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PROMOTING WORKER HEALTH AND SAFETY: ASSESSING POTENTIAL RISKS IN MOLD REPLACEMENT ON INJECT STRETCH BLOW MACHINE THROUGH JSA AND HIRADC

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Article Info

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Abstract

In Indonesia's current industrial development, various types of industries have flourished, leading to significant progress. However, this industrial growth has also brought forth new challenges, notably the increased risk of work accidents in corporate environments. Such accidents can severely impact a company's productivity and employee well-being, as workers are constantly exposed to production equipment and machinery. Consequently, the costs of occupational accidents and diseases, both direct and indirect, are substantial. To address these issues, investments in Occupational Safety and Health (OSH) are essential, as they not only reduce costs but also enhance performance, productivity, and overall well-being.

This study focuses on 19 occupational risk factors, including exposure to long working hours, workplace air pollution, asthma, carcinogens, ergonomic risk factors, and noise. Notably, exposure to long working hours is linked to a significant number of deaths, and workplace air pollution is responsible for a considerable number of fatalities. These work-related diseases and injuries not only strain health systems but also impact household incomes and overall economic performance. While global work-related deaths have decreased, deaths from heart disease and stroke due to long working hours have increased, highlighting the emerging psychosocial occupational risk factor.

The main objective of this research is to analyze potential hazards, conduct risk assessments, and implement risk controls using Job Safety Analysis (JSA) and Hazard Identification Risk Assessment and Determining Control (HIRADC) methodologies. The study focuses on a plastic packaging company that employs an Inject Stretch Blow Machine (ISBM) for bottle production. The mold replacement activity

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within this process is identified as having a high potential for accidents due to the use of heavy equipment and massive molds made of iron.

Through the implementation of Occupational Safety and Health Management Systems (OSHM) and the application of JSA and HIRADC, the company aims to reduce work accident rates and associated costs. These methodologies are vital for identifying and mitigating hazards, setting objectives, and devising work safety and health plans.

Previous studies have highlighted the effectiveness of JSA and HIRADC in preventing work accidents and improving work safety. This research seeks to expand on these studies by proposing strategies to reduce work accidents in the Injection Stretch Blow Machine process. Control measures based on various techniques will be explored, including elimination, substitution, engineering controls, administrative measures, and personal protective equipment (PPE).

In conclusion, the study underscores the importance of Occupational Safety and Health in the industrial sector and emphasizes the need for continuous monitoring, planning, and implementation of measures to create healthier, safer, and more equitable workplaces. By leveraging JSA and HIRADC, companies can take proactive steps to ensure worker safety and well-being, leading to enhanced productivity and reduced costs associated with work accidents.

1. Introduction

In the current industrial development, Indonesia has a relatively high level of development. Results in the industrial sector can be seen from the increase in the types of industries on a small, medium, and large scale. This industrial progress raises new challenges and problems, including the risk of work accidents in the corporate environment. The risk of this accident can impact the company, which can harm or reduce the company's productivity because employees or workers are inseparable from production equipment and machinery. These factors will help the process and production results. The overall costs of occupational accidents and diseases are often much more significant than immediately perceived. Conversely, investing in occupational safety and health (OSH) reduces direct and indirect costs, decreasing insurance premiums while improving performance and productivity. It also reduces absenteeism and increases worker morale. Nationally, reduced social security and health care costs mean lower taxes, better economic performance, and enhanced social benefits. The study considers 19 occupational risk factors, including exposure to long working hours and workplace exposure to air pollution, asthma, carcinogens, ergonomic risk factors, and noise. The critical risk was exposure to long working hours – linked to approximately 750,000 deaths. Workplace exposure to air pollution (particulate matter, gases, and fumes) was responsible for 450,000 deaths. The report warns that workrelated diseases and injuries strain health systems, reduce productivity, and can affect household incomes. Globally, work-related deaths per population fell by 14 percent between 2000 and 2016. This may reflect improvements in workplace health and safety, the report says. However, deaths from heart disease and stroke associated with exposure to long working hours rose by 41 and 19%, respectively. This reflects an increasing trend in this relatively new psychosocial occupational risk factor. This first WHO/ILO joint global monitoring report will enable policymakers to track work-related health loss at country, regional and international levels. This allows for more focused scoping, planning, costing, implementing, and evaluating appropriate interventions to improve workers' population health and health equity. The report shows that more action is needed to ensure healthier, safer, more resilient, and socially just workplaces, with a central role played by workplace health promotion and occupational health services [1]. Occupational safety and health is a form of effort that aims to raise and maintain the highest degree of physical, mental, and social health for workers in all states of work. Occupational safety and health can also be interpreted as a form of protection for workers in their work from risks due to causes that are detrimental to health (World Health Organization). Occupational safety and health is the key as a benchmark for performance in job security for companies that want to protect employees in the work environment, such as general regulations that provide instructions to minimize accidents and provide protection for company assets.

The company that will be doing this research is a plastic packaging company whose main process is an Inject stretch blow machine (ISBM) to produce bottles for medicine, cosmetic bottles, eye drop bottles and so on. In the Inject stretch blow machine (ISBM) process, there is a mold replacement activity where the frequency is quite frequent, namely an average of 2 times per day, where this activity has a high potential for danger. This potential is because quite a lot of equipment is used, including cranes, large locks, clamps, etc. Apart from the equipment used, the molds that were replaced weighed more than 500 kg and were machined about ½ meter, and were made of iron. The causes of work accidents in this case study are very diverse, such as a foot or hand caught in a mold, hit by a wrench, shot by a crane hook, and so on. Seeing that there is a significant potential for workplace accidents in the mold-changing activity, it is necessary to carry out a potential hazard analysis, risk assessment, and risk control by applying the Job Safety Analysis (JSA) method and Hazard Identification Risk Assessment and Determining control (HIRADC).

With the existence of an Occupational Safety and Health Management System (OSHM) that companies have implemented by government standards, it can reduce the risk of a company in terms of work accident rates which can later affect costs. Job Safety Analysis (JSA) is a form of identifying hazards in a working condition as well as controlling and mitigating efforts to minimize illness or accidents caused by accidents and work-related illnesses that may arise from a job [2]. Hazard Identification Risk Assessment and Determining control (HIRADC) is a form of the process of identifying hazards, measuring, and evaluating risks that arise from something that can pose a risk of occupational hazards after that calculating the adequacy of existing control measures and deciding which chances are acceptable or not [3]. JSA and HIRADC are essential elements in the occupational safety and health management system because they are directly related to mitigating and controlling hazards used to determine objectives and work safety and health plans.

Several previous studies on work accidents were mainly carried out using the method of job safety analysis (JSA) and Hazard Identification Risk Assessment and Determining control (HIRADC) regarding the results obtained from his research in the application of job safety analysis as an effort to prevent work accidents and also improve work safety at PT Shell Indonesia [4]. The results obtained from this study by providing refreshments every week about the risks of hazards that exist in the workplace. Research conducted by [5] Based on these problems, the researchers offer suggestions for improvements to reduce the number of work accidents using the Job Safety Analysis (JSA) method. The purpose of this research is to plan a strategy to reduce work accidents and apply the Job safety analysis (JSA) method and Hazard identification, risk assessment, and determine control (HIRADC). Severity and frequency of occurrence of the hazard. Control measures must follow Control Techniques

(Elimination, Substitution, Engineering, Administration, PPE) and their implementation in Injection stretch blow machine which has not been discussed in previous studies.

2. Literature Review

Risk Assessment according is an important systematic process that aims to assess the impact, occurrence, and consequences of human activities in systems with hazardous characteristics and is also a tool that companies want for policies regarding company security [6]. Risk assessment defining the criteria like hood and consequences (severity) [7]. The likelihood criterion used is based on the company's track record within a certain period. The Consequences (severity) bar used is what the worker will receive as a result which is defined qualitatively and takes into account the lost working days [9]. The risk rating is the result of multiplying the value of the likelihood level with the Consequences value of each hazard. Determination of the value of the likelihood and severity of each hazard risk is conducted using interviews with the K3 section. After the likelihood and consequence values have been obtained, the next step is to look for the risk rating value by matching the likelihood value with the resulting Consequences value.

2.1. Job Safety Analysis (JSA)

Job Safety Analysis (JSA) is a way of identifying hazards in an environment or working conditions as well as a form of control and prevention in order to avoid illness or accidents caused by accidents and work-related illnesses that may arise from a job [8].

Job Safety Analysis (JSA), which is a hazard and risk identification process based on each stage in a work process.

1. Identification of hazards associated with each step of the work that has the potential to cause serious harm, before an accident occurs.
2. Determine how to control hazards or reduce injury rates.
3. Create written tools that can be used to train other staff

The advantages of making a Job Safety Analysis are as follows [9]:

1. Provide individual training in safety and efficient work procedures.
2. Establish worker safety contacts.
3. Prepare for planned safety observations.
4. Entrusting work to new workers.
5. Provides pre-job instructions for great jobshere.

2.2. Hazard Identification Risk Assessment and Determining Control (HIRADC)

Hazard Identification Risk Assessment and Determining control (HIRADC) is the process of identifying hazards, measuring, evaluating risks that arise from something that can cause harm, then calculating the adequacy of existing control measures and deciding which risks are acceptable or not [10]. HIRADC is an important element in the occupational safety and health management system because it is directly related to efforts to prevent and control hazards that are used to determine objectives and work safety and health plans.

The advantages of using the HIRADC technique include understanding the stages of work and their hazards, knowing work-related hazards earlier, so that the chance of an accident can be quickly reduced or eliminated, efficiency will increase, the HIRADC technique can also influence the purchase of tools that are safer at work [11].

Things that must be considered in implementing HIRADC:

1. Identification of hazards that may occur
2. Determine the type of hazard and who is potentially exposed to the hazard

3. Risk evaluation and determination for hazard and risk control (must consider the hierarchy of controls: elimination, substitution, isolation, engineering control, marking/warning/administrative control, PPE)
4. Changes from HSE management
5. Recording and documentation of HIRADC activities (eg: HIRADC register)

In determining the making of a methodology or way to carry out HIRADC, and the methodology used is in the form of proactive actions including [12]:

1. Direct observation, the way to do this must be direct observation submitted to the organization depending on the needs of the organization to carry out HIRADC, depending on the scope, nature, size of the organization, time, cost and data availability for HIRADC implementation. selected can cover the implementation of HIRADC in the organization.
2. Group Discussion, before carrying out the HIRADC technique, a focus group discussion is needed by people who are competent and involved in the implementation.
3. Imagine, competent people must be able to imagine risks, hazards, and determine strategies in implementing work safety using the HIRADC technique.

The factors assessed in the HIRADC method are the likelihood and impact of these hazards. In addition, what is considered to be lowered is not to the person, but more to the danger posed up to the permissible limithere.

Hierarchy of Control is a risk control system and mechanism that is carried out in a structured manner starting from the simple to the more complex. The control system should and should be done in stages. Structurally, the Hierarchy of Control can be described as follows [13]:

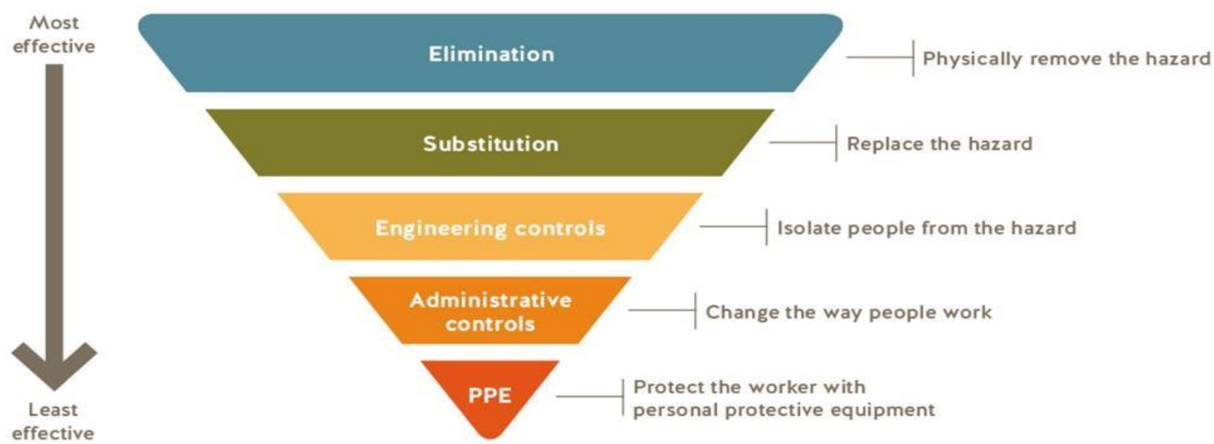

Fig 1. Hierarchy of Hazard Control

Elimination is the first stage in the Control Hierarchy. Elimination is an attempt to eliminate the source of danger. Eliminating the source of the hazard is done by eliminating or removing the object or work that is the source of the hazard [14] [15].

Substitution is the second stage in the Control Hierarchy. Substitution is the process of substituting hazardous materials, processes or procedures with less hazardous ones. With this control system, a redesign of a system or mechanism will be required [16] [17].

Engineering is the third stage in the Hierarchy of Control. Engineering is doing hazard segregation to prevent risks from occurring. In engineering, this is usually carried out in the form of modifications in such a way that potential hazards can be minimized or even eliminated [18] [19].

Administration is the fourth stage in the Hierarchy of Control. In the Hierarchy of Control, administration can also be used as a control tool, namely from the side of the person doing the work, namely by implementing procedures that are deemed necessary. With this administrative control, it is expected that people working around can comply and be able to do work safely [20].

3. Methods

This Based on the method of data collection, this research is observational in nature, because the data was obtained through observation and no treatment was carried out on the research object during the research. Based on the time of research, this research is cross-sectional in nature, because data collection was carried out all at once. If reviewed based on analysis, this research is a descriptive research that is describing the process without analyzing the relationship of variables [21].

In the activity of changing the mold on the machine, it is carried out by at least 2 people considering the equipment that is unloaded is quite heavy and also the complexity in handling it. In general, the activities carried out and the potential hazards that can occur can be described as follows:

Table 1. Changing Mold ISBM analysis activities

No	activity	Potential hazard	Risk
1	Turn off Barrel temperature & hot runner	The skin touches the hot cover barrel	Skin blisters / burns
2	Unscrew the ejector rod unit mounting bolts	The operator is caught in the machine/tool	Wounds or defects
3	Lower the Ejector rod unit from the engine	Incorrect body position when lifting the mold without assistance	Sprain
4	Unscrew the Blow Core fasteners	The operator is caught in the machine/tool	Wounds or defects
5	Lowers the Blow Core unit from the machine	Incorrect body position when lifting the mold without assistance	Sprain
6	Reducing heating pot binders, cores, lip cavities	The hand is pinched/cut into the mold/tooling or work tool	Wounds or defects
7	Lowering bottom Mold & blow mold	The head or limbs hit the mold or machine parts	Wounds or defects
8	Placing the blow mold and bottom mold in the trolly	The foot or hand is caught in the mold	Bruises or broken bones
9	Drain cooling Injection core & Hot runner	Pressurized hot water spray	blisters or burns
10	Reducing Injection cavity, core and hot runner	Limbs	
11	Bring trolley molds and old tooling to MTP	The foot or hand is caught in the mold	Bruises or broken bones
12	Bringing new Molds and Tooling to the machine	Slipping or pulling a load that is too heavy	Sprain
13	Install injection cavity and hot runner	Pinched finger	Cuts or bruises
14	Install blow mold, ejector, blow core	Pinched finger	Cuts or bruises

15	Installing heating pots, heating cores	Hot conditions on the hands directly	Blisters and lip cav
16	Install Injection core, bottom mold, blow core unit	Pinched finger	Cuts or bruises
17	Clamping Injection cav, blow mold, lip cav, heating pot and cav	The foot or hand is caught in the mold	Bruises or broken bones
18	Tighten all mold fixing bolts	Pinched finger	Cuts or bruises
19	Running the machine without material	Plugging the plug into a wet socket	Electric shock
20	Take material from MPC	Back pain due to wrong body position when lifting the mold/tooling	Sprain or back pain
21	Fill Material into the hopper	Fall while climbing stairs or on machinery	Bruises or broken bones
22	Materials Heating	The limbs were sprayed with liquid material	Scalded skin (Burns)
23	Raising the temperature of the barrel and hot runner	Hand touched the hot part	Scalded skin (Burns)

4. Results and Discussion

From the results of observing the activity of replacing the mold or mold consisting of 23 work activities both routine and non-routine, the work activity is broadly divided into 4 stages, namely removing the mold or mold, lowering the mold from the machine, raising the replacement mold and installing the mold to the machine. Hazard identification was carried out in 23 work activities, both routine and non-routine, during mold replacement work using the Job Safety Analysis (JSA) method and continued with the steps of carrying out a risk assessment. In carrying out a risk assessment there are two stages, namely risk analysis and evaluation. The risk assessment carried out in this study uses a semiquantitative risk analysis method which consists of three aspects of assessment [22]. The three aspects assessed and evaluated in the semiquantitative risk analysis method include likelihood [23]. Furthermore, the handling of these hazard risks is carried out using the HIRADC method, where the overall results can be seen in table 2 below.

Table 2 . Risk analysis and countermeasures

No	activity	Potential hazard	Risk	Risk Calculation	Mitigation
1	Turn off Barrel temperature & hot runner	The skin touches the hot cover barrel	Skin blisters / burns	Currently	PPE, with gloves
2	Unscrew the ejector rod unit mounting bolts	The operator is caught in the machine/tool	Wounds or defects	Low	Adm, by making WI
3	Lower the Ejector rod unit from the engine	Incorrect body position when lifting the mold	Sprain	Currently	Technically, by using a lifter
4	Unscrew the Blow Core fasteners	The operator is caught in the machine/tool	Wounds or defects	Low	Adm, by making WI

5	Lowers the Blow Core unit from the machine	Incorrect body position when lifting the mold	Sprain	Currently	Technically, by using a lifter
6	Reducing heating pot binders, cores, lip cavities	The hand is pinched/cut into the mold/tooling or work tool	Wounds or defects	Low	Adm, by making WI
7	Lowering bottom Mold & blow mold	limbs hit by parts of the mold or machine	Wounds or defects	Tall	Technically, by using a lifter

8 Placing the blow The foot or hand is Bruises or broken Tall Technically, by mold and
bottom caught in the mold bones using a crane mold in the trolly

9 Drain cooling Injec- Pressurized hot water blisters or burns Low Adm, by making tion core
& Hot run- spray WI ner

10 Reducing Injection Incorrect body position Sprain Currently Technically, by cavity, core and hot
when lifting the mold using a lifter runner

11 Bring trolly molds The foot or hand is Bruises or broken Low Substitution, usand old
tooling to caught in the mold bones ing a forklift
MTP

12 Bringing new Molds Slipping or pulling a Sprain Currently Substitution, and Tooling to the load
that is too heavy using a forklift machine

13 Install injection cav-Pinched finger Cuts or bruises Currently Adm, by making
ity and hot runner WI

14 Install blow mold, Body crushed by Wounds or Broken Tall Technically, a ejector,
blow core equipment Bones retaining tool is made

15 Installing heating Hot conditions on the Blisters Currently PPE, with gloves
pots, heating cores hands directly and
lip cav

16 Install Injection Pinched finger Cuts or bruises Currently Adm, by making
core, bottom mold, WI blow core unit

17 Clamping Injection The foot or hand is Bruises or broken Tall Technically, a cav, blow
mold, lip caught in the mold bones retaining tool is
cav, heating pot made

18 Tighten the mold Pinched finger Cuts or bruises Low Adm, by making fixing bolts WI

19 Running the ma- Plugging in a socket in Electric shock Currently Adm, by making
chine without mate- wet conditions WI rial

20 Take material from Back pain due to Sprain or back Tall Technically, a
MPC wrong body position pain material suction
when lifting tool is made

21 Fill Material into the Fall while climbing Bruises or broken Tall Technically, a
hopper stairs or on machinery bones material suction

	tool is made				
22	Materials Heating	The limbs were sprayed with liquid material	Scalded skin (Burns)	Currently	Technically, a tool is made to material hold the
23	Raising the temperature of the barrel, part	Hand touched the hot heating pot and hot runner	Scalded skin (Burns)	Currently	PPE, with gloves

5. Conclusion

In The hazard identification that has been carried out resulted in 23 potential hazards contained in the process of replacing the ISBM machine mold from all work activities that could pose a risk. The results of the risk assessment carried out are 23 risks with a risk rating consisting of 6 risks with high risk rating, 11 medium risk, 6 low risk. Risk control for workers in the ISBM machine mold replacement process has been carried out based on a risk control hierarchy, namely Elimination, Substitution, technical, administrative and use of PPE. Where by carrying out these controls, the risk of workers experiencing work accidents can be minimized and even eliminated as well. Henceforth, the JSA and HIRADC analysis processes must also be applied to other processes and machines, where this will reduce the potential for work accidents which in the end can be detrimental to the company if they occur.

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