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OHS Risk Management Using the Hirarc Method (Hazard Identification, Risk Assessment, and Risk Control) on Emu Maintenance Work at PT KCIC

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Abstract

The Electric Multiple Units (EMU) owned by PT Kereta Cepat Indonesia China (PT KCIC) have a height of 4.05 meters, requiring maintenance to be performed at height. Furthermore, workers must climb onto the EMU and work in close proximity to high-voltage electrical systems, specifically the Overhead Catenary System (OCS) (Rahadian Ratry, 2023). To ensure that the production process continues while safeguarding workers, equipment, and the environment from occupational accidents, hazard identification must be conducted, as workplace conditions contain potential hazards that could endanger workers during maintenance. The hazard identification technique used in this study is HIRARC (Hazard Identification, Risk Assessment, and Risk Control). Based on field investigations and studies conducted at the PT KCIC Joint Workshop, where EMU repair operations are performed, three categories of occupational hazards with ten potential risks were identified. Based on the risk assessment of the ten potential hazards, three risks are categorized as moderate, four as high, and three as very high. Risk control for potential hazards in EMU maintenance work is carried out following the completion of the hazard identification and risk assessment stages. The OHSAS 18001:2007 risk control hierarchy is utilized to implement control measures that reduce risks to manageable levels, considering solutions that align with the company's actual conditions.

Keywords: OHSMS, HIRARC, Hazard Identification, Risk Assessment, Risk Control

INTRODUCTION

Formerly known as the Jakarta-Bandung High-Speed Railway (KCJB), Whoosh is operated by PT Kereta Cepat Indonesia China (KCIC), a joint venture managing the high-speed rail network in Indonesia. Featuring capabilities such as the Electric Multiple Unit (EMU), which utilizes electricity as its propulsion power obtained from the Overhead Catenary System (OCS), Whoosh is the first high-speed rail service in Indonesia and Southeast Asia (Rahadian Ratry, 2023). This train can reach speeds of up to 350 km/h (Muhdany Yusuf Laksono, 2022). The operation and maintenance of the EMU are vital components of railway transportation management; the quality of maintenance directly correlates with railway transportation safety, personal safety, property security, and the company's economic benefits.

In EMU maintenance, the occupational safety of personnel must be guaranteed. Technical rules, regulations, technical standards, operational measures, and other relevant systems for EMU operation and maintenance must comply with occupational safety requirements. Personnel are responsible for workplace safety, must adhere to laws and regulations, implement Standard Operating Procedures (SOPs), and ensure operational safety.

EMU maintenance is divided into several levels based on mileage and operational time. One of these levels is Level I maintenance, which is performed after the EMU has traveled 7000±700 kilometers or reached 48 hours of operational time (Situmorang, 2022). Level I maintenance involves several types of work across various parts of the EMU, including: underframe equipment inspection, driver's cabin inspection, interior equipment inspection, dual-side equipment inspection, wastewater suction, and EMU roof equipment inspection.

Working at height is defined as any action performed by an employee in an area with a height difference from the ground or water surface that carries a risk of falling, potentially causing injury, death, or property damage, in accordance with the Ministry of Manpower Regulation No. 09 of 2016. The inspection of EMU roof equipment falls into the category of working at height, as the EMUs owned by PT KCIC reach a height of 4.05 meters. Furthermore, this inspection site is located near the Overhead Catenary System (OCS), requiring workers to perform tasks on top of the EMU with the risk of proximity to high-voltage electricity. Although the EMU roof equipment inspection conducted at the PT KCIC Joint Workshop utilizes adequate technology and operational standards, potential hazards still exist that may threaten the safety and health of workers. Given these risks, hazard identification is a crucial step to ensure the production process runs smoothly while simultaneously protecting the workforce, equipment, and the environment from the possibility of workplace accidents (Giananta et al., 2020).

LITERATURE REVIEW

According to Candrianto (2020), occupational health and safety (OHS) is a condition in the workplace that is healthy and safe for employees, the company, and the residents and environment surrounding the facility. Occupational health and safety is also an effort to prevent unsafe conditions that could lead to accidents. OHS indicators include the environmental conditions at the workplace, the use of personal protective equipment (PPE), and the physical condition of the employees.

The HIRARC (Hazard Identification, Risk Assessment, and Risk Control) technique is used to identify hazards in this study. This approach seeks to assess the risk levels associated with each type of work performed. Through this approach, workers can understand the potential hazards that may occur in their jobs, allowing measures to minimize workplace accidents to be implemented. Furthermore, the HIRARC approach provides recommendations for preventing workplace accidents and guidance on how to perform work safely based on the results of the risk identification.

METHODS

According to Triswandana (2020), research on the Occupational Health and Safety (OHS) risk management system using the HIRARC method for EMU maintenance at PT Kereta Cepat Indonesia China utilizes qualitative and descriptive research methods to understand the company's risk management system processes. Research data were collected through interviews and observations, which serve as the primary reference for data processing. The data processing techniques are conducted in accordance with the HIRARC methodology, covering hazard identification, risk assessment, and risk control. The subsequent step, as stated by Erliana & Azis (2020), involves processing the data obtained from the collection results.

Hazard Identification

The first step is to identify the activities that need to be recognized. To assist in determining the potential hazard risks arising from future work, an identification of the tasks performed in the research area is conducted at this stage. When evaluating potential hazard sources, it is essential to pay attention to situations and events that could trigger hazard risks, as well as the types of accidents that might result from the activities being performed.

Risk Assesment

The second stage follows the completion of hazard identification. From the results of that identification, an assessment can be conducted by considering the likelihood criteria, which are viewed from the perspective of the definition of probability or frequency of occurrence. Subsequently, the severity criteria are considered, viewed from the definition of the resulting impact (Alamsyah et al., 2021).

Table 1. *Likelihood*

Level	Descriptor	Definition
1	Rare	May occur only in exceptional circumstances
2	Unlikely	Could occur at some time
3	Possible	Might occur at some time
4	Likely	Will probably occur in most circumstances
5	Almost Certain	Expected to occur in most circumstances

Source: Standard Likelihood Scale AS/NZS 4360:2004.

Table 2. *Severity Classification*

Level	Explanation	Definition
1	Insignificant	No injury
		Minimal financial loss
2	Minor	First aid required, on-site treatment
		Medium financial loss
3	Moderate	Moderate medical treatment required
		On-site treatment with external assistance
		Significant financial loss due to reduced capacity
4	Major	Extensive injuries
		Leads to production loss
		Effects impact the surrounding environment but are not detrimental
		Large financial loss
5	Extreme	Results in fatality
		Effects impact and are detrimental to the surrounding environment
		Very large financial loss

Source: Standard Severity Scale AS/NZS 4360:2004.

Table 3. Risk Assessment Matrix

AS / NZS 4360:2004	*Insignificant*	*Minor*	*Moderate*	*Major*	*Extreme*	
Almost Certain	5	10	15	20	25	5
Likely	4	8	12	16	20	4
Possible	3	6	9	12	15	3
Unlikely	2	4	6	8	10	2
Rare	1	2	3	4	5	1
	1	2	3	4	5	

Risk Level	
16-25	V.Hight
9-15	Hight

5-8	Moderate
1-4	Low

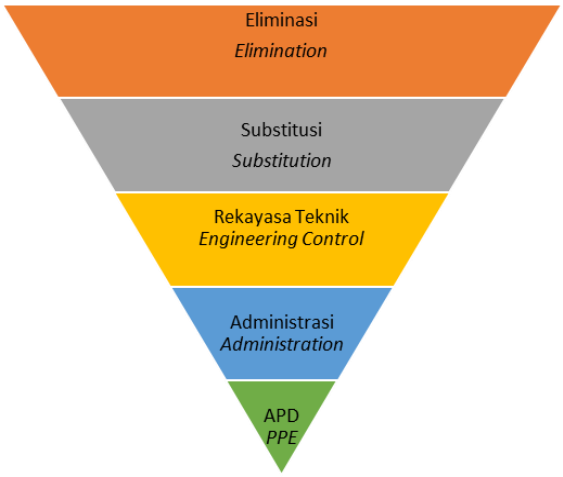
Source: Risk Assessment Matrix AS/NZS 4360:2004.

As can be seen from the table above, probability level and severity are the topics of risk assessment. These levels, when multiplied, produce a risk value that can be categorized into low risk and *very high* risk.

Risk Control

Implementing risk control is the third step, and the results of the risk assessment serve as a guide for this process. Understand the potential hazards that may arise in the form of risk categories *low, moderate*, *high* and *very high* is the way of applying this risk control. The OHSAS 18001:2007 standard, obtained from previous risk assessments, can be used when managing risks (Afifuddin et al., 2021).

Figure 1. OHSAS 18001 : 2007 Risk Control Hierarchy



1. Elimination is a control method that involves the removal of a source of danger.
2. Substitution is a hazard control strategy that involves replacing hazardous equipment, equipment, processes, or systems.
3. The addition or modification of facilities to lower existing hazards and stop human error is known as engineering control.
4. The administration complies with regulations relating to environmental protection, safety, workplace health and safety, and railway safety.
5. One of the items that can protect employees whose job it is to protect all or part of their bodies from potential risks in the work area is personal protective equipment, or PPE.

RESULTS AND DISCUSSION

Contents of Results and Discussion

Hazard *Identification*

The results of the field study and the results of the research at the Joint Workshop owned by PT. KCIC, where maintenance activities on EMU are carried out, maintenance work on EMU has 3 types of activities with 10 potential hazards that can pose risks at the time the work is carried out. These potential dangers are described in table 4.

Table 4. Hazard Identification Results

No	Activities	Potential Hazards	Risks
1	Prior to maintenance work on EMU	Workers do not wear wearpack	Scratched or chapped skin
2		Workers do not use protective shoes with rubber soles	Slipping or slipping
3		Use of tools that do not comply with SOPs or technical capacity	Damage to EMU components occurred
4	Maintenance work activities on top of EMU	Workers don't pay attention to where to stand	Slipping, slipping, falling
5		Workers stepping on AC fan cover	AC fan damage
6		Level 1 *Maintenance checks* above EMU are performed at altitude	Falling
7		There is a gap between the EMU and the 3rd floor platform	Falling
8		Upstream Electricity (LAA) has not been disconnected	High voltage electric shock
9		There is residual voltage when after *Safety Protection Confirmation*	High voltage electric shock
10	After maintenance work on the EMU	Work tools, tools or materials left on the EMU roof	Damage to EMU components occurred

Source : Data Processed

Risk Assessment

To evaluate the value and amount of risk, a risk assessment can be carried out using the results of the *Hazard Identification step*. This involves examining the likelihood of occurrence (*likelihood*) and impact (severity). Any hazards that may be found during treatment above EMU are assessed for risk. Table 5 details the risk assessment findings for treatment above EMU.

Table 5. Risk Assessment Results

No	Activities Activities	Potential Hazards	Risk	Likelihood	Severity	Score	Level Risks
1	Prior to maintenance work on EMU	Workers do not wear wearpack	Scratched or chapped skin	3	2	6	*Moderate*
2		Workers do not use protective shoes with rubber soles	Slipping or slipping	3	2	6	*Moderate*
3		Use of tools that do not comply with SOPs or	Damage to EMU components occurred	4	4	16	*Very High*

No	Activities Activities	Potential Hazards	Risk	Likelihood	Severity	Score	Level Risks
		technical capacity					
4	Maintenance work activities on top of EMU	Workers don't pay attention to where to stand	Slipping, slipping, falling	4	4	16	*Very High*
5		Workers stepping on AC fan cover	AC fan damage	3	2	6	*Moderate*
6		Level I *Maintenance checks* above EMU are performed at altitude	Falling	3	4	12	*High*
7		There is a gap between the EMU and the 3rd floor platform	Falling	4	4	16	*Very High*
8		Upstream Electricity (LAA) has not been disconnected	High voltage electric shock	3	5	15	*High*
9		There is residual voltage when after *Safety Protection Confirmation*	High voltage electric shock	3	5	15	*High*
10	After maintenance work on the EMU	Work tools, tools or materials left on the EMU roof	Damage to EMU components occurred	4	3	12	*High*

Source : Data Processed

Based on Table 5, maintenance work above EMU has three levels of risk, namely: *moderate*, *high*, and *very high*. Risk *moderate* is considered unacceptable because it has the potential to cause work accidents and material damage that has an impact on medium-scale financial losses. Therefore, effective control and mitigation measures are needed to reduce the risk to the *low*. Risk *high*, which has more serious impacts, such as serious injury, significant financial loss, and the risk of death, also require strict control to be at an acceptable level of risk. For risk *very high*, the threat is much greater because it involves the potential for life and enormous financial losses. With such a large risk, the implementation of comprehensive and

effective control and mitigation is a must to protect worker safety and minimize losses (Fathoni, 2020).

Risk Control

Risk control of potential hazards in maintenance work above EMU is carried out after the completion of the hazard identification and risk assessment phases. Taking into account solutions that suit the actual circumstances of the business, control measures are implemented to reduce risk to an acceptable level. The following is risk control that can be carried out using the OHSAS 18001 risk control hierarchy : 2007 (*OHSAS 18001:2007 On Occupational Safety and Health Management System*, 2007) in Table 6.

Table 6. Risk Control in Maintenance Work Above EMU PT KCIC

Yes	Activities	Potential Hazards	Risks	Risisko Control Hierarchy				
				Eliminasi	**Substitution**	**Engineering Engineering**	**Administration**	**APD**
1	Work completeness	Workers do not wear wearpack	Scratched or chapped skin				• Safety induction *is carried out* before carrying out work activities • P3K Preparation • SOP Made for EMU Roofing Equipment Inspection • Regular inspections are carried out as a form of supervision	• Using *the wearpack*
2		Workers do not use protective shoes with rubber soles	Slipping or slipping				• Safety induction *is carried out* before carrying out work activities • SOP Made for EMU Roofing Equipment Inspection • Regular inspections are carried out as a form of supervision	• Using protective shoes with rubber soles
3		Use of tools that do not comply with SOPs or technical capacity	Damage to EMU components occurred				• Maintenance personnel are competent, certified, and have received training • Safety induction *is carried out* before carrying out work activities	

							• SOP Made for EMU Roofing Equipment Inspection • Calibration of the work tool every time before and after use • Regular inspections are carried out as a form of supervision • Re-checked by *the Quality Control team* to ensure that the work results are in accordance with standards	
4	EMU roof inspection activities	Workers don't pay attention to where to stand	Slipping, slipping, falling				• Installing a picture of a warning sign on the roof of an EMU • Safety induction *is carried out* before carrying out work activities • SOP Made for EMU Roofing Equipment Inspection	• Using protective shoes with rubber soles
5		Workers stepping on AC fan cover	AC fan damage			• Installing a footing track made of rubber on the roof of the EMU as a footing place and as a marker that movement on the EMU is only allowed on the track	• Safety induction *is carried out* before carrying out work activities • SOP Made for EMU Roofing Equipment Inspection	
6		Level I inspection of maintenance	Falling			• There is a protective infrastructure of the platform gangway	• Hair fitting occupational hazards at height	

		above EMU is carried out at altitude				between the EMU and the 3rd floor platform that can be raised and lowered	• Safety induction *is carried out* before carrying out work activities • SOP Made for EMU Roofing Equipment Inspection	
7		There is a gap between the EMU and the 3rd floor platform	Falling			• There is a protective infrastructure of the platform gangway between the EMU and the 3rd floor platform that can be raised and lowered to close the gap	• Installation of occupational hazard signs at heights • Safety induction *is carried out* before carrying out work activities • SOP Made for EMU Roofing Equipment Inspection	
8		Upstream Electricity (LAA) has not been disconnected	High voltage electric shock			• Installation of warning signs that provide information on whether OCS is in life or death	• Enforce entry to the 3rd floor platform • Installation of high voltage electrical hazard signs • Periodic socialization related to occupational hazards in high-voltage electrical areas • Safety induction *is carried out* before carrying out work activities • Created OCS Blackout SOP • SOP Made for EMU Roofing Equipment Inspection	• Safety helmet • Insulation gloves • Reflective break • Safety shoes

9		There is residual voltage when after *Safety Protection Confirmation*	High voltage electric shock			• Rod *gounding equipment*	• Enforce entry to the 3rd floor platform • High voltage electrical hazard hair fitting • Periodic socialization related to occupational hazards in high-voltage electrical areas • Safety induction *is carried out* before carrying out work activities • Created OCS Blackout SOP • SOP Made for EMU Roofing Equipment Inspection	• Safety helmet • Insulation gloves • Reflective break • Safety shoes
10	Final inspection	Work tools, tools or materials left on the EMU roof	Damage to EMU components occurred				• Safety induction *is carried out* before carrying out work activities • SOP Made for EMU Roofing Equipment Inspection • Created a form in and out of the equipment in the storage area • Workers bring a form containing a list of the equipment they bring • Re-checked by *the Quality Control team* to ensure that the work results are in accordance with standards	

CONCLUSION

Three hazards have a moderate level of risk, four hazards have a high level of risk, and three hazards have a very high level of risk, based on hazard identification and risk assessment that has been carried out on maintenance work above EMU PT. KCIC.

The results of the risk control provide recommendations for improvement aimed at lowering the level of risk to an acceptable level and preventing potential occupational accidents from any hazards identified. This recommendation is based on a hierarchical approach to risk control according to OHSAS 18001:2007, which includes control through engineering engineering, administrative control, and the use of personal protective equipment (PPE).

SUGGESTIONS AND ACKNOWLEDGMENTS

To improve occupational health and safety, socialization is needed for workers so that they are more aware of the importance of this aspect. Workers are expected to always comply with the applicable work regulations and guidelines in each stage of work. The company is also responsible for providing proper and standard personal protective equipment (PPE) as a protective measure for workers. In addition, consistent supervision is required to ensure that workers use appropriate PPE and that work is carried out in accordance with applicable regulations. In terms of occupational risk control, the implementation of high-level risk control is expected to reduce and even prevent the occurrence of work accidents due to various potential hazards.

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