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OCCUPATIONAL HEALTH AND SAFETY (K3) RISK ANALYSIS USING HIRADC AND JSA METHODS IN BRIDGE REPLACEMENT PROJECTS

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ABSTRACT

Bridge construction work is work that carries great risks. The research aims to determine the type and level of risk as well as risk control and the application of control methods to the Trisula Bridge Replacement Project. Based on the research results, various types of risks were identified and evaluated using the HIRADC approach and the JSA method. These risks are then assessed based on their level of likelihood and impact, and the risk level is determined. From the results of the risk identification carried out on the 10 main jobs for the Bridge Replacement Project, several jobs have moderate risk and high risk. Implementing risk control in the field is considered good for each job. However, to further improve efforts to prevent work accidents, it is necessary to pay attention to several things, namely checking the strength of the railing. In addition, it is important to continuously monitor and evaluate the implementation of risk controls in the field and ensure good awareness and understanding of risk control measures among workers. These efforts will help reduce risks that may arise during project implementation.

Keywords: *Risk; Occupational Safety and Health (K3); HIRADC; JSA; Bridge.*

1. Introduction

K3 risk in construction measures possible losses that may arise to safety, property, human life, and the environment due to certain sources of danger in construction work [1][2]. These risks can vary depending on the type of construction work, environmental conditions, and other factors [3][4].

Work accidents occur suddenly and undesirably which can disrupt planned work processes [5]. Work accidents often do not occur by chance but are caused by a combination of unsafe actions and conditions [6]. Unsafe acts occur when workers ignore existing safety procedures, take shortcuts, or do not comply with safety regulations. Meanwhile, unsafe conditions occur when working conditions do not meet safety standards, such as not having personal protective equipment or working at heights without adequate protection.

The importance of understanding the potential hazards associated with work is critical [7]. This includes the identification and analysis of work-related risks, as well as the development of appropriate risk control measures [8]. By understanding the existing risks and implementing effective risk control measures, you can help prevent work accidents.

The research title that the researcher took is "Occupational Safety and Health (K3) Risk Analysis Using HIRADC and JSA Methods in Bridge Replacement Projects" which seems very relevant and important considering the large risks associated with construction work, especially the implementation of bridge construction [9][10].

With this research, researchers will be able to systematically identify K3 risks, evaluate the level of risk, and develop appropriate control measures to reduce risks to acceptable levels. The results of this research will provide valuable insight for the Trident Bridge Replacement project and can be

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used as a guide in improving occupational safety and health on similar construction projects in the future.

2. Methodology

The Trisula Bridge in Blitar, East Java is a road that connects the city of Blitar with the city of Tulungagung or vice versa. The research was carried out when the Old Trisula bridge replacement project began, namely in 2023, to be precise, researchers were at the location from the beginning of February to the end of March.

The objectives that can be expected in this research are to find out risky activities according to the level of risk that can occur in the Trisula bridge replacement project activities, to find out the stages of work that have the highest risk, based on the HIRADC and JSA methods, to find out how to control the risks that arise on the Trisula bridge replacement project based on Standard Procedures, as well as knowing control efforts in the field.

Researchers used a semi-qualitative analysis method [11], namely implementation using the HIRADC and JSA methods, which was carried out through distributing questionnaires, unstructured interviews with relevant experts or project personnel, and systematic observations with surveys of research objects.

A. Primary data

Primary sources are data sources that directly provide data to data collectors, while data collection techniques can be done using interviews, questionnaires, observations, and a combination of the three [12].

- Questionnaire: Primary data is obtained through a questionnaire containing risk identification probability values and risk impacts from respondents. The number of respondents was 15 people including the K3 Team, Implementers, Quality Control, Surveyors, and Foremen. Data from the questionnaire is processed using a Severity Index which classifies risk levels from 1 to 5. The results will be plotted in a risk matrix to determine the jobs with the highest risk.
- Interview: The risk control stage is carried out by interviewing K3 experts to determine appropriate controls based on the level of risk for each job. Interviews were also conducted with field workers to support the assessment of major hazard risks and matters relevant to the research.
- Observation: After obtaining risk control for work that has a high risk, field observations are carried out to check actual conditions in the field. The observation results will be used as a basis for measuring and presenting the risk control score percentage.

B. Secondary data

The data used in the research are project implementation methods, K3 standard of procedure (SOP) and literature and regulations related to the K3 implementation system, including:

a) OHSAS 18001:2007 regarding SMK3 Requirements
b) PUPR Ministerial Regulation No.14/PRT/M/2020
c) Law no. 1 of 1970
d) Guidelines for Implementing Occupational Safety and Health (K3) for Road and Bridge Construction, Department of Public Works, Directorate General of Highways (2006)
e) Minister of Manpower and Transmigration Regulation No. 8 of 2010
f) Minister of Manpower Regulation No. 9 of 2016
g) PUPR Ministerial Decree No. 05/PRT/M/2014
h) PUPR Ministerial Decree No. 14/PRT/M/2020

2.1. HIRADC

The HIRADC (Hazard Identification, Risk Assessment, and Determining Controls) and JSA (Job Safety Analysis) methods are approaches that can assist in analyzing risks and identifying

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preventive measures to reduce the risk of accidents or hazards related to work[6]. HIRADC involves the following steps:

- Hazard Identification: Identify and list all potential hazards that may occur in the bridge replacement project. These hazards can include risks from heights, risks from working with heavy equipment, risks to human resources and risks to the surrounding environment.
- Risk Assessment: Assessing how likely a hazard is and how much impact or loss might be caused in the event of an accident. In this assessment, a risk scale or matrix is used to categorize risk into different levels of risk. The risk assessment in this study uses the HIRADC and JSA table formats based on PUPR Ministerial Regulation No: 14/PRT/M/2020. This table format is used to identify, evaluate, and control the risks associated with the bridge replacement project construction work.

Table 1. Probability

5	It's almost certain to happen
4	Very possible
3	Might happen
2	It's unlikely that this will happen
1	Almost never happens

Table 2. Impact

5	Fatalities arise; more than 1 main equipment totally damaged; there is damaged material and it is necessary to bring in new material (work stopped for more than 1 week).
4	Causes permanent disability; there is 1 main equipment that is totally damaged: there is 1 damaged material and it is necessary to bring in new material (work stopped for 1 week)
3	Requires inpatient medical treatment; there is more than 1 damaged equipment; there is damaged material and it is necessary to bring in new material (work stopped for less than 1 week).
2	Requires first aid/clinic treatment (within 1x24 hours); there is a broken equipment; there is damaged material and it is necessary to bring in new material which results in work not stopping.
1	Enough first aid treatment continues to work; there is damaged equipment (can be repaired in less than 1x24 hours).

Tabel 3. Risk Assessment

Probability	Impact				
	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Source: [Permen PUPR, 2020]

- The final stage is Determining Controls: Formulating preventive and control measures to reduce or eliminate the identified hazard risks. This can include implementing security and safety regulations, use of Personal Protective Equipment (PPE), employee training, and close supervision during project implementation.

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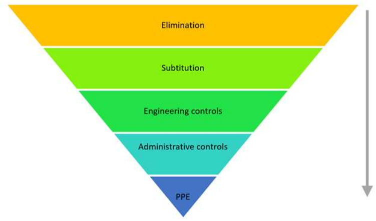

Figure. 1 Hazard control hierarchy
Source: [Ramli, 2010]

Hierarchy of Risk Control (Hierarchy of Controls ANSI ZIO)

Hierarchy of Controls		
Elimination	**Eliminating potential hazards**	Make the workplace safe for workers
Substitution	Substituting equipment/ machine that is no longer suitable for use	
Engineering	Modifying by designing machine/equipment or workplace to become safer	
Administrative	Procuring posters, workshops, OSH regulations, working hours, etc.	Secure workers from exposure
Personal Protective Equipment (PPE)	Providing equipment that can lessen the risk of the occurrence of accidents or occupational illnesses	

Source: [J. E. Mohamed, dkk, 2020]

2.2. Descriptive Analysis

Descriptive analysis is used in the analysis of the results of observations of the application of individual controls carried out on large-risk jobs, for calculating the percentage score value the following equation is used, and classified in the criteria as in table 4.

$$Score\ percentage = \frac{Cumulative\ frequency}{Lots\ of\ data\ (n)} \times 100\% \qquad [3]$$

Table 4. Score Interpretation Criteria

No.	Score presentation	Interpretation
1.	81%-100%	Very good
2.	61%-80%	Good
3.	41%-60%	Pretty good
4.	21%-40%	Not good
5.	0%-20%	very not good

Source: [Jannah et al., 2017]

2.3. Probability and impact analysis

After obtaining the probability value and impact of each risk through the respondents, these points will be calculated using the Severity Index to determine the probability value to be used. The Severity Index method is calculated using the following formula:

$$SI(p) = \frac{\sum_{i=1}^{5} \quad aixi}{5\sum_{i=1}^{5} \quad aixi}(100\%) \qquad [14]$$

Assessment of probability and impact is converted to the rating scale as follows:

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Table 5. Probability matrix categories

Category	SI(%)	Probability matrix level
It's almost certain to happen	81-100	5
Very possible	61-80	4
Might happen	41-60	3
It's unlikely that this will happen	21-40	2
Almost never happens	≤ 20	1

Source: [Jannah et al., 2017]

Table 6. Category Impact matrix

Category	SI (%)	Impact matrix level
Disaster	81-100	5
Heavy	61-80	4
Currently	41-60	3
Small	21-40	2
Not significant	≤ 20	1

Source: [Jannah et al., 2017]

After knowing the probability and impact values to be used, then using the probability and impact multiplication formula. The multiplication of these probabilities and impacts will be plotted in the matrix/risk assessment table to produce a risk level, from small to large level for each job. HIRADC calculation and preparation based on [15].

2.4. JSA

JSA (Job Safety Analysis) is a specific approach to analyzing the risk of a particular task or job. In the bridge replacement project, researchers perform JSA for each critical task, such as work at height, use of heavy equipment, installation of bridge structures. JSA involves identifying the work steps, the hazards associated with each step, and the control measures for each hazard[16].

By combining these two methods, researchers will provide an in-depth understanding of the potential hazards that exist in the bridge replacement project, and will help develop an effective OHS plan to protect the safety and health of workers and reduce the risk of accidents that may occur.

The following is a research flow diagram:

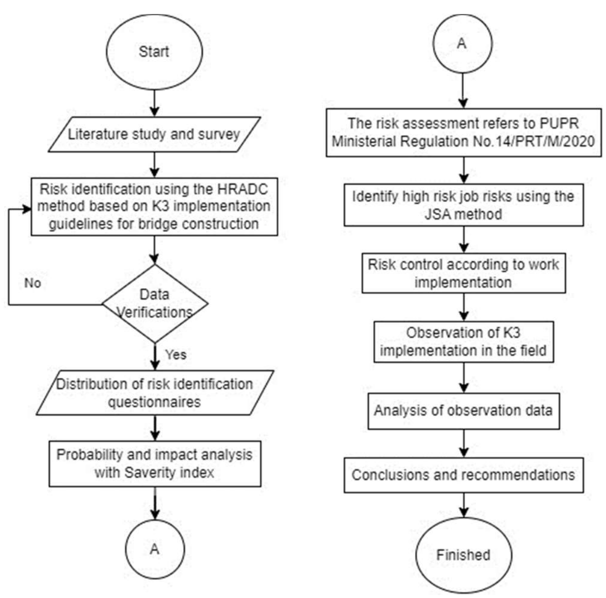

Figure 2. Research Flow Diagram

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3. Results and discussion

The object of this research is the work on the bridge replacement project. The HIRADC method is carried out from the beginning of work to the end of the project to be implemented[17]. From the results of work method data and interviews with executors, it is known that the work methods are as follows:

1. Land preparation
2. Fabrication
3. Borepile foundation
4. Excavation work
5. Borepile drilling
6. Pilecap work
7. Abutment work
8. Column work
9. Pyre head work
10. Still box girder (SBG) erections work

The results of risk identification for each job based on related documents and verification by the HSE Inspector are as follows:

Table 7. Risk Identification

No.	Risk Description	
	Job Description	**Hazard Identification**
1	**Land preparation**	
a.	Cleaning Clearing of land clearing and leveling of the land surface with an excavator	-The excavator overturned due to unstable ground conditions -The excavator is mired -Affected by the excavator maneuver
b.	Unloading piled up soil material using a dump truck	-The dump truck overturned due to unstable ground -There was a traffic accident
2	**Fabrication**	
a.	Heavy equipment mobilization	-Hit by heavy equipment -There was a traffic accident
b.	Disassembly of Iron material	-Crushed iron material -Pinched -Hit by heavy equipment swing when material disassembly
c.	Steel cutting and dismantling	-Injured by manual equipment -Scratches caused by scrap metal
3	**Borepile foundation**	
a.	Heavy equipment mobilization	-Hit by heavy equipment Respiratory disorders due to dust pollution
b.	Install casing (temporary/permanent)	-Crushed by Casing Bore Pile
c.	Drilling	-Affected by heavy equipment swing due to blind spot during drilling -Eye irritation from drilling materials -Hit by a truck transporting drilling materials -An accident occurred when a truck transporting drilling materials headed for the disposal site
d.	Install Reinforcing Steel	-Affected by heavy equipment swing due to blind spot when installing reinforcing steel

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No.	Risk Description	
	Job Description	**Hazard Identification**
e.	Casting	-Eye irritation due to glow and smoke from welding iron reinforcement joints -Get hit by a mixer truck while unloading -Minor irritation/injuries from splashes of concrete during casting -Dropped while casting
4	**Excavation work**	
a.	Cleaning Clearing of land and surface equipment with an excavator	-The excavator overturned because the ground was unstable -The excavator is mired -Affected by the excavator maneuver
b.	Soil excavation	-The dump truck overturned due to unstable ground -There was a miscommunication of traffic control -Affected by heavy equipment maneuvers -Fall into a dug hole
5	**Borepile Burglary**	
a.	Burglary	-Crushed by borepile concrete material -Hit by heavy equipment maneuvers -Exposure to burglary material -Tripped or fell
6	**Pilecap work**	
a.	Reinforcing	-Limbs clamped -Stumbled over scrap metal material -Injured by manual equipment
b.	Install/Remove Formwork	-Crushed formwork material -Limbs clamped -Injured by manual equipment
c.	Casting	-Got hit by a mixer truck while unloading -Crushed by a vibrator machine -Skin/eye irritation from splashed concrete -Hit the pressure hose
7	**Abutment work**	
a.	Reinforcing	-Limbs clamped -Stumbled over scrap metal material -Fall from a height -Hit by material/equipment from a height
b.	Install/Remove Formwork	-Injured by manual equipment -Fall from a height -Limbs clamped -Crushed formwork material
c.	Casting	-Hit by truck mixer/concrete pump while unloading -Crushed by a vibrator machine -Fall from a height

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No.	Risk Description	
	Job Description	**Hazard Identification**
		-Skin/eye irritation from splashed concrete
		-Hit the pressure hose
d.	Care Work	-Fall from a height
		-Injured by manual equipment
8	**Column work**	
a.	Reinforcing	-Limbs clamped
		-Stumbled over scrap metal material
		-Fall from a height
		-Hit by material/equipment from a height
b.	Install/Remove Formwork	-Injured by manual equipment
		-Fall from a height
		-Limbs clamped
		-Crushed formwork material
c.	Install / Dismantle Scaffolding	-Crushed by scaffolding material
		-Fall from a height
		-Injured by manual equipment
d.	Casting	-Hit by truck mixer/concrete pump while unloading
		-Crushed by a vibrator machine
		-Fall from a height
		-Skin/eye irritation from splashed concrete
		-Hit the pressure hose
e.	Care Work	-Fall from a height
		-Injured by manual equipment
9	**Pier head work**	
a.	Reinforcing	-Limbs clamped
		-Stumbled over scrap metal material
		-Fall from a height
		-Hit by material/equipment from a height
b.	Install/Remove Formwork	-Injured by manual equipment
		-Fall from a height
		-Limbs clamped
		-Crushed formwork material
c.	Install / Dismantle Scaffolding	-Crushed by scaffolding material
		-Fall from a height
		-Injured by manual equipment
d.	Casting	-Hit by truck mixer/concrete pump while unloading
		-Crushed by a vibrator machine
		-Fall from a height
		-Skin/eye irritation from splashed concrete
		-Hit the pressure hose
e.	Care Work	-Fall from a height
		-Injured by manual equipment
10	**Steel box girder erections work**	
a.	Land preparation	-Accident due to the mobilization of the excavator

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No.	Risk Description	
	Job Description	Hazard Identification
		-Air pollution due to vehicles transporting fill material
		-Get hit by a Vibro tool
		-Get hit by an excavator
		-Fall into the river while working
b.	Tool Mobilization	- Traffic accidents due to mobilization of tools
		-Hit the tool
		-Get hit by a tool
c.	Execution of Erections	-Fall from a height
		-Fall and sink
		-Crushed steel material
		-Squashed during installation of steel
		-Injured by the tightening of bolts and nuts in the process
		-Accidents due to lifting equipment / crane

From the results of the analysis of questionnaire calculations for each work item as many as 33 jobs, it is known that the most risks are in the form of moderate risk of 20 work items, followed by 13 large risks, and there is no small risk in each job.

Table 8. Risk Assessment in Each Job

Work item	Probability SI (p)		Impact SI (d)		Risk value
Land preparation					
Cleaning Clearing of land	64.44	4	71.11	4	16
Unloading piled up soil material using a dump truck	53.33	3	73.33	4	12
Fabrication					
Heavy equipment mobilization	56.67	3	72.00	4	12
Disassembly of Iron material	60.00	3	61.33	4	12
Steel cutting and dismantling	66.67	4	47.33	3	12
Borepile foundation					
Heavy equipment mobilization	66.67	4	60.67	3	12
Install casing (temporary/permanent)	60.00	3	60.00	3	9
Drilling	55.00	3	63.33	4	12

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Work item	Probability		Impact		Risk
	SI (p)		SI (d)		value
Install Reinforcing Steel	58.67	3	46.67	3	9
Casting	66.22	4	39.56	2	8
Excavation work					
Cleaning Clearing of land and surface equipment with an excavator	62.67	4	75.56	4	16
Soil excavation	56.67	3	63.33	4	12
Borepile burglary					
Burglary	60.33	3	61.33	4	12
Pilecap work					
Reinforcing	72.89	4	46.22	3	12
Install/Remove Formwork	61.78	4	46.22	3	12
Casting	60.00	3	40.33	2	6
Abutment's work					
Reinforcing	60.00	3	70.33	4	12
Install/Remove Formwork	60.67	3	54.00	3	9
Casting	58.40	3	54.40	3	9
Care Work	62.67	4	53.33	3	12
Column work					
Reinforcing	70.67	4	73.33	4	16
Install/Remove Formwork	74.00	4	69.00	4	16
Install / Dismantle Scaffolding	73.78	4	65.33	4	16
Casting	66.67	4	56.00	3	12
Care Work	70.67	4	65.33	4	16
Pierhead work					
Reinforcing	71.33	4	73.33	4	16

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Work item	Probability SI (p)		Impact SI (d)		Risk value
Install/Remove Formwork	75.33	4	70.33	4	16
Install / Dismantle Scaffolding	75.11	4	69.33	4	16
Casting	67.47	4	53.33	3	12
Care Work	73.33	4	63.33	4	16
SBG Erections Work					
Land preparation	71.73	4	70.13	4	16
Tool Mobilization	69.33	4	79.11	4	16
Execution of Erections	75.56	4	88.22	5	20

From the results of the questionnaire calculation analysis it is known that there are as many as 10 main jobs, with a small category risk assessment = 0 jobs; moderate = 8 jobs; big = 2 jobs.

Table 9. Assessment of Main Work

The main job	Impact		Probability		RATING RESULT	Risk level
Land preparation	72.00	4	60.00	3	12	Moderate
Fabrication	60.38	3	61.14	4	12	Moderate
Borepile foundation	53.89	3	60.78	3	9	Moderate
Excavation work	68.57	4	59.24	3	12	Moderate
Borepile burglary	61.33	4	60.33	3	12	Moderate
Pilecap work	43.87	3	64.40	4	12	Moderate
Abutments work	58.40	3	60.00	3	9	Moderate
Column work	58.40	3	70.81	4	12	Moderate
Pierhead work	65.33	4	72.00	4	16	Large
SBG Erections Work	79.81	4	72.86	4	16	Large

The following is an explanation of the controls applied to the Trident Bridge Replacement project based on the JSA:

Pierhead work	
Preparation	Hold a toolbox meeting before starting work
	Carrying out inspections of equipment to be used
	Ensure personal protective equipment is in good condition
	Ensure emergency facilities are available (First Aid, Fire Extinguisher, etc.)
	Make sure all workers are in a healthy condition and are not under the influence of drugs or alcohol
Toolbox Meeting	Explain work plans, duties and responsibilities, potential dangers that arise and work safety regulations

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Pierhead work	
Installation of reinforcing rods	Avoid pinch points when installing the reinforcing rods and use gloves properly
	Make sure the equipment is suitable for use and communicating with colleagues
	Use complete PPE (personal protective equipment) and Full Body Harness
	Make sure your body is in a safe and controlled position when installing the reinforcing rods
	Installation of safety rails/fences
Install Formwork	Avoid pinch points when installing the reinforcing rods and use gloves properly
	Make sure the equipment is suitable for use and communicating with colleagues
	Use complete PPE (personal protective equipment) and Full Body Harness
	Make sure your body is in a safe and controlled position when installing the formwork
Casting	There is a truck guide when unloading material
	Make sure to drive at low speed
	Make sure the worker operating the vibrator is trained
	Use correct and appropriate PPE and work in a safe area
	Make sure there is a flagman when casting
	Installation of safety rails/fences
Maintenance	Use complete PPE (personal protective equipment) and Full Body Harness
	Use respiratory protection/mask
	Make sure the equipment is suitable for use and communicating with colleagues
Areas Housekeeping	Use a mask and gloves
	Close the mixer gutter and wash the gutter in its proper place after casting
Steel Box Girder Erection Work	
Preparation	Carry out a toolbox meeting before starting work
	Carrying out inspections of equipment to be used
	Ensure personal protective equipment is in good condition
	Ensure emergency facilities (First Aid, Fire Extinguiser, etc.)
	Make sure all workers are in a healthy condition and are not under the influence of drugs or alcohol
Toolbox Meeting	Explain work plans, duties and responsibilities, potential dangers that arise and work safety regulations
Installation of signs	Ensure workers use personal protective equipment
	Ensure workers understand the work to be performed
Land preparation and leveling	Carry out a K3 equipment checklist on the tool
	Carry out Safety Induction to operators and Drivers
	Operators must be people who are experts in their field

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Pierhead work	
of the land surface	It is mandatory to wear appropriate PPE, at least a helmet, vest and safety shoes
Tool Mobilization	There are traffic controllers/vehicle guides
	Carry out a checklist on heavy equipment and select operators who are competent in their field
	Make sure to pass at a low speed
Soring Installation	Avoid pinch points when installing soring
	Make sure the operator is competent
	Make sure your body position is good and controlled when installing the soring
	Ensure workers use complete PPE
	Direct supervision by implementers and K3 officers during work activities
Implementation of Erection	Carry out a tool checklist before work
	Carry out worker health checks before carrying out work
	Ensure environmental conditions are supportive/safe for the implementation of Erections, such as wind/rain
	Ensure workers use complete PPE
	Installation of realing/safety fences
	Make sure the operator is competent
	Make sure there are guides when moving steel materials and installing steel
	Direct supervision by implementers and K3 officers during work activities

In the Bridge replacement project, provide work equipment to reduce the consequences of falling workers and implement a work permit system for work at height and provide instructions or do other things related to work conditions, as referred to in Article 2 of the Regulation of the Minister of Manpower of the Republic of Indonesia Number 9 of 2016 [18].

Work procedures on the project include: fall protection techniques and methods, methods for managing equipment, techniques and methods for carrying out work supervision, workplace security and emergency preparedness and response, as well as ensuring that work procedures are well known and understood by the workforce and/or people involved. involved in work before work begins. It has also been implemented installing work area restriction devices to prevent the entry of unauthorized persons.

The availability of a written emergency response plan is an important step in efforts to deal with emergencies in the workplace. Several components that can be included in an emergency response plan include a list of manpower, emergency response equipment, first aid facilities for accidents (P3K), evacuation facilities, important contacts. A written and clear emergency response plan is very important to ensure effective handling of emergencies in the workplace. In addition to compiling it, it is also necessary to carry out routine training and training for workers so that they are trained in dealing with emergencies and know the procedures to be followed.

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Table 10. Analysis of Observation Results on PPE Use

	PPE recommended for each job	total	yes	no	yes%	no%	Application (%)	Category
1	**PIERHEAD WORK**							
-	Safety helmet	18	18	0	100.00	0.00	80.40	Good
-	Safety shoes		18	0	100.00	0.00		
-	Safety gloves		8	10	44.44	55.56		
-	Breathing/respiratory masks		16	2	88.89	11.11		
-	Safety Vest		16	2	88.89	11.11		
-	Full Body Husness		9	9	50.00	50.00		
2	**ERECTIONS WORK**							
-	Safety helmet	30	30	0	100.00	0.00		
-	Safety shoes		30	0	100.00	0.00		
-	Safety gloves		27	3	90.00	10.00		
-	Breathing/respiratory masks		27	3	90.00	10.00		
-	Safety Vest		30	0	100.00	0.00		
-	Full Body Husness	15	10	5	66.67	33.33		
-	Safety Glasses		11	4	73.33	26.67		
-	Protector face / Face shield		5	4	33.33	26.67		

It is known from the analysis table of the results of individual control observations of the 2 main jobs, namely Pier Head and Erection Jobs, there are 18 workers at Pier Head jobs and 30 workers at Erections jobs and plus 15 at Erections height jobs.

Based on the results of the analysis of the results of individual control observations, as shown in table 10, in the 2 main jobs the percentage of application results is 80.40%, it is known that individual implementation in the Old Trisula Bridge replacement project is considered good.

In the use of personal protective equipment (PPE) [19] in the workplace which has a risk of work-related accidents and diseases, there are several obligations regulated in Law no. 1 of 1970 concerning Work Safety. Here are some things to consider when selecting and using PPE: When using personal protective equipment (PPE) in workplaces where there is a risk of accidents and occupational diseases, there are several obligations regulated in Law no. 1 of 1970 concerning Occupational Safety, things that need to be considered in selecting and using PPE are that PPE must provide effective protection, PPE must be comfortable to wear, PPE must be easy to put on and take off, PPE chosen must enable the wearer to maintain good sensory perception to receive warnings. and maintaining overall health, and ensuring the availability of PPE spare parts that are easily found on the market, and the use of PPE must be in accordance with the type of hazard that exists, selecting PPE that suits the characteristics of workers and the work environment will ensure that PPE can be used safely and does not interfere with comfort work, finally PPE must be stored and cared for when not in use. This will keep the PPE in good condition and ready for use when needed [20].

The company has provided sufficient and proper PPE, but workers' awareness of personal safety is still lacking, many workers neglect using PPE or instructions from K3 experts. Work on the grounds that you are used to it, and ignore directions from K3 experts. Therefore, it is necessary to work together with all workers in the old trisula bridge project to always prioritize occupational safety and health, by avoiding unsafe actions, namely using PPE that has been provided properly and correctly, and storing/caring for PPE properly after use. Collaboration between all workers will

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realize the success of SMK3 which will have a positive impact on workers, the company and product quality.

4. Conclusion

From the results of this study, it can be concluded that the bridge replacement project has a big risk, especially in work at height. Risk control has been carried out well through engineering and administrative approaches, but there needs to be more focus on risk elimination and substitution. The application of PPE individually has also been good, but needs to be continuously improved to ensure the safety of workers in carrying out this project.

Reference

[1] G. N. Putri and H. D. Ariesyadi, "Analysis of Occupational Safety and Health (K3) Risk Management in Construction Industry (Case Study: Construction of Natural Gas Transmission Pipelines)," *Devot. J. Res. Community Serv.*, vol. 4, no. 9, pp. 1895–1907, 2023, doi: 10.59188/devotion.v4i9.565.

[2] D. M. Dina and A. Purba, "Occupational Health and Safety Risk Analysis in Construction Projects: A Systematic Literature Review," *IJIEM - Indones. J. Ind. Eng. Manag.*, vol. 3, no. 1, p. 35, 2022, doi: 10.22441/ijiem.v3i1.13790.

[3] KemenPUPR RI, "Peraturan Menteri Pekerjaan Umum Nomor 05/PRT/M/2014 Tentang Pedoman Sistem Manajemen Keselamatan Dan Kesehatan Kerja (SMK3) Konstruksi Bidang Pekerjaan Umum," *Peratur. Menteri Pekerj. Umum*, p. 41, 2014.

[4] A. A. Bayu Dharma, I. G. A. Adnyana Putera, and A. A. D. Parami Dewi, "Manajemen Risiko Keselamatan Dan Kesehatan Kerja (K3) Pada Proyek Pembangunan Jambuluwuk Hotel & Resort Petitenget," *J. Spektran*, vol. 5, no. 1, pp. 47–55, 2017, doi: 10.24843/spektran.2017.v05.i01.p06.

[5] E. P. Rahayu and Dkk, *Kesehatan dan Keselamatan Kerja*. Baki: Pradina Pustaka, 2022.

[6] S. Ramli, *Sistem Manajemen Keselamatan Dan Kesehatan Kerja OHSAS 18001*, Cetakan ke. Jakarta: Dian Rakyat, 2010.

[7] I. Asih, I. Setiawan, H. Hernadewita, and H. Hendra, "Effects of ergonomics intervention on work accidents in the construction sector and their effect on productivity," *J. Sist. dan Manaj. Ind.*, vol. 6, no. 1, pp. 44–55, 2022, doi: 10.30656/jsmi.v6i1.4242.

[8] N. S. S. Nurriwanti, Y. D. A. Wahyudiono, I. Paskarini, and A. P. S. Handayani, "Hazard Identification and Risk Assessment of Sensor Maintenance Work Activity on The Suramadu Bridge Steel Box Girder Area," *Indones. J. Occup. Saf. Heal.*, vol. 12, no. 2, pp. 227–236, 2023, doi: 10.20473/ijosh.v12i2.2023.227-236.

[9] T. Ihsan, S. A. Hamidi, and F. A. Putri, "Penilaian Risiko dengan Metode HIRADC Pada Pekerjaan Konstruksi Gedung Kebudayaan Sumatera Barat," *J. Civronlit Unbari*, vol. 5, no. 2, p. 67, 2020, doi: 10.33087/civronlit.v5i2.67.

[10] T. Mayangsari *et al.*, "Analisis Keselamatan Kerja Dengan Menggunakan Metode Hazard Identification And Risk Assessment Control (HIRAC) Di Pt . Sucofindo Duri Tahun 2022 Occupational Safety Analysis Using the Hazard Identification And Risk Assessment Control (HIRAC) Method at Pt . Sucofindo Duri Year 2022 Program Studi Kesehatan Masyarakat PENDAHULUAN risiko bahaya yang lebih besar dan beraneka ragam karena adanya alih teknologi dimana Tujuan penelitian adalah untuk menganalisis data keselamatan kerja (K3) dengan menggunakan metode Hazard Indetification And Risk Assessment Control (HIRAC) di PT . Sucofindo Duri tahun 2022," vol. 1, no. 3, 2023.

[11] M. Ali and M. Asri, *Manajemen Risiko Indiosyncratic Risk Negara Berkembang*, Cetakan 1. Makassar: UPT Unhas Press, 2021.

[12] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*, Edisi Kedu. Bandung: Alfabeta, 2019.

[13] J. E. Mohamed, I. Mittal, S. Goswami, S. Pai, and V. Bhat, "Evaluation of Knowledge and Attitude of Undergraduate Medical and Dental Students towards Integrative Medicine and Integrative Dentistry: A Questionnaire Study," *Indian J. Public Heal. Res. Dev.*, vol. 11, no.

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Accepted: 30-11-2023 |
Publish: 03-12-2023 |

1, p. 880, 2020, doi: 10.37506/v11/i1/2020/ijphrd/194177.
[14] M. R. Jannah, S. El Unas, and M. H. Hasyim, "Analisis Risiko Keselamatan dan Kesehatan Kerja (K3) melalui Pendekatan Hiradc dan Metode Job Safety Analysis pada Studi Kasus Proyek Pembangunan Menara X di Jakarta," *Tek. Sipil*, p. 9, 2017.
[15] Permen PUPR, *Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat tentang Standar dan Pedoman Pengadaan Jasa Konstruksi Melalui Penyedia*. BN.2020/No.483, jdih.pu.go.id : 92 hlm., 2020.
[16] M. E. B. Sadewa, "Implementasi Keselamatan Dan Kesehatan Kerja (K3) Pada Pekerjaan Pilar Jembatan Menggunakan Metode Hiradc (Implemantation of Occupational Safety and Health on Bridge Pillar Construction Using Hiradc Method) Implementasi Keselamatan Dan Kesehatan Kerja," p. 100, 2021.
[17] 2018 Fuad, Indrayadi, "Penerapan K3 (Keselamatan Dan Kesehatan Kerja) Menggunakan Metode Hiradc (Hazard Identification, Risk Assesment, and Determining Control) Dan Jsa (Job Safety Analysis) Pada Proyek Pembangunan Gedung Direktorat Reserse Kriminal Khusus Polda Kalbar," *Mengetahui Tingkat Risiko Dari Setiap Kegiat. Atau Setiap Pekerj. Proyek.*, vol. 3, pp. 21–25, 2018.
[18] M. Amin, *Kesehatan dan Keselamatan Kerja (K3)*, no. 2008. Baki: Pradina Pustaka, 2016.
[19] A. Widodo and S. B. Setiawan, "Optimalisasi Penggunaan Personal Protective Equipment (PPE) Guna Menghindari Potensi Kecelakaan Kerja Di Atas Kapal MV. Lumoso Karunia VIII," *Meteor STIP Marunda*, vol. 15, no. 2, pp. 390–399, 2022, doi: 10.36101/msm.v15i2.250.
[20] Isna Shofiana, "IDENTIFIKASI POTENSI BAHAYA PEKERJAAN DI KETINGGIAN PADA PROYEK PEMBANGUNAN GEDUNG PARKIR RUMAH SAKIT TELOGOREJO (STUDI DESKRIPTIF PADA PROYEK KONSTRUKSI OLEH PT. ADHI KARYA SEMARANG)," no. 1, pp. 1–27, 2015.