altitude 9. Ensure the condition of workers is healthy before Start Work	7. Use safety body harness when working at heights and dikaitkan pada life line 8. Provide a lifeline for the full body harness fasteners and must use the attached full body harness
8	Scratched hand					9. Use PPE, gloves, safety shoes
9	Tripping material			26. Installation of warning signs and area security 27. Make sure the materials are neatly arranged and placed in place	10. Make sure there is always a supervisor in the field directing	10. Make sure all employees use PPE
Total Levels		0	2	27	10	10
Total Number of Actions				49		

Based on the identification results in table 1, it was found that there were 49 risk control actions identified and divided into five levels, namely Substitution, Elimination, Engineering Control, Administrative Control, and PPE use. Then analyze its effectiveness to determine the percentage of control distribution at each level. The results of the analysis of the percentage distribution of control based on formula 1 are shown in table 2.

Table 2. Distribution Percentage Analysis

No.	Levels Hierarchy of Control	Total Levels	Presentase (%)
1	Elimination	0	0.00
2	Substitution	2	4.08
3	Engineering Controls	27	55.10
4	Administrativ Control	10	20.41
5	PPE	10	20.41
Total Number of Actions		49	100

Based on the level of the Hierarchy of Control, engineering controls is the most widely applied form of control, showing that risk control in the field is still highly dependent on technical measures. At the next level, administrative control and PPE appear in relatively balanced proportions, indicating that work procedures and the use of personal protective equipment are still the mainstay in supporting work safety. Meanwhile, substitution is applied in a more limited scope, and elimination is the least used level. This pattern shows that risk control in formwork still rests at the middle to lower level in the Hierarchy of Control, so reinforcement at a higher level of control is needed to achieve more effective risk reduction.

In formwork activities, it still focuses on the level of engineering control and administrative control, so the implementation of risk control has not fully led to a more effective control hierarchy. This pattern is consistent with the findings (Ajslev et al., 2022) who reported that in the construction sector, about 53% of risk control is carried out through administrative control, 35% through technical control, and less than 10% is at the level of hazard elimination or substitution. This proportion shows that high-effectiveness control measures are still rarely applied to construction projects.

Obstacles in project design and planning lead to limitations in the application of controls at the elimination or substitution level. The study by (Machfudiyanto et al., 2023) identified that budget limitations and technical planning complexity are factors that cause the principles of design for safety to not be fully integrated from the design stage. When the elimination of hazards through design is not possible, risk control efforts in construction projects tend to rely on administrative procedures and the use of personal protective equipment (Che Ibrahim et al., 2022).

The availability of personal protective equipment is not always followed by consistent use in the field, thus showing this tendency. The effectiveness of PPE use is greatly influenced by worker behavior and the quality of supervision (Jalil Al-Bayati et al., 2023). Workers' non-compliance with safety procedures, including the use of PPE, is often a factor that triggers minor accidents (Saputra, 2022). This condition shows that administrative and technical control is not effective enough if it is not balanced with worker discipline and adequate supervision.

The safety culture in the project has not been fully established, as shown by the results of field observations and interviews with K3 officers. This is in line with the findings of (Palupi, 2019) who stated that weaknesses in K3 supervision and safety behaviors that have not been internalized are the main obstacles in risk control efforts. These findings underscore the importance of improving behavioral aspects and safety culture as part of a more comprehensive risk control strategy.

CONCLUSION

Based on the assessment that has been carried out, the results of the analysis are listed in table 2 with As part of efforts to continuously improve the performance of K3 to increase the effectiveness of the occupational safety system in formwork work, the results of the Job Safety

Analysis, which show that several control measures have not been implemented optimally, need to be considered. One of the recommended strategies is to strengthen the application of control at the elimination and substitution levels from the planning and design stages.

formula 1 shows that risk control based on the Hierarchy of Control in figure 4 of formwork work at the construction project site is still dominated by the application of engineering control by 55.10%, followed by administrative control (20.41%) and the use of personal protective equipment (PPE) (20.41%). On the other hand, the implementation of control at the substitution (4.08%) and elimination (0.00%) levels has not been optimally implemented in the field. These findings indicate that most risk control efforts still focus on technical and administrative aspects, rather than on more fundamental strategies such as the removal or replacement of direct sources of hazard. In fact, control at the elimination and substitution level is the most effective step in minimizing risks from the early stages of the work process.

ACKNOWLEDGEMENTS

The researcher expressed his deepest appreciation and gratitude to the Institut Teknologi Nasional Yogyakarta (ITNY) for providing the opportunity and facilities to carry out this research. I would also like to thank PT. Wika Building, which has allowed me to conduct research on the Oncology Building Construction Project of dr. Soeradji Tirtonegoro Hospital. I would also like to express my deep gratitude to my beloved family, especially my parents, who always provide prayers, encouragement, and moral support that have been a source of strength for me during the process of preparing this research. I don't forget to thank my lover, Rian Septian Nugroho, who always provides support, motivation, and practical assistance that is very meaningful in completing this research.

REFERENCES

- 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), 1–14. <https://doi.org/10.3390/ijerph19052731>
- Albrechtsen, E., Solberg, I., & Svensli, E. (2019). The application and benefits of job safety analysis. *Safety Science*, 113(December 2018), 425–437. <https://doi.org/10.1016/j.ssci.2018.12.007>
- Che Ibrahim, C. K. I., Manu, P., Belayutham, S., Mahamadu, A. M., & Antwi-Afari, M. F. (2022). Design for safety (DfS) practice in construction engineering and management research: A review of current trends and future directions. *Journal of Building Engineering*, 52(February). <https://doi.org/10.1016/j.jobbe.2022.104352>
- Deanggi, V. L. (2025). K3 Risks in the Implementation of Multi-Story Building Construction. *KERN : Scientific Journal of Civil Engineering*, 11(1), 27–36. <https://doi.org/10.33005/kern.v11i1.69>
- Gelvan Laurens Tuapetel, A. S. (2019). Symmetrical journal vol.9, no.2, december 2019. *Symmetrical Journal*, 9(2), 208–214.
- Ghasemi, F., Doosti-Irani, A., & Aghaei, H. (2023). Applications, Shortcomings, and New Advances of Job Safety Analysis (JSA): Findings from a Systematic Review. *Safety and Health at Work*, 14(2), 153–162. <https://doi.org/10.1016/j.shaw.2023.03.006>
- Jalil Al-Bayati, A., Renner, A. T., Listello, M. P., & Mohamed, M. (2023). PPE non-compliance among construction workers: An assessment of contributing factors utilizing fuzzy theory. *Journal of Safety Research*, 85, 242–253. <https://doi.org/10.1016/j.jsr.2023.02.008>
- Machfudiyanto, R. A., Kim, S., Latief, Y., Rachmawati, T. S. N., & Laksono, N. B. (2023).

- Analysis of design-for-safety implementation factors in the Indonesian construction industry: A two-staged SEM-artificial neural network approach. *Heliyon*, 9(11), e21273. <https://doi.org/10.1016/j.heliyon.2023.e21273>
- Marfiana, P., Ritonga, H. K., & Salsabiela, M. (2019). Implementation of Job Safety Analysis (JSA) as an effort to prevent work accidents. *Migasian Journal*, 3(2), 25–32.
- Ministry of Public Works and Public Housing. (2021). Regulation of the Minister of Public Works and Public Housing Number 10 of 2021 concerning Guidelines for Construction Safety Management System Guidelines. <https://pu.go.id>
- Nasikhin, M. K. (2023). Method of Implementing Column Structure Work in the Passenger Terminal Building Construction Project of Dhoho Kediri International Airport. *Civil Engineering Vocational Journal*, 1(3), 117–123.
- Palupi, M. S. (2019). *Analysis of Occupational Safety and Health Risk Control in the Yogyakarta-Barongan Road Improvement Project (Imogiri Road Improvement Project)* 84. <https://dspace.uui.ac.id/handle/123456789/15994>
- Pranoto, H. (2024). Risk management related to safety and health in construction projects. *Innovative: Journal Of Social Science Research*, 4(3), 2106–2115. <https://doi.org/10.31004/innovative.v4i3.10745>
- Purwanningrum, D., Maharani, A. V., Hanafi, A. S., Kurnianingtias, M., & Noviar, M. A. (2023). Hazard Analysis and Application of K3 in the Cutting Division of PT XYZ. *Textile Journal: Scientific Journal and Application of Textile and Industrial Management*, 6(2), 109–110. <https://doi.org/10.59432/jute.v6i2.71>
- Saputra, F. D. (2022). *Analysis of Worker Compliance with the Occupational Safety and Health (K3) Program as an Effort to Achieve Zero Accident at Pt. Arara Abadi, Tapung Thesis District*.
- Servanty, I. A., Putra, I. N. D. P., & Soetanto, R. (2025). A comparison allocation of labor qualification on real, plan, and regulation calculation using resource-leveling method. *Jurnal Sistem Dan Manajemen Industri*, 9(1), 1–13. <https://doi.org/10.30656/jsmi.v9i1.10273>
- Suryani, T., Fauzi, A. A., & Nurhadi, M. (2021). Enhancing brand image in the digital era: Evidence from small and medium-sized enterprises (smes) in Indonesia. *Gadjah Mada International Journal of Business*, 23(3), 314–340. <https://doi.org/10.22146/gamaijb.51886>
- Suseno, I. K. B., & Yuliarty, P. (2025). Job Safety Analysis for Accident Risk Control and Occupational Health in Employee Guesthouse Construction Work. *PASTI Journal (Research and Application of Industrial Systems and Engineering)*, 19(1), 65. <https://doi.org/10.22441/pasti.2025.v19i1.006>
- Zhang, W., Zhang, X., Luo, X., & Zhao, T. (2019). Reliability model and critical factors identification of construction safety management based on system thinking. *Journal of Civil Engineering and Management*, 25(4), 362–379. <https://doi.org/10.3846/jcem.2019.8652>