



Analysis Of Work Accident Risk Factors Based On Human Error Among Employees Of Pt. Prima Multi Peralatan Rtg Maintenance Tpk Belawan

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Article details:

Published: 31th October 2023



Abstract

Human error is one of the factors that can lead to workplace accidents. This research focuses on the aspect of human error, drawing from Dan Petersen's theory, which categorizes three types of risks: overload, ergonomic traps, and decision-making errors. The study involved nine research respondents, comprising three key participants, three main respondents, and three additional respondents. This research

follows a qualitative approach with a descriptive phenomenological methodology. Data collection involved in-depth interviews, and data analysis was conducted using a theme-sub-theme-sub-sub-theme matrix method. The research findings highlight various factors that pose a risk of human error resulting in workplace accidents. These factors include individual overload elements (such as physical health conditions, work pressure, work motivation, consumption of substances affecting the central nervous system, work-related stress, and work-life balance), workplace hazards, ergonomic challenges (incompatible workplace designs), and decision-making errors (pressure or encouragement from colleagues to ignore standard operating procedures, misjudgment of risks, and illogical decisions). It is recommended that individuals pay greater attention to their health conditions, increase their water intake, and enhance regulations and supervision concerning occupational health and safety (K3) in the workplace

Keywords: Human Error, Dan Petersen's Theory, Phenomenology, Matrix Analysis

To cite this article :

Anggi Diah Lestari, Gerry Silaban, E. L. M. (2023). Analysis Of Work Accident Risk Factors Based On Human Error Among Employees Of Pt. Prima Multi Peralatan Rtg Maintenance Tpk Belawan. *International Journal of Health, Education and Social (IJHES)*, 6(10), 1–14.



Introduction

Work accidents are incidents that occur in the workplace, resulting in thousands of fatalities, material damage, and disruptions to production every year. Global data also reveals that the annual death toll due to work accidents and work-related diseases exceeds 2.78 million people, with two-thirds of these occurrences happening in Asian countries. This underscores the fact that work accidents continue to be a prevalent issue in workplaces worldwide. One industry that significantly contributes to work accidents is equipment repair (maintenance), where accidents during the maintenance and repair of RTG equipment are not uncommon, owing to various factors specific to this field.

According to Mayysa (2019), in Poland, between 2013 and 2017, there was an average of 1,078 total work accidents registered during the use, repair, and maintenance of heavy machinery and equipment, with an average of 1,088 individuals injured. In line with the global incidence of work accidents, Heinrich's review of thousands of work accident reports in 1930 concluded that the majority of workplace accidents, illnesses, and injuries result directly from human error, stemming from unsafe actions by workers. Of the thousands of reports Heinrich examined, he reclassified 88% of work-related accidents, injuries, and illnesses as being caused by worker errors (Handayani, 2020). Furthermore, human error represents the most significant risk factor for work accidents in Indonesia, with Tarwaka (2008) reporting that 85% of work accidents are attributed to human factors. For instance, the work accident at PT Pindo Deli II, reported by Sindonews on April 20, 2017, involved an employee being fatally crushed by a machine while working, a situation caused by the employee's drowsiness on the job. This incident illustrates that some work accidents occur due to human factors (human error), highlighting the need for improved supervision.

As described by Bastanta (2020), Human Error refers to mistakes resulting from activities that should not have been carried out, leading to work accidents, chaos, operational disruptions, and damage to equipment and supplies. In simple terms, human error can be defined as a failure on the part of individuals to perform their tasks or produce work that aligns with the intended final



goal. Human error is assessed against specific performance standards, where performance represents a set limit or objective that workers must strive to achieve (Handayani, 2020).

Adepegba et al. (2021) assert that human error is the primary contributing factor to work accidents in the construction sector. Furthermore, a study in Canada revealed that organizational factors, such as inadequate supervision, unclear or ineffective policies and procedures, and pressure to increase productivity or meet targets, can lead to workers making mistakes, resulting in a high number of work accidents. According to the Central Statistics Agency (2020), the leading cause of workers making mistakes (human error), especially in the construction and mining sectors in Indonesia, is due to insufficient supervision and training, as well as the use of poor-quality tools and machines. Various research findings worldwide regarding the factors contributing to human error align with Dan Petersen's accident-incident theory, which states that human error can be influenced by overload factors, ergonomic traps (inappropriate workplace design), and workers' decisions to err.

Maintenance is a routine process involving the inspection, cleaning, and repair of various parts of heavy machinery. According to Mayysa (2019), during the years 2013-2017 in Poland, 29% of work accidents in the use, repair, and maintenance of machines/heavy equipment occurred due to human error. This includes accidents while employees were moving (including walking, running, going up and down stairs), which accounted for 29% of accidents, as well as incidents while working with hand tools (both non-mechanical and mechanical), causing 23.2% of accidents. Gripping tools or handling objects with hands accounted for 19% of incidents.

PT Prima Multi Peralatan is a company that operates in the equipment supply and port loading and unloading equipment maintenance services field. It is one of the companies under the PT Pelabuhan Indonesia group, providing various services, specifically handling Rubber Tyred Gantry (RTG) equipment. The main components of the Rubber Tyred Gantry (RTG) tool are the Spreader, Trolley, and RTGC rubber wheels. Mandatory activities carried out by PT. Prima Multi Peralatan RTG Project at Belawan Container Terminal include routine maintenance of Rubber Tyred Gantry (RTG) equipment. However, industrial equipment providers and port loading and



unloading equipment maintenance services are not immune to the risk of work accidents. Based on the company's secondary data, PT Prima Multi Peralatan has operated at the Terminal Belawan Container from 2019 to 2022, during which three work accidents caused by human error were recorded. Two accidents occurred in 2021 when workers were trapped while tidying up work tools, specifically the Automatic Greasing Machine (Grease Pump), and when they were struck by lightning while cleaning the machine room. Furthermore, in 2022, there was one incident in which a worker was injured by an object, resulting in a broken tooth during engine repairs while removing the crankshaft seal. A preliminary survey indicated that these work accidents were caused by human error, as workers admitted to negligence and rushing to complete tasks without considering dangerous weather conditions.

Based on this data, the researcher intends to conduct a study titled "Analysis of Work Accident Risk Factors Based on Human Error Among Workers at PT. Prima Multi Peralatan RTG TPK Belawan Project" to analyze the risk factors for work accidents based on human error at PT. Prima Multi Peralatan TPK Belawan Rubber Tyred Gantry (RTG) equipment branch.

International Journal of Health, Education and Social (IJHES) Methods

This research was conducted at the PT. Prima Multi Peralatan site (RTG) at the International Port Container Terminal located in Pelindo 1 Belawan. It is a qualitative study employing a descriptive phenomenological approach. The researchers aimed to examine the occurrence of human error phenomena in PT. Prima Multi Peralatan from three factors based on Dan Petersen's theory: individual overload, ergonomic traps, and decisions leading to mistakes, all of which can contribute to work accidents.

The data collection method used in this research involved in-depth interviews, employing tools such as notebooks, tape recorders, cameras, and other equipment. Subsequently, data analysis was conducted using the theme-sub-theme-sub-sub-theme matrix method. In qualitative research, data validity is established when there is consistency between the data presented or reported by



the researcher and the actual events involving the subject of the study. Data validity tests in qualitative research encompass credibility (internal validation), transferability (external validation), and confirmability (objectivity).

Results

Characteristics of Research Informants

The informants in this research were employees and management of PT. Prima Multi Peralatan RTGC Belawan, selected for their extensive knowledge regarding factors that pose a risk of causing work accidents based on human error at the research site. There were a total of 6 worker informants, all of whom were mechanics with vocational school education. These workers had an average working period of 3 years, and their ages ranged from 22 to 53 years. All six workers served as key informants and main informants. Additionally, there were 3 informants from the company's management team, each holding bachelor's and master's degrees in education. These management informants had an average working period of 3 years as well, with ages ranging from 25 to 41 years. They held positions as additional informants.

Human Error Risk Factors

According to Bastanta (2020), human error is an error that occurs due to activities that should not be carried out, resulting in work accidents, chaos, or disruptions to operations. As a maritime industry, PT. Prima Multi Peralatan relies on advanced technology for heavy equipment maintenance, indirectly increasing the complexity of work accident risks faced by workers at PT. Prima Multi Peralatan TPK Belawan. It is essential to understand the various accident risks to prevent work accidents. One of these risks involves studying the factors contributing to human error. In this research, we employ Dan Petersen's theory, which identifies three categories of risk factors for human error: individual overload, ergonomic traps, and decision-making errors.



Individual Overload Factor (*overload*)

Table 1. Matrix of Individual Overload Risk Factor Analysis Results (*Overload*)

Research purposes	Theme	Sub Theme	Sub-Sub Themes
Analyzing individual overload factors (<i>overload</i>) is at risk of human error	Physical health condition	There is a physical health problem	There are no routine health checks yet
			The job requires physical workload
			The workplace has many potential dangers
			Not focused while working
			Workers ignore the symptoms they feel
	Work Pressure	There is a work pressure problem	Repair completion target
			Trouble is hard to find
	Work Fatigue	There is no problem of work fatigue	Fatigue is not a risk because the work is done together
	Work motivation	Do not experience loss of work motivation	
		Experiencing a loss of work motivation	He wants his work to be finished quickly
			Weather conditions
			Bored/feeling lazy at work
			The payroll system is deemed inappropriate
	Consumption of substances that affect the central nervous system	There is a risk of consuming harmful substances that affect the central nervous system	Smoking while working and consuming fizzy drinks, coffee and tea



	Work stress	Do not experience work stress	
		Experiencing stress and still being able to overcome it	
		There is a risk of work stress	Stress due to weather conditions
			Stress due to the conditions of other workers
			Stress because of overtime pay is not
			Stress because overtime pay is not given
	Work life balance	Not a problem	
		There is a problem	Less socializing in society
			Lack of interaction with family .
	Work hazards faced	There are occupational hazards to be faced	Extreme weather conditions (hot sun)
			Danger of falling from a height
			Fire hazard



Ergonomic Pitfall Risk Factors

Table 2. Matrix of Risk Factor Analysis Results for Ergonomic Traps

Research purposes	Theme	Sub Theme	Sub-Sub Themes
Analyze factor trap ergonomic risky to human error	Place design work no compatible	There is no risk of incompatible workplace designs	
		There is a risk of incompatible workplace designs	Limited space makes it uncomfortable
	Mismatched expectations	Not to be Problem	

Decision Factors to Do Wrong

Table 3. Matrix of Risk Factor Analysis Results for Making Wrong Decisions

Research purposes	Theme	Sub Theme	Sub-Sub Themes
Analyze factors decisions to make mistakes risk human error	There is pressure or invitation from colleagues to ignore SOUP	There were no invitations from colleagues to ignore the SOP	
		It was found that colleagues were invited to ignore the SOP	Invitation not to wear PPE/not complying with SOP
	Misjudgment of risk	There is no risk of misjudging the risk	
		There is a risk of misjudging the risk	Misjudgment of risk due to chasing targets



			Assuming it is not necessarily an incident/trivial/surrender
			Experiencing boredom
	Management Priorities	There is no risk management priority	It doesn't matter because everything is management's priority
	Decision which is logical	There is no risk of logical decisions	It's not a problem because it still works according to the SOP
		There is a logical decision risk problem	The decision was made according to his wishes because he wanted to finish the work quickly

Discussion

Among the various theories of human error, one used in this research is the theory proposed by Dan Petersen. He introduces new aspects while retaining many elements of the human factors theory. In his theory, factors with the potential to contribute to the risk of work accidents are based on human error factors, which include individual overload, ergonomic traps, and the decision to err. According to Petersen (2003), assessing the factor of individual overload as an accident risk can be done by examining various indicators, including individual capacity (referring to physical condition and worker's physical health), work pressure, work fatigue, work motivation, consumption of substances that affect the central nervous system, work stress, work-life balance, and work-related hazards. Furthermore, identifying ergonomic trap factors as a risk for work accidents involves examining incompatible workplace designs and unrealistic expectations. Finally, understanding the decision-making factor leading to mistakes can be achieved by analyzing peer pressure, misjudgment of risk, management priorities, and logical decisions.



Individual Overload Factor (overload)

Physical health condition. Physical health conditions are still a problem in the workplace. This could risk causing human error because workers often carry out work with various potential dangers in unhealthy health conditions. The health conditions of workers have not been a concern for either the workers or their employers. Health checks on workers are never carried out either before starting work or periodically. Apart from that, working environmental conditions can cause discomfort for someone in carrying out their work and have the potential to disrupt workers' health conditions, for example hot weather from direct sunlight because the workplace is in an open field, excessive noise. comes from ship engines and container trucks that keep passing by, as well as vibrations from RTG and CC machines that are turned on and large trucks that keep passing the work site. This can disrupt workers' physical and mental health conditions. Workers whose physical health and mental health are disturbed can be at risk of causing work accidents. Poor physical condition can reduce workers' work capacity and endurance. There are interview quotes which state the physical health conditions of workers at PT. Prima Multi Peralatan and what its risks are for work accidents, namely:

Yes, so if the condition of the worker himself is bad or he is feeling down, it will definitely affect the occurrence of accidents, that's why sometimes we have to be sensitive ourselves to friends, for example if he is a bit unwell, we limit his work. For example, just below or if he's just monitoring, that's up to us (R8)

..... yes, so that morning he had high blood pressure, he discovered that when he was working, it looked like he was physically moving, he was silent, we asked him why, honestly, he said his blood pressure was high, his head was dizzy, that's why he stopped working, he was told to rest. first, because it is also dangerous, your concentration can definitely be lost (R9)

Work Pressure. Work pressure is a psychological condition as a result of workers' perceptions of the interaction between themselves and their work environment which can cause disturbances. Of the 9 respondents, 6 respondents stated that the risk of work pressure was found



in the workplace. The existence of pressure in the workplace is proven by one of the workers' statements which said:

it could be on the target (i2) the damage is a bit difficult to resolve (i1)

Based on the respondent's statement, it is known that the work pressure obtained comes from the *maintenance completion target* given by the company, where in reality in the field the completion time exceeds the target so that workers feel rushed. Apart from that, problems (*troubleshooting*) on RTG equipment which are sometimes difficult to find are stressful for workers in the *maintenance section* of RTG equipment. The performance pressure experienced by the company can be a risk factor that has the potential to cause work accidents because when workers are pressed for time in completing their work, the worker is less careful and does not focus on work so that workers can experience accidents.

Work fatigue. Work fatigue will occur in every workplace which can cause an individual's level of concentration to decrease in carrying out their work. RTG equipment *maintenance* workers usually experience work fatigue but are not yet at risk of causing work accidents . Informants stated that fatigue was not a risk, including:

Fatigue is actually not a problem here yet, because we work here as a team (i2)

From the results of interviews with respondents, it is known that work fatigue that occurs in the TPK Belawan RTG equipment *maintenance section is not a risk factor for work accidents, because RTG equipment maintenance activities are always carried out together with a flexible team, where workers can take turns dealing with problems* . existing so that it does not have the potential to cause work accidents even though the work activities carried out include work that predominantly relies on physical strength.

Work motivation. Workers can lose motivation at work. The risks of work motivation can be seen in the informants' responses, namely:



because you want to finish it quickly, right? (i1) just then it's ready for the rain (i2)

Various responses from respondents related to work motivation factors can pose a risk of work accidents, where the intended work motivation comes from income or the salary given does not match the worker's expectations, where they often experience delays so that workers can be at risk of losing motivation at work, resulting in work accidents. Apart from that, the factor of loss of motivation when working is felt by workers in the form of having a bad feeling when they want to do their work so that they work in a state of anxiety which is true for the worker to experience a work accident at that time.

Consumption of Substances that Affect the Central Nervous System. When doing their work, workers need full concentration to be able to do their work, along with worker habits that cannot be eliminated even while working. Consumption of substances that affect the central nervous system in RTG equipment maintenance workers, namely smoking, consumption of coffee, tea and fizzy drinks. The informant's statement is:

that, friends like that, he uses ice or drinks on a hot field, sometimes there is that too (i8)

The results of interviews with respondents found that workers still often smoke, consume fizzy drinks, coffee and tea, which is not recommended for field workers such as those in the maintenance and repair section of Rubber Tyred Gantry equipment because smoking can increase the risk of fire caused by the RTG fuel used. also hot from direct sunlight. Apart from that, consuming caffeine in coffee, tea and cola drinks is actually not recommended, because some of these substances are substances that affect the nervous system because they are *stimulants*. *Stimulants* work on the central nervous system to speed up messages to and from the brain. *Stimulants* can increase heart rate, body temperature and blood pressure. These various effects can increase the risk of work accidents, because workers feel unstable, increasing the risk of lack of concentration and can result in the risk of falling or being hit by sharp objects. Other dangers related to smoking, such as smoking in areas with high electrical voltage and having tanks filled with fuel, can be ignited by cigarette flames and can cause fires.



Job Stress. Workers are often required to complete a *troubleshoot* in a very short time, so workers are required to think hard to find where the problem is in the RTG equipment so that it can be repaired as soon as possible. However, sometimes the location of the problem is not easily found, so it is not uncommon for workers to experience stress. Apart from that, workers who are in sweltering hot weather and the presence of noise and vibration can make it easier for workers to experience stress. Apart from that, as a result of work stress, mechanics experience several symptoms of stress that can disrupt work focus and threaten work accidents, such as: irritability and emotion, not wanting to work together and feeling tired easily so that they lack focus on solving existing damage problems, so that workers who feel that they are still focused are carried away by emotions because they cannot go home early because the work has to be done together.

Work hazards faced . Every workplace has different workplace hazards. PT. Prima Multi Peralatan Belawan is a contractor company from the Belawan Container Terminal which is tasked with carrying out maintenance and repairs to damaged *Rubber Tyred Gantry* (RTG) and *Container Crane* (CC) equipment. The location of the RTG equipment maintenance work place is the container port located on the seafront. Because of this, RTG equipment maintenance workers face the dangers of an extreme working climate because it is an open field. When the weather is very hot, workers will feel the sun's heat directly on their bodies while working, so workers are more likely to experience *heat stress*. Respondents complained about the extreme hot weather in the field while working. Moreover, in the current phase the season is very uncertain. Under normal conditions, workers receive temperatures up to 40⁰C and workers are in an open field that interacts directly with the hot sun. Apart from the extreme hot weather, respondents also complained about the danger of falling at heights because workers often work at heights of up to 15 meters.

Workers stated that the work hazard they most often face is the danger of falling from a height due to various causes, such as when after the rain has finished, the RTG equipment will be flooded with water and cause it to become slippery so that workers who are on duty carrying out their work at the height of the RTG equipment will have the potential to fall, however personal protective equipment have been provided at the workplace such as *safety belts*, *body harnesses*,



helmets , vests, etc. Regarding this matter, management considers that the potential for falling from a height is not entirely a work hazard faced because when workers comply with the correct use of PPE, workers will be protected from this danger. However, in reality workers in the field do not fully wear PPE properly because it is known that respondents who are also mechanics in the field admit that workers often do not wear *body harnesses* when climbing to heights to work.

Informants also stated the same thing, namely the danger of falling from heights and climatic factors in the workplace also have the potential to cause fire hazards, especially for RTG equipment that uses fuel. From the results of interviews with respondents to this study, researchers identified three work hazards that workers often face when working, namely: the danger of falling at heights, the danger of hot climates and the danger of fire.

Ergonomic Pitfall Risk Factors

Workers are often trapped in workplace conditions that are not ergonomic for the worker's body, which will cause discomfort while working. This is found in workplace locations where workers often encounter *problems in confined spaces* or limited spaces. Workers who are shorter and thinner will be appointed to enter the limited space and do their work, but this space can only be entered by workers and not to provide comfort while working. It is not uncommon for workers to experience numbness and tingling after half an hour to an hour of work. This was obtained from the respondent's statement during the interview, namely:

Sis often has to go inside her work, so we make it a point to let the smaller bodies come in even though the space still fits... ..(R7)

The ergonomics trap is described by incompatible workplace designs and mismatched expectations.

Incompatible workplace design. Workplace design is not yet fully considered by workers to be a compatible (comfortable) workplace. Compatible means being able to work or play a role in harmony so as to create a comfortable working environment. In fact , workers who maintain the RTG *crane equipment* do not feel completely comfortable when working, the location of the



workplace which is part of the RTG equipment cannot be fully designed in a compatible manner because it has to follow the design of the RTG Crane *equipment* .

Mismatched Expectations. The work carried out in the RTG equipment maintenance section is not fully in accordance with the conditions expected by workers, where workers hope that the workplace is comfortable and safe when working. However, workers are often faced with uncomfortable workplace locations because many workplaces are limited and do not have good air circulation. Apart from that, workers also feel the heat because the workers are directly under the hot sun. According to workers, expectations are not appropriate regarding the conditions of the workplace where the weather is only perceived as hot. However, this condition has also been anticipated by using tarpaulin to cover part of the area where the work is carried out so that workers are more comfortable while working. Based on this, inappropriate expectations are not a risk factor that can cause work accidents for workers.



Decision Factors to Do Wrong

Workers often consciously make wrong decisions, in other words they make decisions to do wrong. Workers usually assume that a hazard in the workplace will not result in anything serious, sometimes due to several factors workers also decide to work according to what they think is logical and achieve faster results.

There is pressure or invitation from colleagues to ignore the SOP . RTG Crane equipment maintenance workers are an activity carried out jointly. Every activity, whether the *preventive maintenance* (PM) process or *troubleshooting repairs* carried out by mechanics, is carried out according to predetermined procedures. Respondents stated that colleagues were invited to ignore applicable procedures due to several reasons. Invitations to colleagues to ignore work procedures are still found in these workplaces. Invitations to colleagues to ignore work procedures are still found in these workplaces. However, this is due to several circumstances, which are known from the respondent's statement:



.....the influence is the same if the money you earn is spent late, yes, that will have an influence. Like if you say there's an incentive, that doesn't make you feel enthusiastic, right? That's also why he invites his friends to work just as much as possible... (R7)

The results of in-depth interviews conducted by respondents revealed that there was an invitation from colleagues to ignore *standard operational procedures* (SOP) at work because of the problem of late incentive payments so that workers felt unenthusiastic at work and tended to have feelings of goiter so they ignored existing procedures and tended to invite colleagues other work so that only the necessary work is done without thinking that ignoring work procedures can also risk causing work accidents to workers.

Management priorities. An activity carried out by a worker may be a major or routine activity carried out at the workplace and the process must be monitored. However, in other activities there may be those that are considered only minor improvements or are so commonly carried out that they are not the center of attention by management. However, according to 9 respondents, all activities that are the company's duties will remain management's priority attention.

There were 9 respondents who stated that all activities carried out in the RTG Crane maintenance process were always supervised by management. Whatever activities are carried out, whether *Preventive Maintenance* (PM), *General Maintenance* (GM) or *Daily Check*, will always be supervised by the company PT. Prima Multi Peralatan and Container Terminal companies. Although not always supervised by PT management. Prima Multi Equipment but also RTG Crane equipment maintenance work is often supervised by the Belawan Container Terminal *management assistant*. Therefore, management priority factors are not a risk factor for work accidents in the RTG equipment maintenance section at PT. Prima Multi Peralatan Belawan.

Logical Decisions. All activities in the company must be carried out according to *Standard Operational Procedures* (SOP). However, in reality, workers often complete their work as is considered more logical and easy to do, even though it can be dangerous and has the risk of causing accidents. The work carried out by workers is sometimes based on their habits and ways of working



that are considered more comfortable and logical because the worker wants to complete the work as quickly as possible and is easy to do. Based on the habits of workers who decide to work which they think is more logical, it becomes a risk factor for work accidents because the worker considers what they do to be harmless, but in reality, the worker's decision which is considered more logical can actually be risky because the decision which the worker considers more logical does not comply with established standards. established where it is known that standards do not necessarily exist but have been studied and analyzed to protect workers from dangerous factors that exist in the workplace.

Conclusion

The research conducted on the analysis of risk factors for work accidents based on human error among Rubber Tyred Gantry (RTG) maintenance workers at PT. Prima Multi Peralatan TPK Belawan has led to the conclusion that the risk factors include individual overload factors that pose a risk of work accidents. These factors encompass physical health conditions, work pressure, work motivation, consumption of substances affecting the central nervous system, work-related stress, work-life balance conditions, and work-related hazards. Additionally, the risk factors for ergonomic traps that can lead to work accidents involve incompatible workplace design. Furthermore, the factors contributing to decision-making errors that carry the risk of work accidents include pressure or encouragement from co-workers to disregard Standard Operating Procedures (SOPs), misjudgment of risks, and making logical errors.

Suggestion

Suggestions aimed at reducing the risk of work accidents among Rubber Tyred Gantry (RTG) maintenance workers at PT. Prima Multi Peralatan TPK Belawan entail several measures. First, the company should conduct regular and periodic health checks for its workers. Additionally, workers should refrain from consuming substances that affect the central nervous system while on the job. Instead of opting for coffee, tea, or soft drinks, it is advisable for workers to increase their



intake of mineral water. Furthermore, workers should prioritize safety when performing their tasks, ensuring strict compliance with standard operational procedures (SOP) to promote safe and comfortable working conditions.



International Journal of Health, Education and Social (IJHES)



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