

## ABSTRACT

### **Risk Control for Gantry Crane Dismantling at Cilacap Plant, PT Adhi Persada Beton**

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**Abstract.** A gantry crane, also known as a portal crane, is designed to lift heavy objects. Initially, gantry cranes were used in loading and unloading containers from ships. However, currently, the function of the gantry crane is not only limited to shipping activities but has entered the construction sector. One of them is used in precast factories. The gantry crane at the Cilacap Plant serves to transport and move the Accropode. The gantry crane dismantling activity is a high-risk job. It has many health and safety risks that need to be addressed for welfare. This study aims to determine the potential hazards and risks to occupational safety and health in the activity of gantry crane dismantling. This research was observational, with a cross-sectional study design. The results of this research are hazard identification, risk assessment, and risk control on gantry crane dismantling using Hazard Identification, Risk Assessment, Risk Control (HIRARC) and dismantling methods. The conclusion can be drawn is that there are 123 potential hazards identified in gantry crane dismantling activities, including 25.2% extreme risk level, 60.9% high-risk level, and 13.8% medium risk level. The extreme risks of gantry crane dismantling are trouble when the crane is lifting; the sling ties are untied/broken when lifting; workers fall while working at height; and unbalanced conditions. A company has done risks control complying with current government regulation.

**Keywords:** Dismantling, Gantry Crane, Hazard and Risk Control

## INTRODUCTION

The rapid expansion of the construction industry can pose risks. One of the factors that may contribute to the disruption or suspension of project work activities is the probability of accidents occurring in construction projects<sup>93</sup>. Occupational Health & Safety (OHS) risk management is an endeavor to manage OHS risk to prevent unintended incidents in a comprehensive, organized, and structured manner within an adequate system<sup>94</sup>.

A gantry crane, also known as a portal crane, is designed to lift heavy objects. Initially, loading and unloading containers from ships used a gantry crane. However, currently, the function of the gantry crane is not only limited to shipping activities but has entered the construction sector. One of them is used in precast factories<sup>95</sup>. Gantry cranes at the Cilacap Plant, PT Adhi Persada Beton, are used for production in the casting process and loading Accropode products into trailers. Accropode is an unreinforced precast concrete product used in coastal buildings. The Accropode produced by PT Adhi Persada Beton at the Cilacap Plant is used for Coastal Protection for the Jetty Infrastructure of the Karangandri Cilacap Steam Power Plant 1x1000 MW unit. This project used two types of Accropode, namely the 11 Ton and 21 Ton types. Accropod production at the Cilacap Plant was completed in April 2022, so the gantry crane is no longer in use and needs to be dismantled. The gantry crane dismantling activity is a high-risk job. Many fatalities of crane accidents were associated with assembling or dismantling of cranes. It has many health and safety risks that need addressing for the welfare of the employees. It is of utmost priority to ensure that cranes are properly maintained, safely deployed and operated, and lifting activities are well-planned and well-managed to minimise the risks of accidents<sup>96</sup>.

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<sup>93</sup> Syahriadi, R., & Tenriajeng, A. T. Analisis manajemen risiko keselamatan dan kesehatan kerja lingkungan mutu proyek jalan tol dan jembatan pada PT. Utama Karya Infrastruktur di Kota Depok. *Jurnal TESLINK: Teknik Sipil dan Lingkungan*. 2020; 2(2): 18-28.

<sup>94</sup> Ramli, S. *Sistem Manajemen Keselamatan dan Kesehatan Kerja OHSAS 18001*. Jakarta: Dian Rakyat. 2010.

<sup>95</sup> LRT Jabodebek. Portal Gantry Crane [Internet]. 2018 [Cited July 25, 2022]. Available from: <https://lrtjabodebek.adhi.co.id/portal-gantry-crane/>

<sup>96</sup> Yu, Y.H. Forensic Investigation on Crane Accidents. *International Journal of Forensic Engineering*, 2017; 3(4): 319-341.

Examples of potential hazards that might occur during crane operation are collisions between cranes, cranes crashing into facilities, employees underneath being crushed or hit by overhead cranes, falling from a height when checking or repairing, and many possible unexposed hazards<sup>97</sup>. The most common causes of construction accidents in Indonesia are falling over cranes while lifting weights and the collapse of bridge girders during construction<sup>98</sup>.

**Table 1.** Construction Accident Cases in Indonesia

No.	Year	Incident	Victim	Cause
1	Oct 17, 2017	Heavy equipment collapses at the Kelapa Gading LRT Project		During the load-lifting test, the portal gantry crane failed due to shear, which resulted in the collapse of the gantry crane and caused damage to the work area
2	Nov 3, 2017	MRT guardrail fell on Street, South Jakarta	Wijaya Injury: 1	Boom wobbling, operator fails to control, so the crane does not stand steady when lifting OCS.
3	Nov 17, 2017	Crane of the Jakarta-Cikampek II Toll Road Construction Project crashes		Crane loses lift due to mechanical error
4	Feb 4, 2018	The crane of the double-double track project in Jatinegara collapsed	Fatality: 4	Cranes for transporting concrete blocks are not strong enough to withstand the load.
5	2019	The collapse of the launching girder of the Jatinegara railway DDT project	Fatality: 4, Injury: 1	The mounts for the rail bearings do not fit.

Source: Doa et al., 2021

This study aims to identify the potential dangers and risks to occupational safety and health posed by gantry crane dismantling and how to mitigate the risks using HIRARC method in which complying related government regulation. The scope of work for dismantling gantry cranes includes a Double Girder Gantry Crane with a capacity of 40 tons, a span of 22 meters, and a lengthy travel length of 34 meters; a Double Girder Gantry Crane with a capacity of 20 tons, a span of 22 meters, and 84 meters of travel; and a Single Girder Crane with a capacity of 10 tons, a span of 22 meters, and 84 meters of travel.

<sup>97</sup> Anthony, M. B. Analisis Risiko Keselamatan dan Kesehatan Kerja (K3) pada Pengoperasian Overhead Crane Menggunakan Metode SWIFT (Structured What If Technique) di PT. ABC. *Jurnal Media Teknik dan Sistem Industri*, 2020; 4(1): 30-38.

<sup>98</sup> Doa, Y. P., Winanda, L. A. R., & Iskandar, T. Faktor-Faktor Penyebab Kecelakaan Kerja Konstruksi di Indonesia dan Pencegahannya. *Student Journal Gelagar*. 2021; 4(2): 1-9.

## LITERATURE REVIEW

### 1. Hazard Identification, Risk Assessment, Risk Control (HIRARC)

Hazard Identification, Risk Assessment and Risk Control (HIRARC) is a method of identification used to review the hazard of an operation or process in a systematic, thorough and structured to pose significant risks to people, facilities, environment, or systems and explain risk reduction<sup>99</sup>. HIRARC is a compound word comprised of three consecutive activities running one after the other. The activities consist of Hazard Identification, Risk Assessment and Risk Control<sup>100</sup>.

### 2. Hazard identification

The term "hazard identification" refers to determining the undesirable occurrences that can result in the materialization of risk and the mechanisms capable of bringing about those undesirable occurrences<sup>101</sup>. *Hazard identification* is a method used to determine if a specific scenario, material, or thing has the potential to cause harm<sup>102</sup>.

### 3. Risk assessment

The term "risk assessment" refers to a methodical procedure used to describe and quantify the risks connected with potentially hazardous chemicals, processes, actions, or events. A risk assessment technique is any self-contained, systematic operation undertaken as part of a risk assessment, i.e., any procedure that may be used to establish a probability distribution for health or environmental effects<sup>103</sup>.

### 4. Risk Control

Risk control is a method of eliminating or reducing the risk associated with a hazard so that the hazard no longer poses a risk or of minimizing the risk to personnel who must access an area or work on equipment as part of their planned work. Managing risks begins with considering the risks with the highest priority and then moves on to those

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<sup>99</sup> Purnama, Deddi Septian. Analisis Penerapan Metode HIRARC (Hazard Identification Risk Assessment and Risk Control) Dan HAZOPS (Hazard And Operability Study) dalam Kegiatan Identifikasi Potensi Bahaya dan Resiko Pada Proses Unloading Unit di PT. Toyota Astra Motor. *Jurnal PASTI (Penelitian dan Aplikasi Sistem dan Teknik Industri)*. 2016 Apr; 9(3).

<sup>100</sup> Engineering Universitas Teknologi Malaysia. HIRARC (Hazard Identification Risk Assessment and Risk Control). [Internet]. 2013 [Cited: August 25, 2022]. Available at: <https://engineering.utm.my/>

<sup>101</sup> Rout BK, Sikdar BK. Hazard Identification, Risk Assessment, and Control Measures as an Effective Tool of Occupational Health Assessment of Hazardous Process in an Iron Ore Pelletizing Industry. *Indian J Occup Environ Med*. 2017 May-Aug; 21(2):56-76

<sup>102</sup> Canadian Centre for Occupational Health & Safety. Hazard Identification [Internet]. 2018 [Cited: July 26, 2022]. Available at: [https://www.ccohs.ca/oshanswers/hsprograms/hazard\\_identification.html](https://www.ccohs.ca/oshanswers/hsprograms/hazard_identification.html)

<sup>103</sup> Canadian Centre for Occupational Health & Safety. Risk Assessment [Internet]. 2017 [Cited: July 26, 2022]. Available at: [https://www.ccohs.ca/oshanswers/hsprograms/risk\\_assessment.html](https://www.ccohs.ca/oshanswers/hsprograms/risk_assessment.html)

with the most negligible impact. The "hierarchy of controls" should be considered when analyzing each risk<sup>104</sup>.

a. Elimination

Redesign the task or find an alternative to the material to remove or do away with the hazard.

b. Substitution

Replace the dangerous material or procedure with a safer alternative.

c. Engineering Controls

Use safety equipment or other precautions to prevent falls when working at height is unavoidable.

d. Administrative controls

Administrative controls are determining and carrying out the processes to work safety.

e. Personal protective clothing and equipment

Personal protective equipment (PPE) should only be utilized after all other measures have been attempted and proven ineffective at reducing risks to an acceptable level.<sup>105</sup>.

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<sup>104</sup> Department of Occupational Safety and Health (DOSH) Ministry of Human Resources (MOHR) Malaysia. Guidelines On Occupational Safety and Health (Osh) Risk Management for Small and Medium Enterprises in ASEAN Member States. 2020.

<sup>105</sup> Health Safety Executive. Management of risk when planning work: The right priorities [Internet]. Leadership and worker involvement toolkit. [Cited: July 26, 2022]. Available at: <https://www.hse.gov.uk/construction/lwit/assets/downloads/hierarchy-risk-controls.pdf>

## METHOD, DATA, AND ANALYSIS

This study used a descriptive observational approach and a cross-sectional methodology. The researcher carries out this study from May to June of 2022. The researcher gathers data from observation, in-depth interviews are primary data for identifying hazards. Once hazards have been identified, the following phase will be to perform risk assessments, an evaluation for risk control, and then an assessment for residual risk. The collected data will be descriptively examined, and the results will be given in the form of hazard identification, risk assessment, and risk control on the dismantling of gantry cranes utilizing Hazard Identification, Risk Assessment and Risk Control (HIRARC), JSA (Job Safety Analysis) and dismantling method.

## RESULT AND DISCUSSION

### 1. Project Overview

Factory Name	:	Cilacap Plant, PT Adhi Persada Beton
The Project Name	:	Coastal Protection for the Jetty Infrastructure of the Karangandri Cilacap Steam Power Plant 1x1000 MW unit
Project duration	:	2 years (2021-2022)
Location	:	Winong, Slarang, Kesugihan District, Cilacap Regency, Central Java
Product	:	Accropode 11 T : 5.484 Accropode 21 T : 3.582
Production time	:	March 2021 to April 2022

2.



**Fig. 1.** Cilacap Plant, PT Adhi Persada Beton  
(Sources: PT Adhi Persada Beton's Documentation)



**Fig. 2.** Accropode  
(Sources: PT Adhi Persada Beton's Documentation)

## 2. Gantry Crane Dismantling Overview

The Project Name	:	Dismantling of gantry cranes at Cilacap Plant, PT Adhi Persada Beton
Dismantling Subcont	:	PT MHE-Demag Indonesia
Project Duration	:	13 days
Work Time	:	8 to 20 May 2022
Scope of Work	:	Dismantling of 3 gantry cranes, including: <ol style="list-style-type: none"><li>1. Double Girder Gantry Crane with a capacity of 40 tons</li><li>2. Double Girder Gantry Crane with a capacity of 20 tons</li><li>3. Single Girder Crane with a capacity of 10 tons</li></ol>
Gantry Crane Specifications	:	1. Double Girder Gantry Crane with a capacity of 40 tons

Gantry Capacity : 40T  
Girder Weight : 11.000 Kg (Per Side)  
Fix Leg : 7.300 Kg  
Flexible Legs : 5.200 Kg  
Crab Hoist : 1.800 Kg  
Other Components : 1.000 Kg

2. Double Girder Gantry Crane with a capacity of 20 tons

Gantry Capacity : 20T  
Girder Weight : 8.000 Kg (Per Side)  
Fix Leg : 5.600 Kg  
Flexible Legs : 3.800 Kg  
Crab Hoist : 1.200 Kg  
Other Components : 1.000 Kg

3. Single Girder Crane with a capacity of 10 tons

Gantry Capacity : 10T  
Girder Weight : 7.600 Kg  
Fix Leg : 4.000 Kg  
Flexible Legs : 2.500 Kg  
Crab Hoist : 600 Kg  
Other Components : 600 Kg

Tools/Equipments : 1. Telescopic Mobile Crane 80T qty 1 unit  
2. Shackle 10T qty 4 EA  
3. Webbing Sling 10 T with a length of 6 M qty 4 EA  
4. Sling cap 10T qty 2 EA  
5. Sling cap 5T qty 2 EA

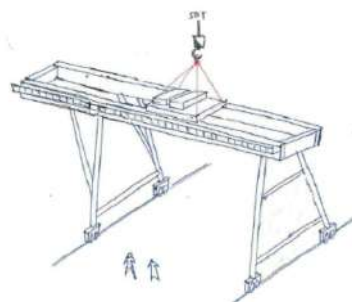


### 3. Dismantling Methods

The following is a procedure for dismantling a gantry crane at the Cilacap Plant:

**Table 2.** Dismantling Methods

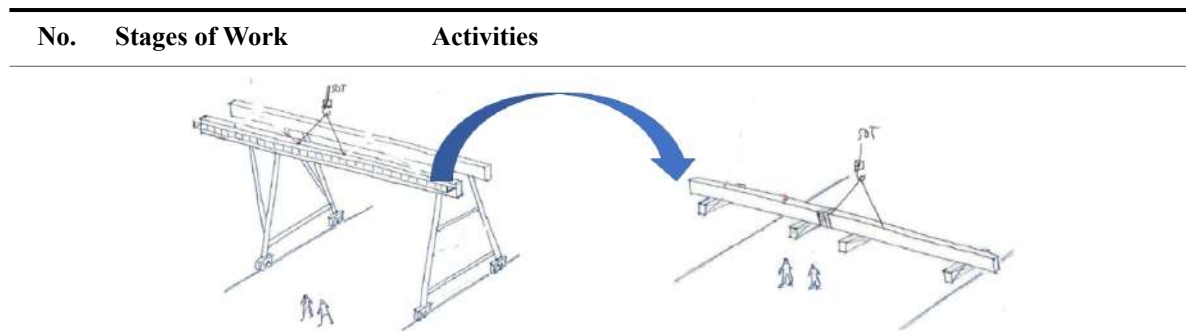
No.	Stages of Work	Activities
1.	Preparation	<ol style="list-style-type: none"> <li>1. Safety induction</li> <li>2. Work permit application</li> <li>3. Toolbox meeting</li> <li>4. Mobilization of equipment and supplies</li> </ol>
2.	Unpacking wires and equipment	<ol style="list-style-type: none"> <li>1. Disassembling mechanical components in each wheel bogie, such as the wheel drive (motor and gearbox).</li> <li>2. Disassemble all panels</li> <li>3. Deconstruction of Platform walkway and other non-lifting components, as well as girder/leg structures</li> <li>4. Dismantling of the festoon system</li> <li>5. The materials are stored in temporary shelters and kept secure.</li> </ol>
3.	Crab Hoist Disassembling	<ol style="list-style-type: none"> <li>1. The two mobile cranes have been checked to verify they are ready for use in the field, and a checklist has been completed.</li> <li>2. Using selling or webbing slings to raise the lifting point and assure safety and balance</li> <li>3. Raise the crab using a mobile crane with a capacity of 50 tons and place it in a secure location.</li> </ol>



**Fig. 3.** Crab Hoist Disassembling

(Sources: PT MHE Demag’s Documentation)

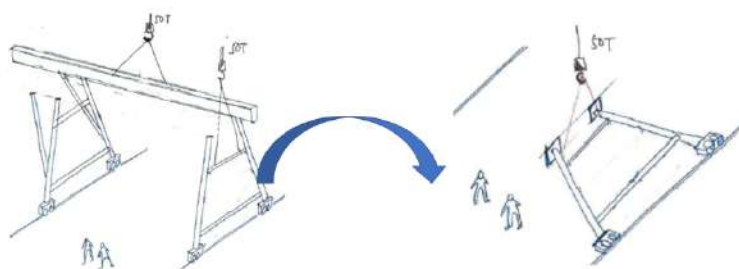
4.	Disassembly of the Girder using the walkway and the tie bar (One side)	<ol style="list-style-type: none"> <li>1. Ensure that two 50-ton-capacity cranes are available on the job site and a checklist has been completed.</li> <li>2. Dismantling with a crane capable of lifting 50 tons and aided with lifting aids such as Shackles, Webbing Slings, Slings, and Lifting Clamps as needed.</li> <li>3. Remove all welds from the Girder Leg bolts and disassemble the Girder Leg bolts.</li> <li>4. Safely lift and install the Girder in a secure area.</li> </ol>
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**Fig. 4.** Girder disassembling

(Sources: PT MHE Demag’s Documentation)

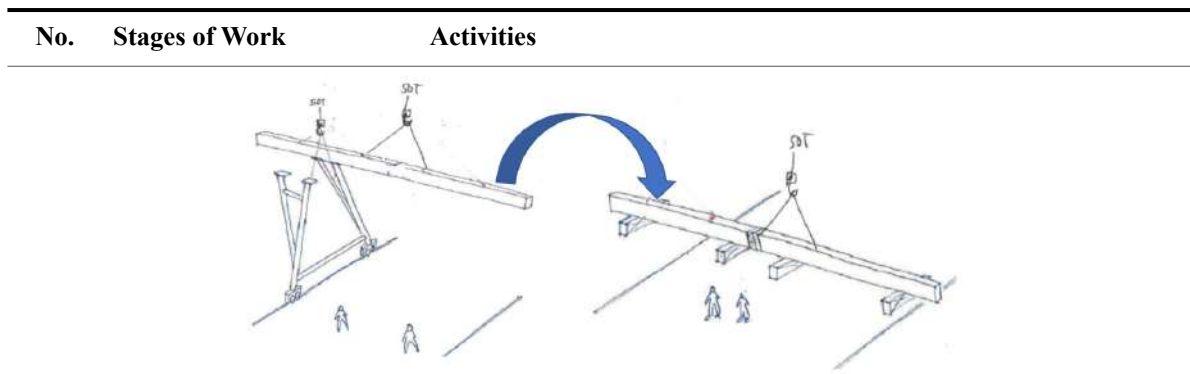
- |    |                           |     |  |
|----|---------------------------|-----|--|
| 5. | Flexible<br>Disassembling | Leg | <ol style="list-style-type: none"> <li>1. Ensure that two 50-ton-capacity cranes are available on the job site and a checklist has been completed.</li> <li>2. Installing shackles for lifting points and assuring their safety and balance.</li> <li>3. One mobile crane supports the Girder, while the other supports the Legs (flexible legs)</li> <li>4. Detach the joint girder bolts from the leg and verify that all welds (if any) have been removed.</li> <li>5. Establishing temporary connectors between the remaining girders</li> <li>6. Lightly raise the Girder to detach the flexible leg from the Girder.</li> <li>7. Place the Flexible Leg in secure location using a mobile crane</li> </ol> |
|----|---------------------------|-----|--|



**Fig. 5.** Flexible Leg Disassembling

(Sources: PT MHE Demag’s Documentation)

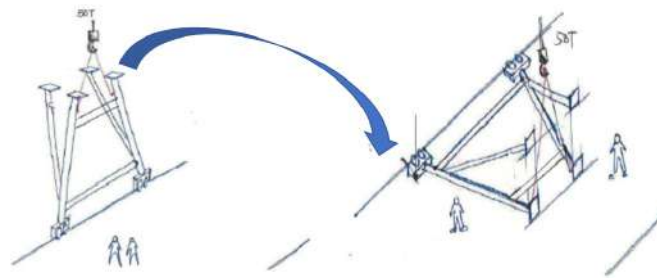
- |    |                        |  |
|----|------------------------|--|
| 6. | Girder B disassembling | <ol style="list-style-type: none"> <li>1. One 50-ton mobile crane still holds the Girder in position.</li> <li>2. After releasing the Flexible Leg, one crane began disassembling the Fix Leg.</li> <li>3. Make sure that the lifting point is in the correct location.</li> <li>4. Raise girder B with a 50-ton mobile crane and position it in a secure area.</li> </ol> |
|----|------------------------|--|



**Fig. 6.** Girder B Disassembling

(Sources: PT MHE Demag's Documentation)

- |    |                       |   |
|----|-----------------------|---|
| 7. | Fix Leg Disassembling | <ol style="list-style-type: none"> <li>1. The Mobile Crane keeps the Fix Leg in a position for the descent.</li> <li>2. Place the Fix Leg in a safe place.</li> <li>3. Removing the Cross-of-Leg beam makes it much easier to transport and place.</li> <li>4. ...</li> </ol> |
|----|-----------------------|---|



**Fig. 7.** Fix Leg Disassembling

(Sources: PT MHE Demag's Documentation)

- |    |                            |   |
|----|----------------------------|---|
| 8. | Packing and transportation | <ol style="list-style-type: none"> <li>1. Packing with wooden pallets for specific components and plastic covering for the hoist.</li> <li>2. Packing plastic around gantry legs and girders</li> <li>3. Pack the stairway and walkway platform in wooden pallets and plastic covers.</li> <li>4. Mark each component and each packaging with identifying information.</li> <li>5. Transferring parts and structures to trucks using forklifts or mobile cranes.</li> </ol> |
|----|----------------------------|---|

#### 4. Hazard Identification, Risk Assessment, And Risk Control

The researcher identified potential hazards and analyzed all of the identified hazards in the workplace using Hazard Identification, Risk Assessment and Risk Control (HIRARC). After identifying the hazards, the next step is conducting a risk assessment and assessing risk control on the gantry crane dismantling. A risk assessment is carried

out on each potential hazard and environmental impact by considering the likelihood and consequence factors.

Likelihood Factor or Frequency (F) / Likelihood (L) is the level of frequency of environmental hazards or impacts that will occur or how often accidents/environmental impacts may occur at PT Adhi Persada Beton.

**Table 3.** Likelihood from PT Adhi Persada Beton’s Procedure

Value	Frequency	Description
1	almost certain	<ul style="list-style-type: none"> <li>- It can occur in most circumstances, for example, once per shift/day.</li> <li>- Likely to happen more than two times a year</li> </ul>
2	probable	<ul style="list-style-type: none"> <li>- Accidents are likely to occur while performing work in almost all conditions.</li> <li>- It probably happened once in the last year</li> </ul>
3	possible	<ul style="list-style-type: none"> <li>- There may be accidents while doing work under certain conditions</li> <li>- It likely happened two times in the last three years</li> </ul>
4	unlikely	<ul style="list-style-type: none"> <li>- There is a slight chance of an accident while working in certain conditions.</li> <li>- It likely happened once in the last three years</li> </ul>
5	almost impossible/ rare	<ul style="list-style-type: none"> <li>- It may only occur in exceptional circumstances.</li> <li>- Never heard of it happening over the last 3 years</li> </ul>

Consequences (C) / Severity (S) factors determine the severity value of a potential hazard or environmental impact.

**Table 4.** The consequence from PT Adhi Persada Beton's Procedure

	Health Impact	Safety Impact	Environmental Impact	Impact of Property
1 (Disaster)	Long-term chronic health effects for workers or communities with the potential for death.	F a t a l i t y , permanent disability & total paralysis.	Large scale & long-term environmental impacts that affect the community. There may be prosecutions for violations of the law.	Losses incurred more than 1 billion and or resulting in work stopping for more than one week

2 (Large)	Long-term chronic health effects for workers or society significantly impact function/lifestyle.	Partial body defects.	Large-scale & short-term environmental impacts may be subject to sanctions due to regulatory violations.	Losses between 500 million to 1 billion and or resulting in work stop for one week.
3 (Medium)	Chronic health effects cause a partial impact on the body functions of workers.	Requires treatment time for > 2 days without any defects caused.	Small-scale & short-term environmental impacts on the factory location can be reported to the relevant agency.	Losses between 100 million to 500 million and or result in work stopping for 2-6 days.
4 (Low)	The health impact is not immediately felt, requires action medical/treatment	Treatment of injuries, requires treatment for 1-2 days.	Minor environmental impact only in certain areas within company, violation of internal	Losses between 10 million to 100 million and or resulting in work stops for 1 day.
5 (Negligible)	The health effects are short term.	Just need to get first aid or near miss events.	The environmental impact is negligible.	Losses below 10 million and do not cause work to stop.

The risk matrix is calculated using the formula frequency (F) x severity (S).

**Table 5.** The Severity from PT Adhi Persada Beton’s Procedure

		Severity				
		1	2	3	4	5
5		7	13	18	23	25
		Low	Medium	High	Extreme	Extreme

		Severity				
		1	2	3	4	5
Likelihood	4	4	10	17	22	24
		Low	Medium	High	Extreme	Extreme
	3	3	9	12	16	21
		Low	Medium	Medium	High	High
	2	2	6	11	15	20
		Low	Low	Medium	Medium	High
	1	1	5	8	14	19
		Low	Low	Low	Medium	High

**Table 6.** Risk Ranking from PT Adhi Persada Beton’s Procedure

Risk Ranking	Risk Score	Status	Remarks
Extreme	22-25	Not Acceptable	Stop the activity and immediately take control. Top management ensures that repairs have been made before activities start.
High	16-21	Not Acceptable	Take corrective or preventive action immediately. Top management reviews corrective action activities.
Medium	9-15	ALARP	Take corrective and preventive actions within a certain period. The Head of Section reviews controls measures through improvement plans.
Low	1-8	Acceptable	Reviewing and controlling the effectiveness of controls in each section.

The evaluation of risk will indicate whether or not the risks are being accepted and will seek to lower the amount of risk. Following this, risk control is one essential stage that needs to be implemented. After this, risk control is one of the most important stages to be implemented because at this stage, the company must be able to choose what kind of risk control is the most effective and per the level of risk.

**Table 7.** Hazard Identification, Risk Assessment, and Risk Control (HIRARC)

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
<b>Heavy Equipment (Crane) Mobilization &amp; Demolition</b>												
	a. Equipment is not decent ( <i>trouble system</i> )	3	5	21	H	Not Acceptable	Conduct a survey for readinees equipment to be used	2	1	2	L	Acceptable
	b. Late arrival of equipment because traffic	4	3	17	H	Not Acceptable	Conduct a traffic survey on the route traversed and permit the mobilization lane, and escort (if needed)	2	1	2	L	Acceptable
	c. Traffic accidents while mobilizing	3	4	16	H	Not Acceptable	TBM before doing work, checking alcohol test on all personnel, socializing safety riding to personnel	2	1	2	L	Acceptable
	d. Miscommunication between personnel	4	3	17	H	Not Acceptable	Good communication between signalman and crane operator, operator competency training and certification	2	1	2	L	Acceptable
	e. Personnel's health condition is not fit (such as fatigue, health problems, and lack of focus)	4	3	17	H	Not Acceptable	Personnel health checks, TBM before doing work, alcohol test and blood pressure check on all personnel, socialization of delivery schedules and safety riding to personnel, additional work nutrition	2	1	2	L	Acceptable
	f. Extreme weather	3	4	16	H	Not Acceptable	Monitoring weather information before departure, preparing signs and equipment during emergency conditions, knowing emergency call	2	1	2	L	Acceptable
<b>Preparation on site project</b>												
Safety Induction	a. Unhealthy workers	4	3	17	H	Not Acceptable	Attach a health certificate from a doctor, initial medical examination of workers, informing workers' qualifications before being brought in	2	1	2	L	Acceptable
	b. Workers are not willing to comply work safety regulations	4	3	17	H	Not Acceptable	Bring in workers who match the company's qualifications, educating workers' commitment to the company's K3L culture before working on the site	2	1	2	L	Acceptable
	c. Workers not qualified	4	3	17	H	Not Acceptable	Bring in workers who meet the company's qualifications, workers have the appropriate skills and a valid license	2	1	2	L	Acceptable
Submitting a work permit before starting work	a. Unhealthy workers	4	3	17	H	Not Acceptable	Health check before work (simple screening), appropriate shift change	2	1	2	L	Acceptable
	b. Personnel related to work are incomplete/inappropriate	4	3	17	H	Not Acceptable	Ensuring personnel are present complete and on time, replacement manpower management in case of an emergency	2	1	2	L	Acceptable
	c. There is no person in charge of work activities	3	4	16	H	Not Acceptable	Ensure that the permit is submitted by the person in charge of the work	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	d. Work permit is not appropriate / incomplete (lack of completeness of PPE, safety devices, etc.)	3	4	16	H	Not Acceptable	Ensure the completeness in the work permit checklist	2	1	2	L	Acceptable
Tool box meeting	a. Unhealthy workers	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints of workers, providing referral clinics/hospitals in cooperation when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	b. The suitability of work with TBM material is out of sync	3	3	12	M	ALARP	Making TBM materials according to the work schedule, TBM speakers must be in accordance with skills, coordination and good work communication	2	1	2	L	Acceptable
	c. Attendance of TBM participants is incomplete	3	3	12	M	ALARP	Giving punishment to workers who do not follow the TBM	2	1	2	L	Acceptable
	d. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered Routine	2	1	2	L	Acceptable
Preparation of Tools and Materials	a. Workers hit by tools	3	3	12	M	ALARP	Mobilization of materials/tools using assistive devices, ergonomic handling positions, arrangement of materials/tools according to the 5R principle, cleaning area (from materials/tools that are not needed at that time) before starting work, installation of safety signs in the work area, use of complete PPE	2	1	2	L	Acceptable
	b. Stumbled by tools/materials	3	3	12	M	ALARP	Mobilization of materials/tools using assistive devices, ergonomic handling positions, arrangement of materials/tools according to the 5R principle, cleaning area (from materials/tools that are not needed at that time) before starting work, installation of safety signs in the work area, use of complete PPE	2	1	2	L	Acceptable
	c. Scratched by tools/materials	3	3	12	M	ALARP	Mobilization of materials/tools using assistive devices, ergonomic handling positions, arrangement of materials/tools according to the 5R principle, cleaning area (from materials/tools that are not needed at that time) before starting work, installation of safety signs in the work area, use of complete PPE	2	1	2	L	Acceptable



ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	d. Tools / materials do not meet specifications	3	5	21	H	Not Acceptable	Inform the specifications in the contract agreement before starting work, inspection and commissioning of tools/material surveys before being brought to the site, Routine inspection/checklist of equipment and materials readiness	2	1	2	L	Acceptable
	e. Breakage tools/materials	3	5	21	H	Not Acceptable	Inform the specifications in the contract agreement before starting work, inspection and commissioning of tools/material surveys before being brought to the site, Routine inspection/checklist of equipment and material readiness, good and correct handling methods	2	1	2	L	Acceptable
<b>Scaffolding Installation</b>												
	a. Scaffolder does not have the competence and license	4	3	17	H	Not Acceptable	Ensuring the scaffolder has competence and a valid license	2	1	2	L	Acceptable
	b. Breakage of scaffolding materials	3	5	21	H	Not Acceptable	Ensure the scaffolding material is in good condition and suitable for installation	2	1	2	L	Acceptable
	c. The installed scaffolding is not suitable / not suitable for use	3	5	21	H	Not Acceptable	Ensure the scaffolding is suitable for use and has been inspected by the scaffolding supervisor (green tagging)	2	1	2	L	Acceptable
	d. Workers hit by scaffolding material	3	3	12	M	ALARP	Ensure that the material is neatly arranged before being installed (according to the type), giving red tags if the scaffolding is not safe to use, using appropriate and complete PPE	2	1	2	L	Acceptable
	e. Workers stumbled by scaffolding material	3	4	16	H	Not Acceptable	Ensure that the material is neatly arranged before being installed (according to the type), giving red tags if the scaffolding is not safe to use, using appropriate and complete PPE	2	1	2	L	Acceptable
	f. Falling from a height while installing scaffolding	3	5	21	H	Not Acceptable	Scaffolding installation by competent, licensed and in fit condition personnel, tagline installation and use of safety body harness when working at height	2	1	2	L	Acceptable
<b>Dismantling of Electrical Portal Gantry</b>												
Dismantling of Panels and Festoon System	a. Workers hit by tools	3	3	12	M	ALARP	Ensure dismantling is carried out by skilled workers, use of appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning areas during dismantling	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	b. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	c. Tool damage during the disassembling process	3	5	21	H	Not Acceptable	Ensure dismantling is carried out by workers who have the skills, safe and appropriate methods of handling equipment disassembly, good communication between personnel.	2	1	2	L	Acceptable
	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered Routinely, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing clinic/hospital referrals, cooperation pains when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
Generator Disassembling	a. Workers hit by tools	3	3	12	M	ALARP	Ensure dismantling is carried out by skilled workers, use of appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning areas during dismantling	2	1	2	L	Acceptable
	b. Tool damage during the disassembly process	3	5	21	H	Not Acceptable	Ensure dismantling is carried out by workers who have the skills, safe and appropriate methods of handling equipment disassembly, good communication between personnel.	2	1	2	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	d. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered Routinely, stop work when the weather is not good	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	d. Workers scratched by tools (auxiliary rope when dismantling)	3	3	12	M	ALARP	Ensure tools are in proper condition, workers wear gloves	2			L	
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered Routinely, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing clinic/hospital referrals, cooperation pains when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. The rope is cut off during manual handling	3	3	12	M	ALARP	Ensure tools are in proper condition, workers wear gloves	2	1	2	L	Acceptable
<b>Hoist Disassembling</b>												
	a. Worker hit by hoist/material	3	4	16	H	Not Acceptable	Ensure dismantling is carried out by skilled workers, use of appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning areas during dismantling	2	1	2	L	Acceptable
	b. Tool damage during the disassembly process	3	5	21	H	Not Acceptable	Ensure dismantling is carried out by workers who have the skills, safe and appropriate methods of handling equipment disassembling, good communication between personnel.	2	1	2	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	d. Workers fall while working at height	4	5	24	H	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered Routinely, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing clinic/hospital referrals, cooperation pains when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	c. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing clinic/hospital referrals, cooperation pains when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
Disassembly of power, long travel, and cross cables	a. Workers hit by tools	3	3	12	M	ALARP	Ensure dismantling is carried out by skilled workers, use of appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning areas during dismantling	2	1	2	L	Acceptable
	b. Tool damage during the disassembling process	3	5	21	H	Not Acceptable	Ensure dismantling is carried out by workers who have the skills, safe and appropriate methods of handling equipment disassembly, good communication between personnel.	2	1	2	L	Acceptable
	c. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling	2	1	2	L	Acceptable
	d. The rope is cut off during manual handling	3	3	12	M	ALARP	Ensure tools are in proper condition, workers wear gloves	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered Routinely, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing clinic/hospital referrals, cooperation pains when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
Conductor pole disassembling	a. Workers hit by piles	3	3	12	M	ALARP	Ensure dismantling is carried out by skilled workers, use of appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning areas during dismantling	2	1	2	L	Acceptable
	b. Tool damage during the disassembling process	3	5	21	H	Not Acceptable	Ensure dismantling is carried out by workers who have the skills, safe and appropriate methods of handling equipment disassembling, good communication between personnel.	2	1	2	L	Acceptable
	c. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
<b>Dismantling of Portal Gantry</b>												
Installation of safety devices lifting (shackle, webbing sling, sling)	a. Workers wedged in safety devices during installation	3	4	16	H	Not Acceptable	Installation of safety device must be carried out by competent workers, wearing appropriate PPE	2	1	2	L	Acceptable
	b. Workers hit by safety devices during installation	3	3	12	M	ALARP	Installation of safety device must be carried out by competent workers, wearing appropriate PPE	2	1	2	L	Acceptable
	c. The security device was discovered to be inappropriate and unsuitable	3	4	16	H	Not Acceptable	Inspection of safety devices before use, procurement of safety devices according to capacity	2	1	2	L	Acceptable
Rigging girder	a. Workers hit by girder	3	5	21	H	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	b. Ties untied during lifting	4	5	24	E	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	2	6	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing clinic/hospital referrals, cooperation pains when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Girder damage during the lifting process	3	4	16	H	Not Acceptable	Work is carried out with appropriate work methods by skilled workers	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	h. Exposed to fire sparks during the welding process	3	4	16	H	Not Acceptable	Work is carried out with appropriate work methods for skilled workers, workers are equipped with additional PPE, face shields and gloves	2	1	2	L	Acceptable
	i. Potential fire hazard	3	4	16	H	Not Acceptable	Work is carried out with appropriate work methods for skilled workers, workers are equipped with additional PPE, face shields and gloves, provide fire extinguishers in the work area	2	1	2	L	Acceptable
<b>Loading Materials to Transport Fleet</b>												
	a. Workers hit by tools	3	3	12	M	ALARP	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	b. Ties untied during lifting, materials fall	4	5	24	E	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	2	6	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	d. Workers fall during the process of loading, arranging, and binding materials	4	5	24	E	Not Acceptable	Ensuring loading is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing referral in collaboration clinics/hospitals when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Girder damage during loading to the fleet	3	4	16	H	Not Acceptable	Work is carried out with work methods that are suitable for skilled workers	2	1	2	L	Acceptable
	h. Delivery fleet damage	3	5	21	H	Not Acceptable	Inspecting the delivery fleet before the loading process is carried out, carried out by drivers and delivery crews who have complete skills and permits	2	1	2	L	Acceptable
<b>Material mobilization</b>												

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing referral in collaboration clinics/hospitals when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Girder damage during the lifting process	3	4	16	H	Not Acceptable	Work is carried out with work methods that are suitable for skilled workers	2	1	2	L	Acceptable
	h. Unbalance Condition	4	5	24	E	Not Acceptable	Modeling a supporting gantry with an H beam for stable condition before dismantling, checking the ground for its capacity and stability	2	1	2	L	Acceptable
Dismantling of gantry leg support	a. Workers hit by materials/tools	3	3	12	M	ALARP	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	b. The sling unties or breaks when lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, carry out inspection, rigging is carried out by experienced riggers, ensuring the girders are properly tied, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing referral in collaboration clinics/hospitals when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Materials damage	3	4	16	H	Not Acceptable	Work is carried out with work methods that are suitable for skilled workers	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
Dismantling of girder B	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing referral in collaboration clinics/hospitals when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Gantry leg damage	3	4	16	H	Not Acceptable	Work is carried out with work methods that are suitable for skilled workers	2	1	2	L	Acceptable
	h. Unbalance Condition	4	5	24	E	Not Acceptable	Modeling a supporting gantry with an H beam for stable condition before dismantling, checking the ground for its capacity and stability	2	2	6	L	Acceptable
	a. Workers hit by girder	3	5	21	H	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	b. The sling unties or breaks when lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, carry out inspection, rigging is carried out by experienced riggers, ensuring the girders are properly tied, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
Dismantling of gantry leg (left and right side)							licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE					
	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing referral in collaboration clinics/hospitals when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Girder damage during the dismantle process	3	4	16	H	Not Acceptable	Work is carried out with work methods that are suitable for skilled workers	2	1	2	L	Acceptable
	h. Unbalance Condition	4	5	24	E	Not Acceptable	Modeling a supporting gantry with an H beam for stable condition before dismantling, checking the ground for its capacity and stability	2	2	6	L	Acceptable
	a. Workers hit by gantry leg	3	5	21	H	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	b. The sling unties or breaks when lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, carry out inspection, rigging is carried out by experienced riggers, ensuring the girders are properly tied, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	2	6	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
Dismantling of girder leg joint bolts A	a. Workers hit by tools	3	3	12	M	ALARP	Rigging is carried out by experienced riggers, ensuring the girders are attached to the	2	1	2	L	Acceptable
	b. Ties untied during lifting	4	5	24	E	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are attached to the	2	1	2	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment licenses, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	1	2	L	Acceptable
	d. Workers fall while working at height	4	5	24	E	Not Acceptable	Ensuring dismantling is carried out by skilled workers, providing safe access, using appropriate PPE (helmets, safety body harnesses), good work communication between personnel, cleaning the area during dismantling, checking workers' blood pressure	2	1	2	L	Acceptable
	e. Extreme weather	3	4	16	H	Not Acceptable	Daily weather monitoring, daily work info delivered regularly, stop work when the weather is not good	2	1	2	L	Acceptable
	f. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Screening workers' initial health checks before starting work, ensuring that there are no health complaints from workers, providing referral in collaboration clinics/hospitals when workers' health problems occur, providing additional work nutrition	2	1	2	L	Acceptable
	g. Unbalance Condition	4	5	24	E	Not Acceptable	Modeling a supporting gantry with an H beam for stable condition before dismantling, checking the ground for its capacity and stability	2	2	6	L	Acceptable
Girder dismantling with mobile crane	a. Workers hit by girder	3	5	21	H	Not Acceptable	Rigging is carried out by experienced riggers, ensuring the girders are properly tied	2	1	2	L	Acceptable
	b. The sling unties or breaks when lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, carry out inspection, rigging is carried out by experienced riggers, ensuring the girders are properly tied, conduct toolbox meeting, appoint one person as an area supervisor, use PPE	2	1	2	L	Acceptable
	c. Trouble occurs when the crane is lifting	4	5	24	E	Not Acceptable	Installing barricades/safety lines, ensure that no one is under when lifting, kept the crane at a safe distance, inspect to ensure that mobile cranes and safety devices are in proper condition, checking operator licenses and equipment	2	1	2	L	Acceptable

ACTIVITY	HAZARD IDENTIFICATION	RISK ASSESSMENT				STATUS	CONTROL	RISK ASSESSMENT				STATUS
		LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL			LIKELIHOOD	CONSEQUENCE	RISK SCORE	RISK LEVEL	
	a. Fleet condition is not feasible / there is trouble	3	5	21	H	Not Acceptable	Conduct a survey of the readiness of the tool to be used, inspection of equipment before work, provision of a maintenance team, test check of tools before use	2	1	2	L	Acceptable
	b. Delay in arrival of equipment due to traffic congestion	4	3	17	H	Not Acceptable	Conducting a traffic route survey and mobilization lanes permit, and escorts (if needed)	2	1	2	L	Acceptable
	c. Traffic accidents while mobilizing	3	5	21	H	Not Acceptable	TBM before doing work, alcohol test checks on all personnel, socialization of safety riding to personnel	2	1	2	L	Acceptable
	d. Miscommunication between personnel	4	3	17	H	Not Acceptable	Good communication between signalman and crane operator, operator competency training and certification	2	1	2	L	Acceptable
	e. Personnel's health condition is not fit (such as work fatigue, health problems, lack of focus)	4	3	17	H	Not Acceptable	Personnel health check, TBM before doing work, alcohol test, blood pressure check for all personnel, socialization of delivery schedule and safety riding to personnel, additional work nutrition	2	1	2	L	Acceptable
	f. Extreme weather	3	4	16	H	Not Acceptable	Monitoring weather information before departure, preparing signs and equipment during emergency conditions, knowing emergency numbers	2	1	2	L	Acceptable
	g. Girder damage during the delivery process	3	4	16	H	Not Acceptable	Work is carried out with appropriate work methods by skilled workers	2	1	2	L	Acceptable

According to hazard identification and risk assessment utilizing Hazard Identification, Risk Assessment and Risk Control (HIRARC) there are 123 potential hazards identified in gantry crane dismantling activities.

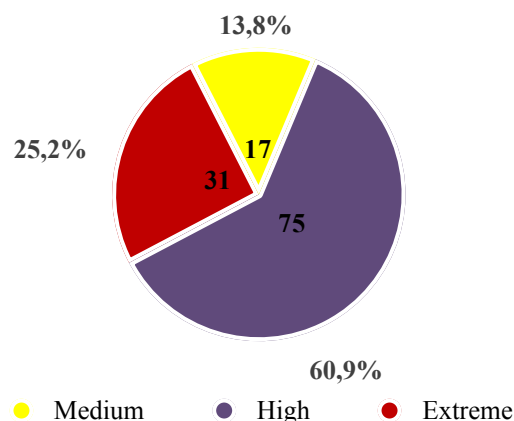


Fig. 8. Risk Percentage

There are 31 (25.2%) extreme risk levels, 75 (60.9%) high-risk level, and 17 (13.8%) medium risk levels. Extreme risks in gantry crane dismantling activities are workers falling while working at height, trouble when the crane is lifting, the sling unties or breaks when lifting, and unbalance conditions. Working at height is still one of the most dangerous activities that can lead to severe injuries or even death. "Work at height" refers to labor performed in any location where, if there were no safety measures, a person could fall a distance that could cause them to sustain personal injuries<sup>106</sup>.

*Peraturan Menteri Tenaga Kerja dan Transmigrasi No. 9 Tahun 2016*, clause 2 Concerning Occupational Safety and Health in Work at Height, the Company must implement OSH in Working at Heights. Concerning Occupational Safety and Health in Work at Height, companies must plan, prepare procedures and safe working techniques, provide special protective equipment, and provide a competent workforce to work at height<sup>107</sup>.

Some of the causes of workers falling from a height are:

a. Personal Protective Equipment (PPE)

Workers either lack the expertise to use personal protective equipment (PPE) properly or do not use equipment that is appropriate for the task at hand.

b. Fit for Duty

Workers who are unfit for duty due to alcohol or drug use/abuse while on the job or outside of work hours, physical or mental exhaustion, or job-related or personal stress

c. Worker is non-Compliant

<sup>106</sup> International Labour Organization (ILO). Working at height [Internet]. [Cited: July 26, 2022]. Available at: <https://www.ilo.org/global/topics/labour-administration-inspection/resources-library/publications/guide-for-labour-inspectors/working-at-height/lang--en/index.htm>

<sup>107</sup> Menteri Tenaga Kerja dan Transmigrasi. Peraturan Menteri Tenaga Kerja dan Transmigrasi No. 9 Tahun 2016 Keselamatan dan Kesehatan Kerja dalam Pekerjaan pada Ketinggian. Peraturan Menteri, 2016.



Workers do not implement safe work practices for various reasons, such as supervisors' lack of discipline or the proper tools to execute the job correctly.

d. Piecework

Due to demands and competing goals, employees believe they save time and increase productivity by taking shortcuts.

e. Attitude

Due to various factors, such as a temporary workforce, amount of care, and disagreements amongst trades, workers have an "it will not happen to me" mentality and are unconcerned with safe work standards<sup>108</sup>.

Controls that are carried out to prevent workers from falling from a height are:

a. Engineering Control/Isolation:

- 1) Use Guardrails, Protective Covers, and Warning Barriers to prevent a fall from unprotected edges or openings.
- 2) Provide safe access

b. Administrative controls:

- 1) Make a work permit for work at height;
- 2) Conducting toolbox meetings;
- 3) Select competent workers and provide training on procedures for working at heights;
- 4) Conduct Toolbox Meeting;
- 5) Appoint one person as an area supervisor

c. Personal Protective Equipment (PPE): wear a safety belt and full body harness.

**Table 8.** Legal Compliance Analysis

Regulation	Subject	HIRARC	GAP	Recommen-dation
Permenaker No. 9/2016, clause 5	It is a must for company to provide working tools or safety to minimize falling distance or to reduce a risk of worker to fall <sup>15</sup>	Use Guardrails, Protective Covers, and Warning Barriers	Company has emergency plan, however it is not stated on HIRARC control	Put the emergency plan, and it is stated on HIRARC control
Permenaker No. 9/2016, clause 5	To ensure that the works could be done on a safe way and ergonomics through provided enter access path and out access <sup>14</sup>	Provide safe access	Permenaker No. 9/2016, clause 5 It is a must for company	

<sup>15</sup> Menteri Tenaga Kerja dan Transmigrasi. Peraturan Menteri Tenaga Kerja dan Transmigrasi No. 9 Tahun 2016 Keselamatan dan Kesehatan Kerja dalam Pekerjaan pada Ketinggian. Peraturan Menteri, 2016.

<sup>108</sup> Infrastructure Health & Safety Association (IHSA). Top 10 Causes of Workers Falling from Heights in Residential Construction [Internet]. [Cited: July 26, 2022]. Available at: <https://www.ihsa.ca/PDFs/Products/Id/W208.pdf>

Regulation	Subject	HIRARC	GAP	Recommen-dation
Permenaker No. 9/2016, clause 5	Implement working permit system to work at high and give instruction that relate with working condition <sup>15</sup>	Make a work permit for work at height	make a written - emergency plan	
Permenaker No. 9/2016, clause 31	It is a must for company to provide the workers that competent and responsible for HSE sector on working at height <sup>15</sup>	Select competent workers and provide training on procedures for working at heights		
Permenaker No. 9/2016, clause 6	It is a must for company to ensure that working procedure is known and well-understood by workers and people who involve before the work starts <sup>15</sup>	Conduct Toolbox Meeting		
Permenaker No. 9/2016, clause 4	It is a must for company to ensure all activity at heigh that is company responsibility is well-plan and executed on the safe way and monitored <sup>15</sup>	Appoint one person as an area supervisor		
Permenaker No. 9/2016, clause 21	It is a must for company to provide PPE for free and ensure the workers wear the proper PPE on working at height <sup>15</sup>	Use personal protective equipment		

Potential hazards in the form of trouble occur when the crane is lifting, ties are untied during lifting, and unbalance conditions can cause the material to fall. Falling material is a potential hazard in all work activities at height. *Peraturan Menteri Tenaga Kerja dan Transmigrasi No. 9 Tahun 2016*, clause 8 Concerning Occupational Safety and Health in Work at Height, the Company should ensure, when workers work at height, there are no falling objects that may cause injury or fatality.

Hazard controls that are carried out to prevent material from falling during lifting are:

- a. Engineering Control/Isolation:
  - 1) Installing barricades/safety lines
  - 2) Ensure that no one is under when lifting
  - 3) Kept the crane at a safe distance from any obstacles, underground hazards, electrical hazards, depressions in the ground, big holes, and other dangerous areas.
- b. Administrative control:
  - 1) Inspect to ensure that mobile cranes and safety devices are in a proper condition

- 2) Before lifting any load, verify the capacity of the crane, verify the weight of the load, check the slings or straps to make sure that their size is correct and that they are in good condition, and check the ground for its capacity and stability to support the crane.
- 3) Checking operator licenses and equipment licenses
- 4) Rigging is carried out by experienced riggers
- 5) Ensuring the girders are properly tied
- 6) Modeling a supporting gantry with H beam for stable condition before dismantling
- 7) Conduct Toolbox Meeting
- 8) Appoint one person as an area supervisor

c. PPE: Operators must wear safety belts at the time of operating the crane

**Table 9.** Legal Compliance Analysis

Regulation	Subject	HIRARC	GAP	Recommendation
Permenaker No. 9/2016, clause 7	It is a must for company to install a barrier for working area to prevent strangers/people get into the area <sup>15</sup>	Installing barricades/safety lines	Not yet to do wind-speed measurement	Do wind-speed measurement
Permenaker No. 8/2020, clause 51	Operators have to give a warning to surrounding workers to move to safe area when lifting happens	Ensure that no one is under when lifting	Permenaker No. 8/2020, clause 49 Stop the lift crane activity if the wind speed is more than 38 Km/hour	
Permenaker No. 8/2020, clause 51	Operators have to give a warning to surrounding workers to move to safe area when lifting happens <sup>17</sup>	Kept the crane at a safe distance		
Permenaker No. 8/2020, clause 167	OHS Expert on crane has a duty to inspecting, analyzing, and testing the crane and its equipment <sup>17</sup>	Inspect to ensure that mobile cranes and safety devices are in a proper condition		
Permenaker No. 8/2020, clause 147	Crane operators are classified into class III operator, class II operator, and class I operator <sup>17</sup>	Checking operator licenses and equipment licenses		
Permenaker No. 8/2020, clause 157	Riggers has to meet the requirements to be a good rigger <sup>17</sup>	Rigging is carried out by experienced riggers		
Permenaker No. 8/2020, clause 53	Riggers have to tie the sling on hook strongly before the crane starts <sup>17</sup>	Ensuring the girders are properly tied		
Permenaker No. 8/2020, clause 22	Crane installation on top of foundation or building wall has to be strong to hold the weight of crane or the load and meet with construction requirement comply with the regulation and standard <sup>17</sup>	Modeling a supporting gantry with H beam for stable condition before dismantling		

Regulation	Subject	HIRARC	GAP	Recommendation
Permenaker No. 8/2020, clause 22	Crane installation on top of foundation or building wall has to be strong to hold the weight of crane or the load and meet with construction requirement comply with the regulation and standard <sup>16</sup>	Check the ground for its capacity and stability		
UU No. 1 Tahun 1970	A company have to present and explain to new workers about the condition and dangerous that could occur at working area	Conduct Toolbox Meeting		
Permenaker No. 8/2020, clause 170	It is a must for OHS expert on crane to set working plan for monitoring and/or testing for crane <sup>17</sup>	Appoint one person as an area supervisor		
Permenakertrans No. 8/2010, clause 2	It is a must for company to provide PPE for workers	Use personal protective equipment		

## CONCLUSION

1. There are 123 potential hazards identified in gantry crane dismantling activities, including 25.2% extreme risk level, 60.9% high-risk level, and 13.8% medium risk level.
2. The extreme risks of gantry crane dismantling are trouble when the crane is lifting; the sling ties are untied/broken when lifting; workers fall while working at height; and unbalanced conditions.
3. A company has done risks control complying with current government regulation. A recommendation for company is to add more controlling part. It could be emergency plan, and a wind-speed measurement before the work starts

## LIMITATION

This research is limited by the fact that it is only conducted during gantry crane dismantling operations and that Hazard Identification, Risk Assessment and Risk Control (HIRARC) is the single method employed for hazard identification, risk assessment, and risk control.

## REFERENCES

1. Syahriadi, R., & Tenriajeng, A. T. Analisis manajemen risiko keselamatan dan kesehatan kerja lingkungan mutu proyek jalan tol dan jembatan pada PT. Utama Karya Infrastruktur di Kota Depok. *Jurnal TESLINK: Teknik Sipil dan Lingkungan*. 2020; 2(2): 18-28.

2. Ramli, S. Sistem Manajemen Keselamatan dan Kesehatan Kerja OHSAS 18001. Jakarta: Dian Rakyat. 2010.
3. LRT Jabodebek. Portal Gantry Crane [Internet]. 2018 [Cited July 25, 2022]. Available from: <https://lrtjabodebek.adhi.co.id/portal-gantry-crane/>
4. Yu, Y.H. Forensic Investigation on Crane Accidents. *International Journal of Forensic Engineering*, 2017; 3(4): 319-341.
5. Anthony, M. B. Analisis Risiko Keselamatan dan Kesehatan Kerja (K3) pada Pengoperasian Overhead Crane Menggunakan Metode SWIFT (Structured What If Technique) di PT. ABC. *Jurnal Media Teknik dan Sistem Industri*, 2020; 4(1): 30-38.
6. Doa, Y. P., Winanda, L. A. R., & Iskandar, T. Faktor-Faktor Penyebab Kecelakaan Kerja Konstruksi di Indonesia dan Pencegahannya. *Student Journal Gelagar*. 2021; 4(2): 1-9.
7. Purnama, Deddi Septian. Analisa Penerapan Metode HIRARC (Hazard Identification Risk Assessment and Risk Control) Dan HAZOPS (Hazard And Operability Study) dalam Kegiatan Identifikasi Potensi Bahaya dan Resiko Pada Proses Unloading Unit di PT. Toyota Astra Motor. *Jurnal PASTI (Penelitian dan Aplikasi Sistem dan Teknik Industri)*. 2016 Apr; 9(3).
8. Engineering Universitas Teknologi Malaysia. HIRARC (Hazard Identification Risk Assessment and Risk Control). [Internet]. 2013 [Cited: August 25, 2022]. Available at: <https://engineering.utm.my/>
9. Rout BK, Sikdar BK. Hazard Identification, Risk Assessment, and Control Measures as an Effective Tool of Occupational Health Assessment of Hazardous Process in an Iron Ore Pelletizing Industry. *Indian J Occup Environ Med*. 2017 May-Aug; 21(2):56-76
10. Canadian Centre for Occupational Health & Safety. Hazard Identification [Internet]. 2018 [Cited: July 26, 2022]. Available at: [https://www.ccohs.ca/oshanswers/hsprograms/hazard\\_identification.html](https://www.ccohs.ca/oshanswers/hsprograms/hazard_identification.html)
11. Canadian Centre for Occupational Health & Safety. Risk Assessment [Internet]. 2017 [Cited: July 26, 2022]. Available at: [https://www.ccohs.ca/oshanswers/hsprograms/risk\\_assessment.html](https://www.ccohs.ca/oshanswers/hsprograms/risk_assessment.html)
12. Department of Occupational Safety and Health (DOSH) Ministry of Human Resources (MOHR) Malaysia. Guidelines On Occupational Safety and Health (Osh) Risk Management for Small and Medium Enterprises in ASEAN Member States. 2020.
13. Health Safety Executive. Management of risk when planning work: The right priorities [Internet]. Leadership and worker involvement toolkit. [Cited: July 26, 2022]. Available at: <https://www.hse.gov.uk/construction/lwit/assets/downloads/hierarchy-risk-controls.pdf>
14. International Labour Organization (ILO). Working at height [Internet]. [Cited: July 26, 2022]. Available at: <https://www.ilo.org/global/topics/labour-administration-inspection/resources-library/publications/guide-for-labour-inspectors/working-at-height/lang--en/index.htm>

15. Menteri Tenaga Kerja dan Transmigrasi. Peraturan Menteri Tenaga Kerja dan Transmigrasi No. 9 Tahun 2016 Keselamatan dan Kesehatan Kerja dalam Pekerjaan pada Ketinggian. Peraturan Menteri, 2016.
16. Infrastructure Health & Safety Association (IHSA). Top 10 Causes of Workers Falling from Heights in Residential Construction [Internet]. [Cited: July 26, 2022]. Available at: <https://www.ihsa.ca/PDFs/Products/Id/W208.pdf>
17. Menteri Ketenagakerjaan Republik Indonesia. Peraturan Menteri Ketenagakerjaan Republik Indonesia Nomor 8 Tahun 2020. Keselamatan dan Kesehatan Kerja Pesawat Angkat dan Pesawat Angkut. Peraturan Menteri, 2020.
18. Presiden Republik Indonesia. Undang-Undang Republik Indonesia Nomor 1 Tahun 1970. Keselamatan Kerja. 1970.
19. Menteri Tenaga Kerja dan Transmigrasi Republik Indonesia. Peraturan Menteri Tenaga Kerja dan Transmigrasi Republik Indonesia Nomor PER.08/MEN/VII/2010. Alat Pelindung Diri. Peraturan Menteri, 2010.