



Risk Assessment of Bagged Fertilizer Unloading Activity at TUKS Pusri Banyuwangi Branch

¹ Diyah Purwitasari,² Intan Sianturi,³ Renta Novaliana Siahaan, ⁴ Faizal Arrofi

¹Engineering, Surabaya Sailing Polytechnic

²Marine Transportation, Surabaya Shipping Polytechnic

³Ship Operation Engineering Technology, Surabaya Shipping Polytechnic

⁴Marine Transportation, Surabaya Shipping Polytechnic

email: diyah.purwitasari@poltekpel-sby.ac.id

Submitted on : 26/03/2024 Revised : 30/05/2024 Accepted : 31/05/2024

Abstract

The port is one of the distribution centers for goods in which there are loading and unloading activities. Loading and unloading activities sometimes involve loading and unloading personnel and heavy equipment which raises the potential for hazards that can cause work accidents and damage to goods. The purpose of this research is to conduct a risk assessment using the HIRARC (Hazard Identification, Risk Assessment and Risk Control) method on bagged fertilizer unloading work in the TUKS PUSRI Banyuwangi Branch Port area. The stages of bagged fertilizer unloading work activities include the unloading activity process, which consists of five work stages: opening the ship's hatch, workers (stevedores) entering the hatch, stevedoring, cargodoring, and delivery. The results stated that from a total of 5 work stages, 26 sources of hazards were identified with 6 sources of low risk level hazards at 23%, 7 sources of moderate risk level hazards at 27%, 6 sources of high risk level hazards at 23%, and 7 sources of very high risk level hazards (extreme) at 27%. Control measures that can be implemented are conducting briefings on OHS (Occupational Health and Safety) before starting work activities, supervision of compliance with the use of complete personal protective equipment and also the need for sanctions for workers who do not comply with the rules for using personal protective equipment.

Copyright ©2024, **METEOR STIP MARUNDA**, pISSN: 1979-4746, eISSN: 2685-4775

Keywords: Unloading Activities, Risk Assessment, HIRARC

INTRODUCTION

The Occupational Safety and Health Administration (OSHA) in the United States states that work safety is an applied scientific discipline that aims to create a safe work system. **Error! Reference source not found..** Work safety is an action that must be taken in relation to work machines, work tools, materials that are being

processed, work locations and the environment. **Error! Reference source not found..**

Factors that cause work accidents are unsafe acts and unsafe conditions. **Error! Reference source not found..** Unsafe acts consist of incorrect and non-standardized actions, which are usually caused by an unsafe working environment or dangerous working equipment conditions.

Error! Reference source not found..The use of machinery, tools, materials and production processes has become a source of harm. **Error! Reference source not found..** Occupational accidents can cause injuries and disabilities to body parts such as hands, feet, nose, ears, eyes, neck, chest, abdomen, genitals, lungs, heart, intestines, and brain **Error! Reference source not found..** Everyone should always be concerned and aware when performing tasks in accordance with standards to support safety at work **Error! Reference source not found..**

This research was conducted at PT Adhiguna Putera Tanjung Wangi Branch which is a shipping company categorized as a cargo shipping service, which has a large number of loading and unloading workers (TKBM). One of the unloading activities carried out is the bagged fertilizer unloading activity carried out in the TUKS PUSRI Banyuwangi Port Area.

From 2011 to 2014, there were 64 work accidents (including fatalities) at TKBM in Tanjung Wangi Port, as shown in Table 1.

Table 1. Work Accident Data of TKBM Pelabuhan Tanjung Wangi

Year	Number of Victims	%
2011	13	20,3
2012	19	29,7
2013	22	34,4
2014	10	15,6
Total	64	100,0

The main trigger for work accidents during this period was not following the rules, and can be seen in the *tree map* in Figure 1.



Fig 1. Data on the main triggers of work accidents at Tanjung Wangi Port

In dismantling activities, there are various types of sources and possible hazards that can occur. For example, work carried out in the dock area when directing vehicles, which can cause

work accidents being hit by vehicles; work carried out in the ship's hold area when lifting fertilizer into the transport net, which can cause the danger of being crushed by fertilizer and errors in lifting fertilizer, which although already using the help of heavy equipment in the form of ship cranes, but most of the unloading activities are still done manually by TKBM with the risk of work accidents such as slipping, bouncing, and crushed by fertilizer. **Error! Reference source not found..**

Work accidents are unexpected and undesired incidents that can disrupt regulated activities **Error! Reference source not found..** Work accidents during unloading activities remain a significant concern, necessitating the implementation of countermeasures to prevent an increase in such incidents. It is imperative to conduct hazard identification, risk mitigation, and formulate control measures to reduce the likelihood of work accidents. This research aims to address two primary questions regarding the unloading of fertilizers at the Tanjung Wangi Branch of TUKS PUSRI: What are the most significant potential hazards and risks faced by TKBM during fertilizer unloading activities at TUKS PUSRI Tanjung Wangi Branch? and, What control measures can be devised to mitigate the risk of work accidents for TKBM during fertilizer unloading activities at TUKS PUSRI Tanjung Wangi Branch? Unloading activities involving fertilizers present various hazards and risks for TKBM workers at TUKS PUSRI Tanjung Wangi Branch. One of the most prominent risks is the exposure to harmful chemicals present in fertilizers, which can lead to respiratory issues, skin irritation, and other health problems. Additionally, the physical strain of lifting heavy bags or containers can result in musculoskeletal injuries. Furthermore, the potential for accidents such as slips, trips, and falls is heightened due to the nature of the work environment, which may include slippery surfaces or uneven terrain.

To address these risks, several control measures can be implemented. Firstly, comprehensive training programs should be conducted to educate TKBM workers about the hazards associated with fertilizer unloading and the proper safety measures to mitigate these risks. This includes training on the correct use of personal protective equipment (PPE) such as gloves, masks, and safety goggles. Regular maintenance and inspection of equipment used in the unloading process, such as forklifts and conveyor belts, are also essential to ensure their safe operation. Furthermore, the implementation of engineering controls, such as the installation of

handrails, non-slip surfaces, and proper lighting, can help reduce the risk of accidents.

Administrative controls, such as establishing clear unloading procedures and providing adequate rest periods for workers to prevent fatigue, are also crucial. Additionally, regular monitoring and evaluation of these control measures are necessary to ensure their effectiveness and identify any areas for improvement. The unloading of fertilizers at TUKS PUSRI Tanjung Wangi Branch poses significant hazards and risks for TKBM workers. However, by implementing a combination of hazard identification, risk mitigation, and control measures, the risk of work accidents can be significantly reduced. It is essential for management to prioritize the safety and well-being of TKBM workers by implementing these measures effectively.

This research undertakes a critical risk assessment of unloading bagged fertilizers at the TUKS PUSRI Port area of the Banyuwangi Branch using the HIRARCH (Hazard Identification, Risk Assessment, and Risk Control) method. The primary objectives are twofold: a) to identify potential hazards and determine the highest risks faced by TKBM in fertilizer unloading activities at TUKS PUSRI Tanjung Wangi Branch, and b) to formulate effective control measures to reduce the risk level of TKBM work accidents during these activities. The HIRARCH method is a structured approach that involves identifying hazards, assessing risks, and implementing controls to mitigate these risks. It provides a systematic framework for evaluating workplace hazards and developing strategies to manage them effectively. In the context of unloading bagged fertilizers, this method is particularly relevant due to the various potential hazards associated with handling chemical substances and heavy loads.

The benefits of this research are manifold. Firstly, it contributes to the development of scientific knowledge in the port sector, specifically concerning the risk assessment of unloading activities. By identifying and addressing potential hazards, this research aims to improve work safety in the port environment. The findings of this study are expected to be valuable not only to academic researchers but also to companies engaged in logistics, providing them with a reference for formulating risk control measures for similar unloading activities. One of the key challenges in unloading bagged fertilizers is the risk of exposure to hazardous chemicals. Fertilizers contain various substances, such as ammonia and phosphorus, which can pose serious

health risks if not handled properly. Inhalation of these chemicals can cause respiratory issues, while contact with the skin can lead to irritation or burns. Additionally, the physical strain of lifting and carrying heavy bags increases the risk of musculoskeletal injuries, such as strains and sprains.

To mitigate these risks, several control measures can be implemented. Firstly, workers should receive comprehensive training on the safe handling of fertilizers and the use of personal protective equipment (PPE), such as gloves, masks, and goggles. Regular maintenance and inspection of equipment, such as forklifts and conveyors, are also essential to ensure their safe operation. Engineering controls, such as the installation of ventilation systems and non-slip surfaces, can further reduce the risk of accidents. Administrative controls, such as establishing clear unloading procedures and providing adequate rest periods for workers, are also crucial. Regular monitoring and evaluation of these control measures are necessary to ensure their effectiveness and identify any areas for improvement.

By implementing a combination of these measures, the risk of work accidents during fertilizer unloading activities can be significantly reduced. This research serves as a valuable contribution to the field of port logistics by providing a comprehensive risk assessment of unloading bagged fertilizers. By identifying potential hazards and formulating effective control measures, this study aims to improve work safety in the port environment. The findings of this research are expected to be beneficial not only to academic researchers but also to companies engaged in logistics, providing them with practical insights into managing risks associated with unloading activities.

METODE

This research was conducted using a quantitative approach. Quantitative research methods are research methods based on the philosophy of positivism (relying on empiricism) which are used to research on certain populations or samples, sampling techniques are generally carried out randomly (*random*), data collection using objective research instruments, and data analysis is quantitative or statistical, with the aim of testing predetermined hypotheses **Error! Reference source not found.**

1. Time and Place of Research

The research was conducted at TUKS Pusri Banyuwangi Port, located at Jl. Raya Situbondo Banyuwangi, Bulusan, Kalipuro, Banyuwangi Regency, East Java using data from cadets during land practice for 6 months, from February 2022 to August 2022..

2. Data Collection Techniques and Types

The two types of data used in this research are primary data and secondary data. Primary data is the data source directly obtained by data collector **Error! Reference source not found.** Secondary data is a source that indirectly provides data to the data collector **Error! Reference source not found.**, in this research secondary data include company records, work instructions, and standard operating procedures.

3. Research Subject

The population of this study were all workers involved in the loading and unloading process of PT Adhiguna Putera, Tanjung Wangi branch, totaling 286 people. Proportional stratified random sampling utilized in this research, which is a sampling technique used when the population has non-homogeneous and proportionally stratified elements **Error! Reference source not found.** From the results of the sample calculation using the Slovin formula, a sample of 74 research subjects was needed.

4. HIRARC (Hazard Identification Risk Assessment and Risk Control)

In controlling health hazards and safety hazards, there is a need for occupational health and safety management to reduce the potential for workplace accidents in workers. **Error! Reference source not found.** The HIRARCH (*Hazard Identification Risk Assessment and Risk Control*) risk assessment method is used. HIRARCH is a method that starts by identifying the type of work activity that has the potential to cause harm and then identifying the source of the risk. Next, risk assessment and risk management are carried out to reduce the risks associated with each type of work. **Error! Reference source not found.** Hazard Identification, Risk Assessment, And Risk Control (HIRARC) A method taken on activities at the port, especially unloading a cargo. **Error! Reference source not found.** To conduct a risk assessment, this study uses likelihood criteria and consequence criteria which can be seen in tables 2 and 3.

Table 2. Likelihood Criteria
(Likelihood of occurrence)

Level	Kriteria	Deskripsi
-------	----------	-----------

Level	Kriteria	Deskripsi
1	Jarang terjadi	Terdapat \geq 1-11 kejadian dalam setahun
2	Kemungkinan kecil	Terdapat \geq 12-47 kejadian dalam setahun
3	Mungkin	Terdapat \geq 48-275 kejadian dalam setahun
4	Kemungkinan besar	Terdapat \geq 276-827 kejadian dalam setahun
5	Hampir pasti	Terdapat \geq 828 kejadian dalam setahun

Table 3. Consequence (Impact) Criteria

Level	Description	Severity of Injury	Working Day
1	Not Significant	The incident did not cause human loss or injury	Does not cause loss of working days
2	Small	Causes minor injuries, minor losses and no serious impact on business continuity	Can still work on the same day/shift
3	Medium	Serious injury and hospitalization, no permanent disability, moderate financial loss	Lost workdays under 3 days
4	Weight	Resulting in serious injury and permanent disability and major financial loss and serious impact on business continuity.	Loss of working days of 3 days or more
5	Disaster	Resulting in deaths and severe losses and can even stop business activities forever.	Lost work days forever

The HIRARC method formula in calculating the *Risk Rating* is by multiplying the *likelihood* (L) by the *consequences* (C). The results of the risk level calculation are mapped in the risk matrix in table 4.

Table 4. OHS System *Risk Matrix*

Likelihood	Consequences				
	1	2	3	4	5
5	M	H	H	E	E
4	M	M	H	H	E
3	L	M	M	H	E
2	L	M	M	H	H
1	L	L	M	M	H

The risk value from the multiplication of *likelihood* and consequences varies from 1 to 25 (5x5 matrix multiplication) with the following risk scale:

Table 5. Risk Rating Scale

Value	Description
1 - 4	Low risk (L)
5 - 9	Moderate risk (M)
11 - 14	High risk (H)
>15	Extreme risk (E)

By conducting risk mapping, it will be possible to manage risks with a choice of control measures in the form of risk *avoidance*, risk *transfer*, risk *reduction*, risk *acceptance*, and risk *sharing*.

Prioritization of risk control in accordance with the hierarchy is able to minimize existing risks through a decrease in the value of existing risks. **Error! Reference source not found.**

RESULTS AND DISCUSSION

The risk assessment was conducted by averaging the responses of all respondents in each department based on the probability and consequence criteria. The combined average was obtained using the following equation 1:

$$\bar{X}_{Gabungan} = \frac{n_1 \bar{x}_1 + n_2 \bar{x}_2 + n_3 \bar{x}_3 \dots}{n_1 + n_2 + n_3 \dots} \quad (1)$$

After the average is obtained, based on the equation to calculate the Risk Rating of the HIRARC method in AS/NZS 4360: 2004 **Error! Reference source not found.**, the calculation results are obtained in Table 3.1. The following Risk Score equation is used in equation 2:

$$RS = L \times C \quad (2)$$

Description:

RS = Risk Score
L = Likelihood
C = Consequences

By referring to table 4, the risk rating will be obtained, listed in table 6.

Table 6. Calculation of Risk Value and Risk Rating of Fertilizer Unloading Activities

Unloading Process	Hazard Source	Potential Hazards	Risk Assessment			Risk Rating	%
			L	C	RS (L*C)		
(1) Ship hatch opening	Steep stairs when boarding the ship	Falling down the stairs	4	3	12	High Risk	4,69
(1) Ship hatch opening	Loss of balance while on board	Falling from a height	3	3	9	Moderate Risk	3,52
(2) Ship hatch opening	Exposure to sunlight	Direct exposure to sunlight (<i>sun burnt on skin</i>)	3	2	6	Moderate Risk	2,34
(2)	Slippery and	Falling down the	4	3	12	High Risk	4,69

Unloading Process	Hazard Source	Potential Hazards	Risk Assessment			Risk Rating	%
			L	C	RS (L*C)		
(3) Stevedoring	Workers enter the ship's hold	rusty ladder when descending the hatch ladder					
	Fertilizer bag leaking on the hatch floor	Slipped	3	2	6	Moderate Risk	2,34
	Narrow dock location / lack of signage facilities at the dock	Hit by a truck	3	4	12	High Risk	4,69
	Heavy equipment operator negligence	Fallen on heavy equipment/bagged fertilizer	3	4	6	High Risk	4,69
	Long sitting position (Ergonomics)	Back pain	3	2	6	Moderate Risk	2,34
	Exposure to sunlight (while waiting at the dock)	Direct exposure to sunlight (<i>sun burnt on skin</i>)	2	2	4	Low Risk	1,56
	Standing upright for too long (Ergonomics)	Muscle or joint pain in the legs	4	2	8	Moderate Risk	3,13
	Exposure to sunlight (in the work process)	Direct exposure to sunlight (<i>sun burnt on skin</i>)	2	2	4	Low Risk	1,56
	Uneven location of the fertilizer bag on the net	Bagged fertilizer falls out of the net	4	3	12	High Risk	4,69
	Lifting heavy fertilizer bags (Ergonomics)	Muscle pain in the back or joints and being crushed by fertilizer	3	3	9	Moderate Risk	3,52
(4) Cargo-doring	The room smells of chemical fertilizers	Inhalation of fertilizer chemicals	3	3	9	Moderate Risk	3,52
	Exposed to heavy equipment slings	Entangled/overwhelmed by slings	4	4	16	Extreme Risk	6,25
	Exposed to a load of fertilizer bags	Hit / pushed hard by bags of fertilizer	3	4	12	High Risk	4,69
	Exposed to fertilizer bag loading net	Body crushed/falling off the truck	3	4	12	High Risk	4,69
	Exposed to slings	Struck by a sling	3	4	12	High Risk	4,69
	Uneven placement of fertilizer bags on the truck	Fallen on fertilizer bags	3	3	9	Moderate Risk	3,52
	Standing upright for too long (Ergonomics)	Muscle or joint pain in the legs	4	2	8	Moderate Risk	3,13
	Standing upright for too long (Ergonomics)	Hand muscle or joint pain	4	2	8	Moderate Risk	3,13
	Lifting heavy fertilizer bags (Ergonomics)	Muscle pain in the back or joints	4	2	8	Moderate Risk	3,13
	Slippery surface conditions of fertilizer bags and leaking fertilizer bags	Slipping off the surface of a pile of fertilizer bags	4	4	16	Extreme Risk	6,25
(5) Delivery	Driver negligence	Hit by a truck	3	4	12	High Risk	4,69
	Driver negligence	Headtruck collision	4	4	16	Extreme Risk	6,25
	Long sitting position (Ergonomics)	Pain in the waist	3	2	6	Moderate Risk	2,34
TOTAL	26			256			100

If it is assumed that the *risk appetite* of PT Adhiguna Putera Tanjung Wangi Branch is to mitigate *Risk Rating with High Risk* and *Extreme Risk* status only, then risk mitigation and recommendations for control measures are given to these two *risk ratings*. In this study, one (1) highest risk rating will be taken at each stage of unloading work with the results in table 7 as follows:

Table 7. Risk Control Prioritization

Unloa	Hazard	Potential	Risk	%
-------	--------	-----------	------	---

ding Proces s	Source	Hazards	Rati ng	
(1) Ship hatch openin g	Steep stairs when boarding the ship	Falling down the stairs	High Risk	4, 69
(2) Worke rs enter the ship's hold	Slippery and rusty ladder when descending the hatch ladder	Falling down the stairs	High Risk	4, 69
(3) Steved oring	Exposed to heavy equipment slings Slippery surface	Entangled/o verwhelmed by slings	Extre me Risk	6, 25
(4) Cargo doring	conditions of fertilizer bags and leaking fertilizer bags	Slipping off the surface of a pile of fertilizer bags	Extre me Risk	6, 25
(5) Delive ry	Driver negligence	Headtruck collision	Extre me Risk	6, 25

The Risk Control Recommendations in table 7 are described as follows:

- 1) Control of falls when climbing steep ship ladders, to reduce the risk of slipping on the stairs, the author suggests the use of non-slip foot aids and the application of three point contact.
- 2) To reduce the risk of slipping when descending the slippery and rusty hatch ladder, the author suggests modifying and servicing the hatch ladder.
- 3) Control of being crushed by slings when installing slings and hooks on fertilizer-loaded jars, the author suggests regular repairs to prevent damage to forklifts and forklift engines, minimize repair costs and extend machine life, and reduce damage when installing hoists and hooks.
- 4) Control of slipping from the surface of a pile of fertilizer bags, to reduce the risk level of slipping from the surface of a pile of fertilizer bags, namely by elimination control in the form of removing fertilizer powder that comes out of the bag using a broom or other cleaning tools.

- 5) Headtruck collision control as a result of reducing driver risk negligence, collision for driver-induced, regular truck engine maintenance and repair can prevent truck engine damage, minimize repair costs, extend engine life and reduce damage that can occur at any time during the production process.
- 6) Control by providing PPE in every unloading activity, such as: Safety helmet c, 10cm Hercules safety shoes, yellow PVC boots, flatflod safety spectacles, cotton gloves, N95 masks, class 3 safety performance vests.
- 7) Administrative control in the form of K3 program planning, which includes: preparation of K3 SOP, OHS Forum, Toolbox Meeting, 5R, OHS Award, K3 posters, banners or slogas, physical and spiritual health checks, issuance of SMK3. Risk mitigation, risks at PT Adhiguna Putera in every fertilizer unloading process are carried out using a risk transfer strategy, namely insuring the health and safety of each worker, especially workers in the operational part of loading and unloading activities who have more potential for accidents and occupational health problems.

Based on the data analysis that has been carried out, it is found that there are 3 types of potential hazards in the hatch opening process, 2 types of potential hazards in the process of unloading workers entering the hatch, 14 types of potential hazards in the *stevedoring process*, 5 types of potential hazards in the *cargodoring process*, 2 types of potential hazards in the *delivery process*.

The results of the risk assessment *in the in-bags* fertilizer unloading activity of PT Adhiguna Putera obtained the highest value in each type of unloading activity, namely the type of danger of falling from the stairs getting a risk value of 12 (*high risk*) with a percentage of 4.69% in the process of opening the hatch, the type of danger of slipping from the stairs getting a risk value of 12, with a *high risk risk* rating with a percentage of 4.69% in the process of workers entering the hatch, the type of danger of being hit by a sling received a risk value of 16, with an *extreme risk rating* of 6.25% in the *stevedoring process*, the type of danger of slipping from the surface of a pile of fertilizer bags received a risk value of 12, with a *high risk rating* of 4.69% in the *cargodoring process*, and finally the type of danger of headtruk collision due to driver negligence received a risk value of 16, with an *extreme risk* rating of 6.25% in the *delivery process*.

Risk control formulated in accordance with the five risks that have the highest value in each activity, including slipping on the stairs, namely by using *anti toe slip safety tools* and implementing *three point contact*, namely the concept of using stairs safely and always maintaining three points of contact, namely two hands and one foot or two feet and one hand on the stairs at all times, The second type of hazard is slipping when descending the slippery and rusty hatch ladder. The recommendation is to make modifications by adding *guard rails* or *railings* as handrails. The third type of hazard is being hit by slings when installing *slings* and *hooks*. The recommendation is to carry out periodic equipment repairs to prevent damage to lift and transport aircraft engines, minimize repair costs, extend engine life, and minimize damage that can occur at any time during the production process. The fourth type of hazard is slipping on the surface of the fertilizer pile due to a leaking fertilizer bag, namely by controlling the handling to eliminate the risk of slipping on the fertilizer pile when using a broom or broom to remove fertilizer powder from the bag. other cleaning tools, the fifth type of hazard is headtruck collisions due to driver negligence, namely Periodic equipment repairs can prevent damage to the headtruck engine, minimize repair costs, extend engine life, and minimize damage that can occur at any time during the production process. Recommendations are also given from an administrative perspective, such as planning OHS programs and providing PPE. In addition to implementing risk mitigation by including every worker in insurance in the form of Work and Health BPJS programs.

CONCLUSION

Based on the data analysis conducted, it is evident that various potential hazards exist within different activities of the in-bags fertilizer unloading process at PT Adhiguna Putera. These hazards encompass falling from stairs during hatch opening, slipping from stairs when workers enter the hatch, being hit by slings during stevedoring, slipping from the surface of fertilizer bags during cargodoring, and headtruck collisions due to driver negligence during delivery. The risk assessment results reveal the highest risk values for each activity. These include the risk of falling from stairs and slipping from stairs during hatch opening and worker entry, respectively, both rated as high risk. In the stevedoring process, the risk of being hit by slings is rated as extreme risk. Similarly, slipping from the surface of fertilizer bags during cargodoring and headtruck collisions

due to driver negligence during delivery are also rated as high and extreme risk, respectively. To control these risks, specific recommendations have been formulated. For instance, measures to prevent slipping on stairs include using anti-slip safety tools and implementing the three-point contact rule. Modifications such as adding guard rails or railings are suggested to prevent slipping on slippery and rusty hatch ladders. Periodic equipment repairs are recommended to minimize the risk of being hit by slings. Controlling handling practices to eliminate the risk of slipping on fertilizer piles and ensuring periodic equipment repairs to prevent headtruck collisions due to driver negligence are also advised. Administrative measures, such as planning occupational health and safety (OHS) programs, providing personal protective equipment (PPE), and including workers in insurance programs like Work and Health BPJS, are also recommended to mitigate risks comprehensively.

REFERENCES

- [1] B. Wijaya and C. F. B. Hartanto (2021). Nickel Ore Load Handling for Improved Safety of MV. RASHAD. *Politeknik Bumi Akpelni Semarang*,
- [2] H. Rohima and L. Yulia (2019). Analysis of the Implementation of the Occupational Safety and Health Program in an Effort to Minimize Work Accidents in Employees of PT Kereta Api Indonesia (Persero): Case study at the Daop 2 Bandung Locomotive Depot of PT KAI. *IKOPIN Scientific Journal*.
- [3] P. K. Suma'mur (2022). Occupational Safety and Fire Prevention, Jakarta: Gunung Agung.
- [4] S. Supriyadi, A. Nalhadi and A. Rizal (2015). Hazard Identification and Risk Assessment of OHS in Maintenance & Repair Actions Using the HIRARC (Hazard Identification and Risk Assessment Risk Control) Method at PT. X. *Prosiding Seminar Nasional Riset Terapan / SENASSET*, pp. 281-286.
- [5] A. M. Mayadilani (2020). Use of HIRARC in Hazard Identification and Risk Assessment in Loading and Unloading Work. HIGEIA. *Journal of Public Health Research and Development*.

- [6] A. Jannati (2020). Analysis of Potential Hazards and Risks of Container Loading and Unloading Activities for Workers at the Port of PT Pelindo I (Persero) Dumai Branch in 2019. *Universitas Sumatera Utara*,
- [7] A. Rianto (2023), Upaya Pencegahan Kecelakaan Kerja saat Kegiatan Bongkar Muat di Pelabuhan pada KM. Mare Mas," BP3IP Jakarta, Jakarta.
- [8] R. Muhamid, W. Tambunan and L. D. Fatimahhayati (2018). Risk Analysis of Occupational Safety and Health of Fertilizer Loading and Unloading Activities. *INTECH Journal, Teknik Industri Serang Raya*, pp. 42, 45, 52.
- [9] I. O. Ramisdar (2019), Analisis Risiko Kecelakaan Kerja pada Proses Bongkar Muat dengan Metode Job Safety Analysis (JSA) dan Hazard and Operability Study (HAZOPS) di PT. PELINDO IV (PERSERO) TERMINAL PETIKEMAS MAKASSAR. UIN ALAIDDIN, Makassar.
- [10] Sugiyono (2020). Quantitative, Qualitative and R&D Research Methods, Bandung: Alfabeta.
- [11] K. Fuadah (2021). Analisis Strategi Promosi Melalui Penerapan Sales Promotion Dalam Perspektif Prinsip Syariah (Studi Kasus Pada Toko Pertanian Tani Berkah Desa Kubangpari Kecamatan Kersana Kabupaten Brebes). IAIN Syekh Nurjati Cirebon, Cirebon.
- [12] Sugiyono (2019). Metodologi Penelitian Kuantitatif dan Kualitatif Dan R&D, Bandung: Alfabeta.
- [13] Sugiyono (2018). Metode Penelitian Kuantitatif, Bandung: Alfabeta.
- [14] H. Mauliyani, N. Romdhona, Adriyani and M. Fauziah (2022). Occupational Safety Risk Identification Method (HIRARC) at the Tank Manufacturing Stage at PT Gemala Saranaupaya. *Universitas Muhammadiyah Jakarta*.
- [15] . D. S. Purnama (2015). Analysis of the Application of HIRARC (Hazard Identification Risk Assessment and Risk Control) and HAZOPS (Hazard and Operability Study) Methods in the identification of potential hazards and risks in the unloading unit process at PT Toyota Astra Motor," *Universitas Mercu Buana Bekasi*.
- [16] D. B. Prasetio, I. Aryani and W. Meikawati (2018). Risk Analysis of Occupational Safety and Health of Fertilizer Loading and Unloading Activities. *Jurnal Intech Universitas Serang Raya*.
- [17] S. Aditya (2018). OHS Risk Management Using JSA and HIRARC Approaches to Minimize Potential Hazard (Case Study: PT Alam Lestari Unggul). *Universitas Islam Indonesia*.
- [18] S. Ramli (2010). OHSAS 18001 Occupational Safety and Health Management System, Second Edition, Jakarta: Dian Agung,
- [19] G. Smarandana, A. Momon and J. Arifin (2021). OHS Risk Assessment in the Manufacturing Process Using the Hazard Identification, Risk Assessment and Risk Control (HIRARC) Method. *INTECH Teknik Industri Universitas Serang Raya*, vol. 7 No.1,
- [20] B. Hard and T. Committee OB-007 (2004). Australian/New Zealand Standard Risk Management, Sydney: Standards Australia International Ltd, Sydney: Standards Australia International Ltd,.

