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Work Accident Risk Control in Road Construction Projects with the Hiradc Approach

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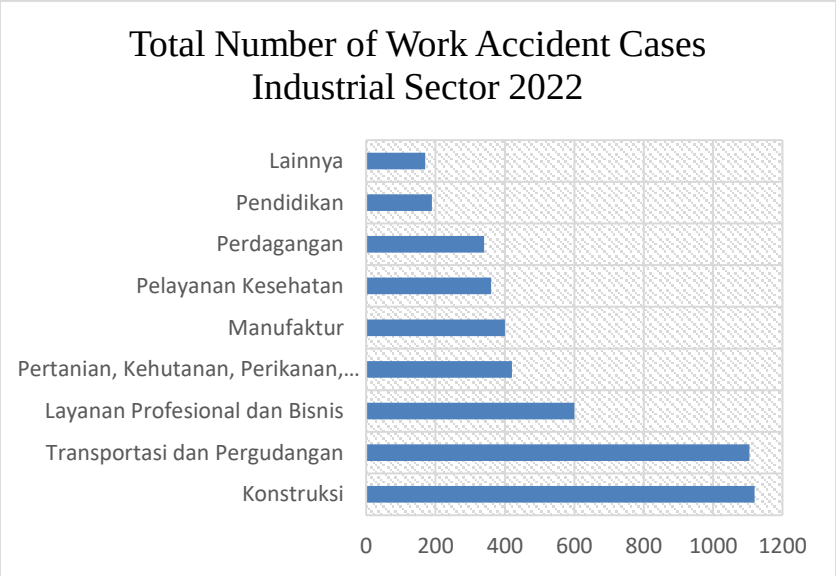
ABSTRACT

Construction projects are a field of work with a high risk of work accidents. CV XYZ, a construction service company, often experiences work accidents on highway projects. These work accidents are caused by human negligence, substandard materials, and inadequate occupational safety and health (OSH) implementation methods. Based on these problems, this study aims to design work accident risk control at CV XYZ to reduce and prevent work accidents on road construction projects. The design of occupational safety and health (OSH) control is carried out by conducting risk analysis on road construction project activities through the HIRADC (Hazard Identification, Risk Assessment, and Determining Control) approach and designing improvements to the occupational safety and health (OSH) control business process. The design of OSH risk control created in this study aims to implement risk control and reduce the risk of work accidents in the company.

Introduction

Construction projects are a field of work with a high risk of work accidents, this is due to the prevalence of unsafe behavior and unsafe working conditions during the implementation of construction projects (Alfiansah, Kurniawan, & Ekawati, 2020). Based on data compiled by the Construction Development of the Ministry of Public Works and Spatial Planning in 2019, there were 130,923 work accidents. Construction projects in Indonesia have the highest number of work accidents, so measures are needed to ensure Occupational Safety and Health (K3). OSH in the construction sector is an integral part of the organizational management system in public works, which aims to control OSH risks in various construction activities (Ihsan, Hamidi, & Putri, 2020). The construction sector is one of the sectors that contributes the highest and most fatal work accidents in the case of work accidents (Askarno & Nendi, 2023). Based on data from the Ministry of Public Works of the Republic of Indonesia, the construction sector and the manufacturing industry are the largest contributors to work accidents in Indonesia, at 32% (Sugiyanto & Thoif, 2023). The following is data on work accident cases in various industrial sectors in 2022 based on the fatal rate recorded by BPJS Ketenagakerjaan:



Work accidents are caused by the existence of unsafe conditions, which refer to physical environmental factors that have the potential to cause accidents, such as unsafe machinery, inadequate lighting, ineffective use of Personal Protective Equipment (PPE), the presence of oily floors, and so on (Umam & Abdurokhim, 2023). In addition, dangerous acts (unsafe acts) are also causes, which include behaviors or actions that can cause accidents, such as negligence, non-compliance in using personal protective equipment, and so on. These factors can be caused by health problems, visual impairments, diseases, anxiety levels, and lack of knowledge related to work processes and how to work. Based on statistical data, 85% of work accidents in Indonesia are caused by dangerous acts (unsafe acts), while 15% are caused by dangerous conditions (unsafe conditions).

In this study, the author conducted research on a company engaged in construction. In the course of the project, the company still causes work accidents every year. Work accidents on CV XYZ are caused by several factors, including worker negligence, the use of non-standard materials, and inadequate construction implementation methods. Although the company has provided personal protective equipment (PPE), many workers do not comply with and implement the occupational safety and health management system (SMK3). In the process of work, CV XYZ uses a lot of heavy equipment and involves many workers, so many risk factors cause work accidents. Work accidents that often occur in this company are in highway construction projects.

Research Methods

The research method used, namely HIRADC (Hazard Identification, Risk Assessment, and Determining Control) is a process to identify, measure, and assess hazard risks that can occur in routine and non-routine activities in the company (Cholil, Santoso, T RIZA, Sinulingga, & Nasution, 2020). The results of the risk assessment are used to create a hazard control program so that the company can minimize the risks that

may occur and prevent work accidents (Pamungkas, 2021). The steps of the identification process using the HIRADC method are:

1. Hazard Identification (Identifikasi Bahaya)

Hazard identification is a stage carried out to identify all activities that have the potential to cause accidents or occupational diseases that may occur in the construction industry sector (Mawardani & Herbawani, 2022). There are several ways to identify a hazard. Some of these ways are direct interviews with the company, workplace observations, discussions, reviews about the company's K3, K3 rules or regulations, and literature studies on K3. According to (Mawardani & Herbawani, 2022). Some ways that can be done to identify potential occupational hazards in the workplace are: Checking and analyzing accidents, injuries, and near misses.

Consultation with workers

2. Risk Assessment (Penilaian Risiko)

Risk assessment is a step in analyzing and evaluating the extent of the level of risk, assessing the feasibility of accepting risks within the company, and compiling and evaluating the risk control measures required by the company. The level of risk in the work environment can be calculated by multiplying how often the risk occurs (likelihood) by the resulting severity (severity) (Ermiyati, Fakhri, & Hockiana, 2021). The following are the likelihood and severity criteria used:

Scale	Criterion	Qualitative Description	Quantitative Description
1	Rare	Conceivable but not only in extreme circumstances	Less than 1 time per 10 years
2	Possible Occurrence	It hasn't happened yet but can appear/happen at some time	Occurs 1 time per 10 years
3	Can Happen	It should have happened and may have happened here or elsewhere	1 time per 5 years to 1 time per year
4	Frequent Occurrence	Can happen easily, appearing in the most common circumstances	More than 1 time per year to 1 time per month
5	Almost Certain to Happen	It occurs frequently, it is expected to appear in the circumstances that occur the most.	More than 1 time per month

After determining the value of severity and likelihood, calculations are carried out to determine the level of risk. The following is a description of the matrix of risk assessment:

Likelihood		*Severity (consequence)*				
		Insignificant	Small	Keep	Tall	Extreme
		1	2	3	4	5
Almost Certain to Happen	5	T	T	And	And	And
Frequent Occurrence	4	S	T	T	And	And
Can Happen	3	R	S	T	And	And
Kadang	2	R	R	S	T	And
Very Rare	1	R	R	S	T	T

With the caption:

1. E: Extreme, Activities or work should be postponed or stopped until the risk is successfully reduced. If risk reduction is not possible with limited resources, then the work should not be carried out.
2. Q: High, Activities or work should not be continued until the risk is successfully reduced. Resources allocated to mitigate risk need to be carefully considered. If a risk arises in the ongoing work, immediate action must be taken.
3. S: Moderate, Measures are required to reduce the risk, but the necessary preventive costs must be carefully calculated and limited. Measurement of the success rate of risk reduction must be carried out within the specified time frame.
4. R: Low, Risk is at a tolerable level, so no additional control is needed. Regular monitoring needs to be carried out to ensure that the control that has been implemented is maintained and carried out effectively.

Determining control

Risk control can be carried out in various ways, one of which is by using a control hierarchy approach. The control hierarchy is a systematic approach to controlling risks in order from the most effective level of control to the lowest level of control (Ihsan et al., 2020). The control hierarchy consists of five levels, namely elimination (efforts to eliminate sources of danger from the workplace), Substitution (efforts to replace hazardous materials or processes with safer materials or processes), and Engineering (efforts to control risks by using engineering techniques). Engineering can be in the form of modification or addition of work equipment or facilities to reduce the risk of work accidents or occupational diseases), administrative control (efforts to control the risk of work accidents by using work regulations or procedures), and the use of personal protective equipment (PPE) which is equipment used by workers to protect themselves from hazards when carrying out a work/project at the workplace.

Results and Discussion

In the results of this study, a discussion was carried out on the risk control of work accidents using the HIRADC method to analyze potential hazards, risk assessment, and

control, and recommendations for improvement from the results of risk assessment and control were described.

Risk Analysis With Hiradc

1. Hazard Identification (Identifikasi Potensi Bahaya)

Hazard identification is a stage carried out to identify all activities that have the potential to cause accidents or occupational diseases that may occur in the construction industry sector (Mawardani & Herbawani, 2022). There are several ways to identify a hazard. Some of these ways are direct interviews with the company, workplace observations, discussions, reviews about the company's K3, K3 rules or regulations, and literature studies on K3. In this study, hazard identification was obtained from the results of interviews with workers and safety officers in the company. The following are the results of the identification of risk hazards of road construction projects:

No	Stages of Work	Work Activities	Potential Hazards	Risk
1	Preparation Stage	Mobilization of project needs (equipment and materials) to the project site	Traffic accidents	Workers hit bydaraa and injured
			Hit by objects (concrete, steel, stairs)	Injured and injured
			Tripping and falling due to road conditions (slippery and messy)	Workers sustained minor injuries Injured
		Clearing of land or project area	Hit by sharp objects (gravel, asphalt blocks)	
			Respiratory distress due to traffic dust	Shortness of breath
		Road traction measurement	Traffic accidents	Workers were hit by vehicles and sustained injuries.

No	Stages of Work	Work Activities	Potential Hazards	Risk
			Tripping and falling due to road conditions (slippery and messy)	Workers are injured (light and severe)
		Road boundary marking and installation of stakes	Traffic accidents	Falling and injuring
2	Implementation Stage	Excavation and disposal of soil	Falling from a height (landslide)	Workers with broken bones
			Stumbling and falling due to wet, slippery, and uneven conditions in the project area	Workers sustained minor injuries.
		Paving the road	Exposure to hazardous materials (asphalt and fuel oil)	Injured and blistered skin
			Tripping and falling due to messy and slippery environmental conditions	Workers are injured
		Installation of road structures (Installation	Hit by an object (concrete block)	Workers with moderate injuries

No	Stages of Work	Work Activities	Potential Hazards	Risk
		drainage channels, installation of traffic signs)	Stumbling and falling due to the messy and slippery conditions of the project area	Workers sustained minor injuries
		Paving	Exposed to asphalt fragments	Blistered skin
			Injured by manual tools (hot asphalt mixer)	Injured hand

2. Risk Assessment

Then the second stage after identifying the hazard is to conduct a risk assessment as an evaluation stage of the risks that arise (Abdurokhim, 2024). This stage is carried out to find out the risk and risk level of each activity. The criteria used in this stage are calculated by multiplying how often the risk occurs (likelihood) by the severity produced (severity) (Ermiyati et al., 2021). The following are the results of the risk assessment of road construction project activities based on hazard identification that has been carried out previously:

No	Work Activities	Potential Hazards	Risk	L	S	Skoring	Level Risk
1	Mobilization of project needs (equipment and materials) to the project site	Traffic accidents	Workers were hit by vehicles and sustained injuries	2	3	6	Keep
		Hit by objects (concrete, steel, stairs)	Injured and injured	2	3	6	Keep

		Tripping and falling due to road conditions (slippery and messy)	Workers sustained minor injuries	4	3	12	Tall
2	Clearing of land or project area	Exposed to sharp objects/materials (gravel, asphalt blocks)	Injured	3	2	6	Keep
		Respiratory distress due to traffic dust	Shortness of breath	3	1	3	Low
3	Road traction measurement	Traffic accidents	Workers were hit by vehicles and sustained injuries	2	3	6	Keep
		Tripping and falling due to road conditions (slippery and messy)	Workers are injured (light and severe)	4	2	8	Tall
4	Road boundary marking and installation of stakes	Traffic accidents (being hit by a vehicle)	Falling and injuring	2	2	4	Low

		Falling from a height (landslide)	Workers with broken bones	2	3	6	Keep
5	Excavation and disposal of soil	Stumbling and falling due to wet, slippery, and uneven conditions in the project area	Workers sustained minor injuries	4	3	12	Tall
6	Paving the road	Exposure to hazardous materials (asphalt, concrete splashes, fuel oil)	Injured and blistered skin	3	3	9	Tall
		Tripping and falling due to environm ental conditions messy and slippery	Workers are injured	4	3	12	Tall
7	Installation of road structures (Installation of drainage channels, installation of traffic signs)	Hit by an object (concrete block)	Workers with moderate injuries	3	2	6	Keep
		Stumbling and falling due to conditions	Workers sustained minor injuries	4	3	12	Tall

		Messy and slippery project areas					
8	Paving	Exposed to asphalt fragments	Blistered and injured skin	4	2	8	Tall
		Injured by manual tools (hot asphalt mixer)	Injured hand	3	3	9	Tall
9	Cleaning and tidying of the project area	Tripping and falling due to road conditions (slippery and messy)	Workers sustained minor injuries	4	2	8	Tall
		Exposed to material fragments (gravel, asphalt blocks)	Wounded and slashed	3	2	6	Keep
10	Quality inspection and testing of work	Hit by a vehicle/traffic accident	Workers are injured, injured, or fractured	2	2	4	Low

Based on the results of the risk assessment, several activities have a high level of risk, namely tripping and falling due to road conditions, exposure to hazardous materials, exposure to asphalt fragments, and injuries due to manual asphalt mixers. Therefore, to reduce the value of work accidents, it is necessary to control risks in activities that have high risks in road construction projects.

3. Determining Control

This stage is an effort to reduce or eliminate risks that can cause work accidents to occur. The determination of risk control is determined based on a risk assessment. The control hierarchy and control strategy prioritize the level of possible risk based on their order, which obtains a greater risk average score (Mahardhika & Pramudyo, 2023). This study only focuses on determining risk control that has a high level of risk. Risk control consists of several approaches, namely administrative approaches, technical approaches, and the use of PPE. The following are the results of the analysis of the control determination of road construction project activities that have a high level of risk:

Work Activities	Potential Hazards	Risk	Treatment	Approach
Mobilization of project needs (equipment and material) to the project site	Tripping and falling due to road conditions (slippery and messy)	Workers sustained minor injuries and severe injuries	Planning SOPs (Standard Operating Procedures) on OSH risk management	Administrative Control
Road traction measurement			Identifying hazards (Identification of hazard risks, occupational accident risks, and their control)	
Excavation and disposal of soil			Use PPE (footwear, safety boat, and gloves) and ensure the use of PPE by making a checklist sheet.	Engineering Control
Installation of road structures (Installation of drainage channels, installation of traffic signs)			Installing *safety signs* warning of slippery roads and leveling the road surface	Engineering Control
			Reporting hazards	
			Conduct supervision	

Work Activities	Potential Hazards	Risk	Treatment	Approach
Paving the road	Exposure to hazardous materials (asphalt, concrete splashes, fuel oil)	Injured and blistered skin	Sealing and ensuring hazardous materials do not come into contact with workers (using sealed containers and personal protective equipment)	Engineering Control
			Planning SOPs (*Standard Operating Procedures*) on OSH risk management	Administrative Control
			Create and implement hazard identification, risk assessment, and control results.	
Paving	Exposed to asphalt fragments	Blistered, cut, and injured skin	Install protective boards around the paving area and warnings regarding the use of complete PPE.	Engineering Control
			Planning SOPs (*Standard Operating Procedures*) on OSH risk management	Administrative Control
			Identifying hazards (Identification of hazard risks, occupational accident risks, and their control)	
	Injured by the asphalt mixer manual tool (exposed to the heat of the tool, falling because the tool is on an unsuitable	Injured hands, injuries to the legs, and injuries	Limit asphalt temperature by installing visual displays	Engineering Control
			Installing protective equipment and ensuring the use of PPE by making a checklist sheet	

Work Activities	Potential Hazards	Risk	Treatment	Approach
	surface rata, hit by the stirring device)		Planning SOPs (Standard Operating Procedures) on OSH risk management	Administrative Control
			Identifying hazards (Identification of hazard risks, occupational accident risks, and their control)	

Based on the determining control table above, controls are determined for high-risk activities. The control carried out can be administrative and technical. Administrative controls are carried out such as creating and identifying potential hazards and designing Standard Operating Procedures (P3) for OSH Control. For technical control such as the use of PPE, installation of safety signs, asphalt temperature restrictions, installation of protective equipment in the work area, work reporting, and supervision.

Repair Recommendations

Based on the stages of risk analysis using HIRADC, several activities have a high level of risk. This study focuses on designing improvements to reduce the risk of work accidents in activities that have a high level of risk. After carrying out the determining control stage, recommendations for improving risk control for high-risk activities were obtained. The recommendations for improvement are:

1. Designing Standard Operating Procedures (SOP) for K3 Control, which contains the flow of K3 control business processes.
2. Checklist Sheet for the Use of PPE, which contains instructions for workers to use PPE and is used as supervision documentation.
3. The Project Area Inspection Checklist Sheet contains things that must be done before the project starts, such as the stages of cleaning the project area, preparing project equipment, and others.
4. Safety Sign Installation Checklist Sheet, contains instructions to install hazard signs during the project to prevent potential hazards that have been identified.
5. The design of the K3 dashboard, in this integrated information system, contains matters related to Occupational Safety and Health (K3) such as the flow of K3 management business processes, hazard identification formats, checklist sheets, incident reporting, and guidelines regarding K3.

Conclusion

To reduce work accidents that occur in road construction projects, this study designs occupational safety and health control by identifying risks through the HIRADC (Hazard

Identification, Risk Assessment, and Determining Control) approach which produces hazard identification and risk assessment so that activities with high potential hazards are known and control is obtained for each activity. In addition to identifying risks, to carrying out K3 control, business process improvements regarding K3 control are designed. Based on the results of business process control and improvement, a Standard Operating Procedure (SOP) for K3 control business processes was also designed, as a checklist sheet regarding project area inspections, the use of PPE, and the installation of safety signs in the K3 control stage. The recommendations for improvement that have been designed are then integrated into a dashboard system so that it is easily accessible to the company and used as a K3 reporting system for the company.

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