Volume 6, Issue 3, pp. 10-14, 2022
International Journal of Scientific Engineering and Science
ISSN (Online): 2456-7361

Risk Management of the Occupational Health and Safety (OHS) Aspects on the Megaprojects of UINSA's Campus II Development Surabaya

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***Abstract**— Occupational health and safety (OHS) is an important aspect that determines the successful implementation of a construction project. It is directly related to the effectiveness and efficiency of time and cost. This study aims to investigate the potential and risk of occupational accidents in the construction project of UINSA's campus II, Surabaya, to further formulate a systematic occupational safety and health risk control strategy to support the success of construction projects. This study implements a quantitative method with a survey approach. Primary data were collected using a questionnaire distributed to 35 contractor personnel related to OHS aspects. Analysis of the potential level and risk of work accidents was carried out based on the 2014 AS/NZS 4360 matrix. Based on the results, molding, metal reinforcement, casting, wall, and ceramic installation, door, and window installation, and painting work on UINSA's campus II construction project obtained work accident risks index in the "medium" to "high" category. In addition, the potential risk of work accidents in all types of work is proven to have a significant impact ($p < 0.05$) on contractor performance in completing construction projects. Therefore, OHS management needs to be the contractor's primary concern to mitigate and prevent potential work accidents in the project environment. The risk control strategy can reduce potential risks by preparing health, safety, and environment (HSE) plans that include HIRARC (Hazard Identification Risk Assessment and Risk Control), implementation of safety induction, and safety patrol and installation of HSE warning signs.*

***Keywords**— Occupational health and safety (OHS), Risk management, UINSA, AS/NZS4360 matrix, construction project.*

I. INTRODUCTION

Occupational health and safety (OHS) are one of the priorities of various organizations today because it covers issues in the human aspect, economic costs and benefits, legal aspects, accountability, and the image of the organization itself. These things have the same level of importance [1]. Occupational safety and health are the most critical factors in achieving project objectives. Maximum results in cost performance, quality, and time are meaningless if the level of work safety is ignored. Work safety indicators can be in the form of a high rate of work accidents, such as the number of workers who died, permanent disability, and damaged project installations. This causes tremendous material loss [2]. Occupational health and safety are conditions and factors that impact or may impact the health and safety of employees or other workers, including contract workers and contractor personnel, or other people in the workplace (Occuptional Health and Safety Management System 2007).

Every construction project has a work accident risk. Work accident risk depends on the type of work, technology, and risk control or mitigation efforts. In general, work accidents are caused by two factors, namely human actions that do not meet work safety standards (unsafe act) and hazardous environmental conditions [4]. The project's complexity tends to increase the risk of work accidents. This can be seen from the number of stakeholders involved, including new methods and technologies. This development is especially evident in large-scale projects in Indonesia, such as high-rise buildings, bridges, telecommunications, power plants, mining, mineral processing, toll roads, and others. Therefore, it is necessary to manage occupational safety and health risks, one of which is the management of OHS risks to prevent accidents in a comprehensive, planned, and structured manner in a good system. OHS risk management is related to the health and safety in the workplace that are crucial to the company [5].

The government must protect labor through existing regulations, such as the Law of the Republic of Indonesia No.1 of 1970 on occupational safety (Undang-Undang Keselamatan Kerja, 1970), Law No. 3 of 1992 on social security of labor (Undang-Undang Jaminan Sosial Tenaga Kerja, 1992), and Regulation of the Minister of Manpower No. Per.05/Men/1996 on OHS management system [8]. Based on the decision of the Directorate General of Labor Inspection No. Kep 20/DJPPK/2004 concerning certification of occupational safety and health competitions in the construction sector, every project with more than 100 workers with project implementation of more than six months must have a Young K3 Construction Expert personnel [9]. In addition, the Contractor must also have a BNSP General K3 certificate, International Organization for Standardization/ISO 9001 certification in 2008 [10], and *Occupational Health and Safety Assessment Series/*OHSAS 18001 of 2007 [3].

One of the ongoing development projects in Surabaya is the construction of the campus II building, UIN Sunan Ampel, Surabaya. This project does not escape the risk of work accidents, so special attention is needed to minimize the risk of accidents in the development project's implementation. This development project is carried out by PT. Adhi Karya (Persero), Tbk, Department of Building construction. The UINSA's campus II development is a construction project included in the "high rise building" category, with several tall buildings and various supporting infrastructures. The buildings that were built were the AEFG Building (10 floors), the Faculty of Psychology

(10 floors), the Faculty of Social and Political Sciences (5 floors), the Faculty of Science and Technology (5 floors), the Religion Laboratory Building (2 floors), the powerhouse 1 (1 floor), powerhouse 2 (1 floor), and STP1 (1 floor) and STP 2 (1 floor) buildings. In addition, there are several other supporting buildings, namely landscape and connecting roads between buildings. The construction of the entire building has a relatively high risk of work accidents, thus it requires special attention and a thorough analysis of the risks that may occur. The increased risk of work accidents makes the mitigation of these risks significant for the safety of construction workers and project success.

This study aims to analyze the potential and risk of work accidents in the construction project of UINSA's campus II development based on the 20004 AS/NZS4360 matrix [11]. The research results will be beneficial in formulating a strategy for controlling occupational health and safety (OHS) risk. In the end, it can increase the success of the implementation of construction projects.

II. Method

This study uses a quantitative method with a survey approach. Primary data was obtained directly by interviewing respondents in the building and infrastructure construction project of UINSA's Campus II development in Surabaya. The activities studied in this study are molding process, metal reinforcement, casting, wall and ceramic installation, door, and window installation, and painting works. Research respondents include 35 competent contractor personnel, particularly those related to OHS in the construction project (Table 1). Data were collected using a questionnaire that has been through the instrument validity and reliability test [12]. In addition to analyzing the potential and risk of work accidents, statistical analysis is also carried out using the Multiple Regression method to determine the relationship between the risk of work accidents in each construction division and the performance of contractors.

TABEL 1. Research respondents

Construction personnel	Number of people
Project Production Manager	1
Project Engineering Manager	1
Quality Control	1
Supervisor	7
HSE staff	3
Engineering staff	9
MEP Engineering staff	1
Surveyor staff	8
Mechanical staff	4
Total	35 Respondents

Risk assessment is formulated as a function of probability and consequences [11]. In short, the formula can be written as follows:

Risk = Probability x Consequences (1)

Furthermore, the grouping of risk levels is carried out by referring to the AS/NZS 4360 matrix in 2004, which includes four categories; Very High (VH), High (H), Moderate (M), and Low (L). The level or level of risk is an essential tool for management in making decisions through risk ratings. The project management can determine priorities and prevention strategies if these risks occur.

TABLE 2. The matrix of risk analysis

Score	Risk Category	Interpretation
1-3	L	Low
4-9	M	Moderate
10-16	H	High
17-25	VH	Very High

Source: AS/NZS 4360 (2004)

III. Result and Discussion

The company that handles building and infrastructure projects for UINSA's Campus II development is PT. Adhi Karya (Persero), Tbk, which is one of the leading construction companies in Southeast Asia. The UINSA Surabaya Campus II Development Project aims to improve the quality of university education to produce competent graduates. The construction of the second campus building will support facilities and infrastructure for students and lecturers.

As a major construction project, the construction of the campus II building is accompanied by the risk of work accidents in various construction works. In the construction structure work, there are molding process, metal reinforcement, casting, wall and ceramic installation, door, and window installation, and painting works. The molding process is a temporary mold used to hold concrete as long as the concrete is poured and shaped to the desired shape. This process begins with assembling the molding mall, then transported by tower crane to be installed at a height. The molding process uses dangerous tools, such as saws, to cut wood, hammers, and tower cranes. Furthermore, the metal reinforcement process begins with the fabrication of reinforcing steel which also uses equipment that can be dangerous for workers, such as bar banders and bar cutters. Then, the assembly of iron rings is done manually by workers. The iron ring is transported by tower crane to be installed at a height. The following process is pouring the concrete mix into the molding that has been installed with steel reinforcement using a vibrator machine. The following process is the wall and ceramics installation, doors and windows installation, and painting work. The whole series of work is accompanied by a high risk of work accidents.

The importance of risk management on OHS aspects in construction work has been described by several previous researchers, such as Hidayat (2018) in the construction project of the integrated lecture building at the State Islamic University of North Sumatra, Gita (2015) in the Linden Tower construction project, Marvell City, Surabaya, Junaedi et al. (2013) on the Jakarta–Cikampek toll road construction project, and Soputan (2014) on the construction project of the Eben Haezar High School building. In conducting a risk assessment, the parameter used is the probability multiplied by the consequences so that the risk value of each measured parameter is obtained. This article does not present the risk assessment results but focuses directly on the classification of occupational accident risk based on the AS/NZS 4360 risk matrix. The results of the analysis are presented in Table 3.

Fig. 1. 3D imagery of UINSA's campus II development plan

Fig. 2. The molding process, steel reinforcement, and casting process in the construction site (UINSA Surabaya)

The types of work are sorted from the highest accident risk score (13.69) to the lowest (5.14). Overall, it can be seen that most types of work have a work accident risk in the "medium" category. However, 19 types of construction work are included in the "high" risk, namely the kind of work in iron, formwork, casting, wall, and ceramic work, door and window work, as well as on painting. In addition, this study proves that no type of work is included in the "low" risk category in the UINSA's campus II development project. Information related to the level of risk of each type of work is critical data for project management to determine the priority scale in handling or controlling potential work accidents before they occur.

Furthermore, data analysis using the multiple linear regression method was carried out to determine the effect of work risks in each construction process; molding (X_1), metal reinforcement (X_2), casting (X_3), wall and ceramic installation (X_4), doors and windows installation (X_5), and painting works (X_6) on the contractor's performance (Y) in the completion of construction projects. Before the regression analysis, the data had passed the classical assumption requirements.

Based on the results of regression analysis, both in the partial test (t-test) and simultaneous test (F test), it can be seen that the risk of work accidents in all types of construction work has a significant impact (sig. < 0.05) on contractor performance in completing construction projects. The influence of the risk factors for work accidents from all types of work is powerful, reaching 98.9% (adjusted R square 0.988). Thus, it can be emphasized that the potential and risk of work accidents is significant to be considered by project management, including having to prepare preventive measures and preparations for handling work accidents before they occur.

Based on the findings of the two analyses carried out, it is then necessary to formulate alternative risk controls for potential work accidents. The risk control strategy can be carried out with the following approaches:

a. Reducing the chance (probability) of the potential risk of work accidents by compiling an HSE Plan that includes HIRARC (Hazard Identification Risk Assessment and Risk Control). The final product is JSA (Job Safety Analysis) for each job in the field. Furthermore, it is necessary to prevent any potential risks as early as possible, namely through the implementation of safety induction for new workers to inform project conditions, applicable HSE regulations, use of PPE, to self-rescue. The second effort is to conduct safety patrols disciplined in all work areas. Finally, it is necessary to install K3 warning signs to remind construction workers always to be vigilant and comply with work protocols.

Volume 6, Issue 3, pp. 10-14, 2022
International Journal of Scientific Engineering and Science
ISSN (Online): 2456-7361

TABLE 3. The ranking of OHS aspects based on AS/NZS4360 matrix

No	Construction Work	Risk	Score	Category
1	Doors and windows installation	Workers electrocuted	13,69	High
2	Ceramics installation	Workers electrocuted	13,49	High
3	Molding, spacing, and floor plate installation	Workers fall from a height	13,23	High
4	Casting	Workers fall from a height	13,00	High
5	Wall installation and refinement	Workers fall from a height	12,97	High
6	Casting	Workers fall from a height	12,94	High
7	Molding, spacing, and floor plate installation	Workers fall from a height during the molding removal process	12,63	High
8	Casting	Concrete mold collapse	12,57	High
9	Steel reinforcement	Workers fall from a height	12,49	High
10	Casting	Sling cable cut	12,43	High
11	Casting	Workers hit by falling concrete bucket	12,31	High
12	Casting	Trim pipe disconnected	12,26	High
13	Steel transportation	Workers hit by falling steel	11,71	High
14	Molding, spacing, and floor plate installation	Workers hit by falling concrete mold	11,57	High
15	Molding, spacing, and floor plate removal	Workers hit by falling concrete mold	11,43	High
16	Painting work	Workers' eyes were exposed to paint splashes	11,23	High
17	Metal cutting	Workers' fingers/hand hit/cut by bar cutter/bender	10,46	High
18	Metal reinforcement	Worker's hand stuck in iron reinforcement	10,06	High
19	Casting	Worker slips while transporting concrete bucket	9,91	Medium
20	Ceramics installation	Workers injured by ceramic cutting machine	9,83	Medium
21	Wall installation and refinement	Workers' eyes are exposed to the material	9,80	Medium
22	Molding, spacing, and floor plate removal	Worker's feet hit by falling tools	9,57	Medium
23	Metal cutting	Worker's hand pierced by iron	9,51	Medium
24	Metal cutting	Worker's hand pierced by iron	9,51	Medium
25	Casting	Worker's eyes are exposed to the concrete mix during the casting process	9,23	Medium
26	Molding, spacing, and floor plate removal	Worker's hand get stuck during steel reinforcement	9,14	Medium
27	Painting work	Inhaled paint vapor	9,11	Medium
28	Steel transportation	Worker's hand stuck between steels	8,91	Medium
29	Metal reinforcement	Worker's hand pierced by iron	8,74	Medium
30	Wall installation and refinement	Respiratory problems due to sand/cement dust when cutting bricks	8,69	Medium
31	Metal reinforcement	Worker's foot hit by iron tip	8,66	Medium
32	Metal reinforcement	Worker's hand is scratched by iron	8,60	Medium
33	Molding, spacing, and floor plate installation	Worker's feet pinched during molding placement	8,49	Medium
34	Doors and windows installation	Worker's hand caught in door/window	8,40	Medium
35	Metal cutting	Worker’s hand scratched by iron during fabrication	8,37	Medium
36	Metal cutting	Worker's eyes caught by sparks	8,14	Medium
37	Ceramics installation	Respiratory problems due to dust from ceramic cutting	8,11	Medium
38	Ceramics installation	Workers injured from ceramic flakes	8,09	Medium
39	Steel/metals transportation	Worker's hand scratched by iron	7,83	Medium
40	Doors and windows installation	Worker's hand hit the drill bit	7,80	Medium
41	Metal reinforcement	Worker was hit by a barbed wire	7,71	Medium
42	Molding, spacing, and floor plate installation	Worker's hand injured by nails/wood	7,51	Medium
43	Molding, spacing, and floor plate installation	Worker's hand hit by a hammer	7,09	Medium
44	Steel transportation	Worker's hand pierced with iron	7,06	Medium
45	Molding, spacing, and floor plate removal	Worker's hand is pierced by nails/wood	6,94	Medium
46	Molding, spacing, and floor plate removal	Worker's hand hit by a hammer	6,89	Medium
47	Metal cutting	Worker's hand injured from the grinding process	6,71	Medium
48	Ceramics installation	Noise interference when using the grinding machine during ceramics cutting	6,11	Medium
49	Metal cutting	Noise interference when using steel/iron bar cutter	6,00	Medium
50	Doors and windows installation	Worker's hand hit by a hammer	5,71	Medium
51	Casting	Scratches due to concrete vibrator	5,14	Medium

TABLE 4. Regression’s t-test results

	t-statistics	Sig. (α 0.05)
(Constant)	117.191	.000
Molding (X_1)	-5.560	.000
Metal Reinforcement (X_2)	-2.554	.016
Casting (X_3)	-3.603	.001
Wall and ceramics installation (X_4)	-2.828	.009
Doors and windows installation (X_5)	-2.136	.042
Painting work (X_6)	-2.225	.034

TABLE 5. Regression’s F test results

	Sum of Squares	df	Mean Square	F	Sig. (α 0.05)
Regression	341.053	6	56.842	467.742	.000b
Residual	3.403	28	.122		
Total	344.456	34			

International Journal of Scientific Engineering and Science
Volume 6, Issue 3, pp. 10-14, 2022
ISSN (Online): 2456-7361

TABLE 6. Coefficient of determination

R	R Square	Adjusted R Square	Std. Error of the Estimate
.995a	.990	.988	.34860

b. Minimizing the impact (consequences) of potential risks by making preparations for self-protection if at any time a work accident occurs. Ways to control the effects of work accidents are by always wearing personal protective equipment (PPE), innovating work tools and methods (for example, by installing a safety net), checking the condition of work equipment before use, cleaning the remains of pieces of material regularly, and providing safety training and use of tools for workers.
c. Avoiding the risk of work accidents can be avoided by regularly replacing work equipment that is no longer suitable.

IV. Conclusion

This study proves that each construction process; molding, metal reinforcement, casting, wall, and ceramic installation, doors and windows installation, and painting works in the UINSA's campus II building construction project have a work accident risk index in the "medium" to "high risk" category according to the risk matrix AS/NZS 4360 of 2004. In addition, all the potential risks of work accidents in all types of construction work are proven to have a significant impact ($p < 0.05$) on the performance of contractors in completing construction projects. For this reason, efforts to mitigate and prevent potential work accidents in the construction project environment are significant to be a substantial concern for project management. The risk control strategy can be carried out by reducing the probability of potential risks by preparing an HSE Plan, which includes HIRARC (Hazard Identification Risk Assessment and Risk Control), implementation of safety induction, safety patrol, and installation of OHS warning signs. In addition, the consequences of potential work accidents also need to be suppressed by using personal protective equipment (PPE), innovating work tools and methods (for example, installing a safety net), checking the condition of work equipment, cleaning up scraps of material, as well as providing training on workplace safety and the use of tools. Finally, avoiding the risk of work accidents can be done by replacing work equipment that is no longer suitable for use.

Acknowledgements

The research team greatly appreciates PT. Adhi Karya (Persero), Tbk as the contractor (service provider) for their cooperation and contribution as research respondents, as well as to UINSA Surabaya as the owner (service user) of the construction project for their collaboration in granting research permits and as an essential secondary data source in research data analysis.

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