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RISK HAZARD IDENTIFICATION USING THE HIRARC METHOD IN THE CONSTRUCTION OF THE KAI BOUTIQUE HOTEL CIHAMPELAS BUILDING - BANDUNG

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ABSTRACT
Construction projects involving heavy equipment, work at heights, and hazardous conditions are inherently high-risk, making safety management crucial. This study identifies hazards related to work accidents at the KAI Boutique Hotel Cihampelas project using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method. The research applies a mixed-method approach, combining site observations, interviews, and questionnaires with project stakeholders. Statistical analysis and risk mapping classify risks based on severity and probability. Findings reveal 29 identified risks across ten work categories, including six high-risk items, 20 medium-risk items, and three low-risk items. The study emphasizes the need for consistent safety measures such as protective equipment, safety training, and adherence to standard procedures. The research's novelty lies in its tailored HIRARC application in a specific construction context, offering actionable insights into mitigating occupational hazards and enhancing site safety.

Keywords: building construction implementation, building construction risk hazard analysis, hazard risk identification, hierarchy method, k3 management analysis

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INTRODUCTION

Construction work is one of the most dangerous jobs in the world as structures (Alfiyah et al., 2023a; Egan & Caulfield, 2024; Lu et al., 2023; Mohammad & Weng, 2024). The use of safety procedures such as inspection of non-permanent ladders and scaffolding and the use of adequate safety equipment can reduce the risk of accidents. The construction project development process is usually hazardous (Putri & Lestari, 2023; Sherratt et al., 2024). A high accident rate is a consequence of work construction. Many people, especially power workers, experience significant loss as a consequence of the amount case accidents and disease consequences of work (Atmaja et al., 2018; Demirkesen, 2024; Fatima et al., 2023; Johansen et al., 2024; Shanti et al., 2022; Urbanik, 2024).

Basic safety and health in the workplace are not implemented as expected (Murtaza et al., 2024; Sari et al., 2022; Son et al., 2024). The problem with this project is that they need to maximize the occupational health and safety management system at work. Then, there will be a life-threatening work risk that is described if you do not identify, assess, and control the risk (Andriani et al., 2022). Danger accident Work will identified by research. This is based on the magnitude of risks, impacts, and actions prevention (Maulana et al., 2023).

Based on data from the Minister of Manpower (Menaker), the number of work accident cases in Indonesia increased from 114,000 in 2019 to 177,000 in 2020, a one-year increase. To minimize the risk of work accidents, a hazard and risk analysis using the HIRARC method is necessary (Sofyan & Maulana, 2022). Health and Safety Work Occupational Health and Safety Assessment Series

(OHSAS) 18001:2007, accidents Work is factors and situations that can threaten the health and safety of employees or workers, including contractors, visitors, guests, or other persons present on the premises. Work (ardiyansyah, M, 2023).

The Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method is used To identify dangerous accident work on-site. It can reduce and minimize the risk of accidents (Cahyo & Sutarto, 2022). This method also allows assessment and control of risk to ensure that all the work that occurs on the project is under control so that system management safety and health work can be applied with Good. HIRARC is a tool or method used to consider the dangers that exist in the workplace and implement proper control to prevent accidents. The purpose of occupational safety and health risk management is to identify hazard risks and determine their control.

The construction industry is recognized as one of the most hazardous sectors globally, with significant risks associated with various activities involved in building projects. Previous studies, such as Alfiyah et al. (2023) and Putri et al. (2023), highlight the high accident rates attributed to inadequate safety protocols and insufficient training among workers. This context underscores the need for robust safety management systems, particularly in Indonesia, where the number of work-related accidents rose from 114,000 in 2019 to 177,000 in 2020 (Menaker).

Recent research emphasizes the effectiveness of implementing the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method, which systematically identifies and mitigates potential hazards (Fatima et al., 2023). Integrating these findings with existing literature provides a comprehensive understanding of the multifaceted nature of construction risks and the importance of proactive safety measures. This study aims to build on this foundation by identifying hazards associated with the construction of the Kai Boutique Hotel in Cihampelas, Bandung, and proposing effective risk management strategies. By addressing gaps in previous research and synthesizing current theoretical frameworks, this research contributes to the ongoing discourse on occupational safety in construction.

METHODS

Research Object

This research focuses on the object of the construction of a multi-story building to be studied, namely the Kai Boutique Hotel Cihampelas, Bandung, West Java.

Figure 1. Research Location

Data Collection

Data collection here measures the data to be collected, such as primary data and secondary data.

1. Primary data is data obtained directly from the source and collected by data collectors or researchers through observations, interviews, and questionnaire distribution.
2. Secondary data is data obtained from workforce data.

The following are question variables for data collection from questionnaire sources that will be used as follows:

Table 1. Variables Question

Variables	Information
X1	**Site cleaning**
X1.1	Workers are scratched or cut
X1.2	Worker fall down
X2	**Excavation and Tidying of the base of the excavation**
X2.1	Worker slip or fall down
X2.2	Workers hit by landslide from excavation
X3	**Installation frame column**
X3.1	Worker squeezed iron
X3.2	Worker stabbed wire
X3.3	Worker stabbed flakes wood
X4	**Install and disassemble Scaffolding /PCH**
X4.1	Scaffolding /PCH collapsed
X4.2	Worker fall down
X4.3	Workers do not wear Body Harnest
X5	**Welding**
X5.1	Worker's skin exposed to welding sparks
X5.2	Worker hit by grinding tool
X5.3	Workers inhale welding dust particles
X5.4	Eyes exposed to welding light and smoke
X5.5	electrocuted (electrode welding)
X5.6	Fire consequence spark fire
X5.7	Noise tool grinder
X6	**Work dismantle and install formwork**
X6.1	Workers impaled by nails or wire
X6.2	Worker scratched by formwork material (iron)
X7	**Workmanship making Formwork**
X7.1	Worker stabbed wire bendrat
X7.2	Worker hit by plywood /wood cutting tool
X8	**Work Casting**
X8.1	Worker's eyes hit by concrete splashes
X8.2	Skin irritation due to cement splashes
X8.3	Worker exposed vibration Vibrators
X9	**Installation Walls (Precast / Brick)**
X9.1	Worker's finger caught in precast wall
X9.2	Workers hit by collapsed bricks
X9.3	Worker fall from height

X10	Work Plastering and Cementing
X10.1	Worker fall down from height
X10.2	Eyes affected cement splash

Determination of the number of respondent samples taken from the entire workforce population with a tolerance level of error of 5% from a data accuracy level of 95% using the formula:

$n = N/(1+N.e^2)$

Where :

n = Sample size

N = Population size

E = Margin of error

So, from the sample calculation, using the Slovin formula based on possibility, it can be considered normal because, in one field of work, it is clear that they have the same level of experience and can be said to be expected.

The method section utilized a structured questionnaire designed to assess various risk factors in construction work. Each variable was operationalized through specific questions targeting key activities, such as site cleaning and scaffolding installation. The questions were formulated based on industry standards and prior research, ensuring clarity and relevance. Respondents rated their experiences and observations, allowing for a quantitative analysis of risk levels associated with each identified hazard. This approach facilitated a comprehensive understanding of the potential dangers in the construction environment.

RESULTS AND DISCUSSION

This study resulted in 51 respondents having characteristics consisting of each experience, including Site Manager (SM), Quality Control (QC), HSE, Surveyor, Drafter, and Worker, regarding the work in the construction of the Boutique KAI Hotel Cihampelas building.

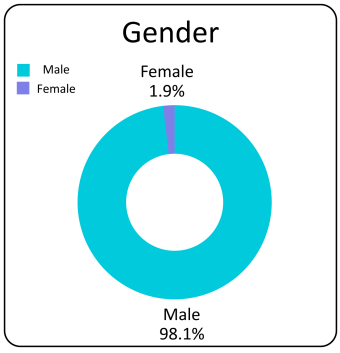

Figure 2. Gender Diagram

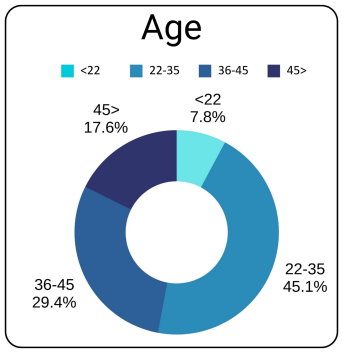

Figure 3. Age Diagram

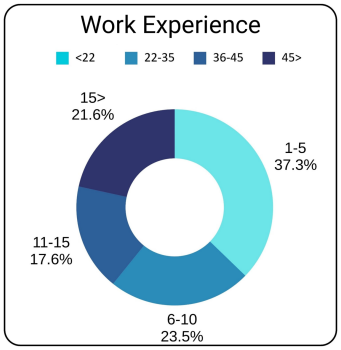

Figure 5. Work Experience Diagram

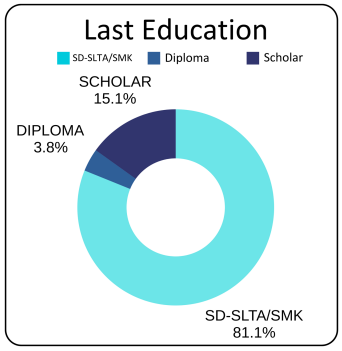

Figure 4. Last Education Diagram

Validity Test

The validity test determines the validity of the measuring instrument. The measuring instrument referred to here is the questions in the questionnaire. A questionnaire is considered valid if the questions can reveal something that is measured by the questionnaire (Janna & Herianto, 2021). The r moment value in this impact and possibility validity test is 0, 281, which is obtained from the df (n-2) formula. The r value is calculated from all question items in each variable that are declared valid. The r moment product value in this impact and possibility validity test is 0, 281, which is obtained from the df (n-2) formula.

Table 2. Validity Test Possibility

		N	%
Cases	Valid	51	100.0
	Excluded [a]	0	0.0
	Total	51	100.0

Table 3. Validity Test Impact

		N	%
Cases	Valid	51	100.0
	Excluded [a]	0	0.0
	Total	51	100.0

Reliability Test

Reliability is a measure used to determine whether a questionnaire is reliable or not. A questionnaire is considered trustworthy if the respondents have consistent or stable responses (Arsi, 2021). From the results of the reliability test calculation, the possibility of Cronbach's Alpha method above produces r11, which is 0,903. The results of the calculation of the impact reliability test of Cronbach's Alpha method (recalculate). This can be seen in the table, namely 0,849 with N of Items showing that the number of items or the number of questions entered into the variable view is 29.

Table 4. Assessment Level Cronbach's Alpha

Cronbach's Alpha (r) value	Reliability Level

0.00-0.20	Very Low
0.21 - 0.40	Low
0.41 - 0.60	Currently
0.61 - 0.80	Tall
0.81 - 1.00	Very high

Table 5. Reliability Test Calculation Results Probability and Severity

K	$\Sigma\sigma^2$	σ^2	r11
29	10,3545	80,7929	0.903
29	73,6667	13,2564	0.849

The results of the calculation of the reliability test of the possibility and impact using Cronbach's Alpha method obtained the results of r11, namely 0.903, for the reliability of the possibility, and the reliability of the effect obtained the results of r11, namely 0.849.

Table 6. Cronbach's Alpha Value Possibility

Cronbach's Alpha (r) value	Reliability Level
0.903	Very high

Table 7. Cronbach's Alpha Value Impact

Cronbach's Alpha (r) value	Reliability Level
0.849	Very high

The statement results-level evaluation shows that Mark Cronbach's Alpha possibilities and impacts are level; its reliability is very high and stated to be strong. Can it be said that reliability is perfect?

Hazard Identification, Risk Assessment, and Risk Control

Data processing, using the methods of Hazard Identification, Risk Assessment, and Risk Control (HIRARC), aims to identify risks or possible dangers that appear during the work process (Muhammad Rizki Fauzi et al., 2022). The main objective of this method is to reduce the risk of work accidents.

Risk Identification

After identifying potential risks, it is essential to record and rank them according to their severity and likelihood of occurrence. These are effective risk-reduction measures to address or even avoid adverse outcomes. The results of the risk hazard identification process carried out on each Kai Cihampelas boutique building construction project are as follows:

Table 8. Identification Results Danger

Variables	Work	Risk
X2.1		Worker slip / fall

X2.2	Excavation of soil and smoothing of the base of the excavation	Workers hit by landslide from excavation
X4.1	Install and dismantle scaffolding/PCH	Scaffolding/PCH collapsed
X4.2		Worker fall down
X4.3		Workers do not wear body harnesses

Risk Assessment

Once hazards have been identified in the workplace, a risk assessment is performed. A risk assessment is a procedure used to identify potential hazards that may occur. The purpose of this assessment is to ensure that risk control is at an acceptable level for the process, operation, or activity being performed. (Muhammad Nur et al., 2023). Risk assessment is carried out by considering the characteristics of the impact (severity) and possibility (likelihood). The following table is a sample assessment.

Table 9. Sample Assessment Risk

Respondents	Likelihood				
	X2.1	X2.2	X4.1	X4.2	X4.3
RS 1	2	2	1	1	1
RS 2	3	2	1	2	1
RS 3	3	2	2	2	3
Average	8	6	4	5	4
	3	2	1	2	1

Table 10. Category Risk

Description	Action
High	Medical Treatment Cse (MTC) case accident work that requires maintenance the wound from power professional medical (worker) hit by material) so that need Handling in a way experts by medical professionals
Medium	Accident (part body stabbed object sharp) which is necessary action For reduce risk accident Work
Low	Nearmibss (almost) accident) near miss almost happen Still Can avoided and not cause accident serious work

The results of the risk index mapping of all variables are then categorized for each risk in the construction work of the KAI Cihampelas Bandung Boutique Hotel building, which can be seen in the table above.

Table 11. Risk Rating Scale Matrix

Possibility (Likelihood)	Severity or Impact (Severity)		
	1	2	3
1	1	2	3

2	2	4	6
3	3	6	9

Risk Control

Risk control is to avoid dangers in the work environment. This is done to ensure that employees entering the work area will not be exposed to danger while doing their jobs (Fandy & Widiawan, 2022). By setting a priority scale in advance, potential hazards can be reduced. This priority scale then helps in the selection of risk controls, known as the risk control hierarchy (Wijaya et al., 2015). Hierarchy control risk is an ordered action to prevent and control possible risks that appear. It consists of several different levels, such as elimination, substitution, engineering/control technique, control administration, and tools protector self (APD) (Caron & Markusen, 2016)

Table 12. Risk Control

Risk Level	Potential Dangers	Risk Control
Low	**Site Cleaning**	
	Worker falls	Make sure workers wear appropriate PPE, such as non-slip shoes, harnesses, or hard hats .
	Column Frame Installation	
	The worker was impaled by a splinter of wood	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Casting Work	
	Workers exposed to vibrator vibrations	Use special gloves and shoes designed to dampen vibrations and reduce their impact on the hands and arms. Gloves hand This can help reduce HAVS risk .
Medium	**Site Cleaning**	
	Worker scratched/cut by sharp material	Holding TBM, before working wear complete personal protective equipment according to SNI
	Excavation and Tidying of the Base of the Excavation	
	Worker slip / fall	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .

	Workers hit by landslide from excavation	Install the retainer or bracing for support wall excavation , such as sheet piling, shoring, or use cofferdam system for prevent landslide .
	Column Frame Installation	
	Worker squeezed iron	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Worker stabbed wire	Ensure workers use appropriate PPE, such as gloves, harnesses, or protective helmets, arm protectors.
	Pa sang and Dismantle Scaffolding or PCH	
	Worker No use Body Harness	Give training must for all workers working at heights about method using a body harness with right , including How install it , secure it , and check it before used .
	Welding	
	Worker's skin exposed to welding sparks	Make sure workers wear protective clothing made of fire-resistant and heat-resistant materials, such as wool or thick cotton clothing coated with fire-resistant materials. This clothing should cover the entire body, including the arms and legs.
	Workers inhale welding dust flakes	Make sure workers wear appropriate masks or respirators, such as N95 respirators or higher, which are designed to filter out hazardous welding dust particles.
	Eyes exposed to welding light and smoke	Use welding goggles with appropriate filters to protect your eyes from ultraviolet (UV) and infrared (IR) rays produced during the welding process.
	Workers get electrocuted (Electrode Welding)	Use insulating gloves specially designed to protect against electric shock, and make sure the gloves are in good condition without damage.
	Noise tool grinder	Use ear protection or earplugs designed to reduce noise, such as earmuffs or earplugs with a noise reduction rating appropriate to the noise level of the grinder.
	Work Dismantle and Install Formwork	
	Worker stabbed nail / wire	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves, or protective helmets.
	Worker scratched formwork material	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves, or protective helmets.

	Work Making Formwork	
	Worker stabbed wire bendrat	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Worker hit by plywood /wood cutting tool	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Casting	
	Worker's eyes hit by concrete splashes	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets and glasses.
	Skin irritation due to cement splashes	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Installation Walls (Precast / Brick)	
	Worker's finger caught in precast wall	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Workers hit by collapsed concrete/bricks	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets .
	Work Plastering or Plastering	
	Eyes affected cement splash	Make sure workers wear appropriate PPE, such as non-slip shoes, gloves , or protective helmets and glasses.
High	**Install and Dismantle Scaffolding or PCH**	
	Scaffolding or PCH collapsed	Ensure workers wear appropriate PPE, such as non-slip shoes, harnesses, or hard hats . Wear a body harness that meets safety standards. The harness must be properly fitted and fit the worker. Use a stable and standard work platform or scaffolding. Make sure the platform or scaffolding is in good condition and properly installed.
	Worker fall down	Ensure workers wear appropriate PPE, such as non-slip shoes, harnesses, or hard hats . Wear a body harness that meets safety standards. The harness must be properly fitted and fit the worker. Use a stable and standard work platform or scaffolding. Make sure the platform or scaffolding is in good condition and properly installed.
	Welding	
	Worker hit by grinding tool	Make sure workers wear appropriate PPE, such as shoes. safety , gloves , or protective helmets . Provide training to workers on the correct and safe way to use the grinder,

	Fire consequence spark fire	Make sure the work area is free from flammable materials such as paper, cloth, chemicals, and other materials that can easily catch fire. And use PPE according to SNI standards.
	Installation Walls (Precast / Brick)	
	Worker fall down from height	Ensure workers wear appropriate PPE, such as non-slip shoes, harnesses, or hard hats . Wear a body harness that meets safety standards. The harness must be properly fitted and fit the worker. Use a stable and standard work platform or scaffolding. Make sure the platform or scaffolding is in good condition and properly installed .
	Work Plastering or Plastering	
	Worker fall down from height	Ensure workers wear appropriate PPE, such as non-slip shoes, harnesses, or hard hats . Wear a body harness that meets safety standards. The harness must be properly fitted and fit the worker. Use a stable and standard work platform or scaffolding. Make sure the platform or scaffolding is in good condition and properly installed.

The highest risk factor variables are three. Therefore, risk control is significant; here are the variables and their risk control. Scaffolding or PCH collapse control, namely, Scaffolding, must be installed and dismantled by trained and certified workers in accordance with applicable safety procedures and standards. Workers are hit by a grinding cutting tool; its control is to ensure workers use appropriate PPE, such as safety shoes, gloves, or protective helmets. Provide training to workers on the correct and safe way to use a grinder and prevent workers from falling from the height of its control. Ensure workers use appropriate PPE, such as non-slip shoes, harnesses, or protective helmets. Wear a body harness that meets safety standards.

CONCLUSION

Based on the results and discussion, the implementation of construction work at the KAI Boutique Hotel Cihampelas project revealed 29 risk factors from 10 types of work, classified into six high-risk, 20 medium-risk, and three low-risk categories. These findings highlight the critical need for effective safety management through comprehensive training, regular equipment inspections, and the consistent use of personal protective equipment.

Additionally, ensuring workplace safety requires systematic procedures, including daily safety briefings and maintaining a well-prepared emergency response system. Continuous monitoring of the work environment and weather conditions further mitigates potential hazards. The research underscores that proactive implementation of occupational safety and health management systems is essential to reducing work-related accidents and ensuring a safer construction environment.

Overall, this study emphasizes that risk management must be a dynamic process involving risk identification, assessment, and control measures tailored to specific construction activities. Regular evaluations and updates to safety protocols are vital in maintaining an effective safety culture on construction sites.

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