

Occupational health and safety at a metal casting company

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ABSTRACT

A cast metal company has become a vital industrial sector. It creates various kinds of products like cages, souvenirs, kitchen appliances, ashtrays, ship joint shafts, hotplates, fitness equipment, manual water pumps, pendulum scales, garden benches, lamp posts, interior lights, wall lamps, grills, manhole, and other types of equipment to deal with workplace safety. However, some workers ignore the various potential hazards during the production process. They are more concerned with comfort aspects than safety. This research enhances occupational safety and health (OSH) aspects through Hazard Identification Risk Assessment and Risk Control (HIRARC). It was done by identifying potential hazards in the workplace and making a hazard risk assessment to determine appropriate controls for reducing the hazard risks. Based on hazard identification and risk assessment, the results show 11 high, 2 medium-risk, and 1 low-risk level. The risk control proposals are in the form of training on the importance of OSH among employees and also efforts in raising awareness to provide work safety facilities and establish policies related to OSH.

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1. Introduction

A work accident is an unwanted work event that causes illness and/or damage (loss) to people, assets, the environment, or reputation during production. Another term, hazard, is the potential to cause harm, including health problems and injury to humans (workers). It also creates a loss of working time, property destruction, and damage to the work area, place, product or the surrounding environment. [1][2]. Based on the commission of the International Labor Organization (ILO)/ World Health Organization (WHO) in 1998, Occupational Safety and Health (OSH) is a promotion and protection to achieve the optimal level of health consisting of physical, social and mental aspects for the welfare among workers in the real work environment. The OSH application is to produce a comfortable and healthy work environment which is environmental pollution-free to decrease work accidents or infectious diseases [3].

Accidents and workers' health problems are caused by many things, such as overcrowded workplace conditions, unaccounted placement of dangerous goods, poor air circulation in the workplace (dirty, dusty, unpleasant smell), and unconditioned air temperature [4]. All industries have risk of fire that can disrupt production activities and drain the company's assets, thereby permanently stopping the company's operations [5]. Industrial accidents are generally caused by two main things, human behaviour or unsafe action and unsafe environmental conditions [6].

ILO report in 2013 shows that one expert in the world dies every 15 seconds due to work accidents, and 160 workers are infected with workplace diseases. Other data from The Bureau of Labor Statistics in 2016 confirms that 0.9 cases per 100 workers suffer from occupational injuries and illnesses in the production sector. Meanwhile, in Indonesia, a survey of 26 provinces indicates that throughout 2013 there were 2,998,766 cases of work accidents and 428,844 cases of occupational diseases [7].

Referring to Law No. 1 of 1970 on Occupational Safety, Law No. 23 of 1993 on Health, and Law No. 13 of 2003 on Manpower, industrial sectors are obliged to provide a workplace environment which is healthy, safe and free from work risks. The Minister of Manpower Regulation No. PER 05/MEN/1996 also urges the OHS Management System in the workplace, production sources and production processes [8]. OSH has been stated in Article 86, paragraph 2, number 31 of Law No. 13 of 2003, which demands that every employee has the right to obtain protection for occupational safety and health to achieve optimal work productivity, safety and health [4].

This condition raises the importance of Hazard Identification and Risk Assessment to identify unwanted events and estimate the hazard's impact [9][10]. Hazard Identification, Risk Assessment and Risk Control, or HIRARC, is a critical element of the OSH management system to prevent and control hazards. The entire process of HIRARC, also known as risk management, is formulated in a HIRARC document which is very useful for avoiding work accidents. [11]. Risk management's benefits are preventing companies from failure and increasing profits directly and indirectly. It also establishes confidence among managers caused by risk protection and public image guarantee [12]. Implementing an efficient and appropriate OSH system is indispensable to realising a safe workplace in the manufacturing industry. The use of HIRARC is considered effective in identifying, assessing, managing and mitigating the hazards among workers [13].

This study focused on a metal casting company established in 2008. Based on the field observation, many workers still ignore potential factors that may cause work accidents, such as a lack of awareness of the importance of OSH. They also gave little attention to safe machine operation and other potential hazards on the production floor. Based on the description of the existing problems related to work risks in metal casting companies, the HIRARC method was chosen to analyse the work risks to improve the quality of the OSH system in the company.

2. Method

The data collection process was carried out through direct observation on the metal production floor, the interview session, and a literature study related to OSH. In the data processing, the HIRARC (Hazard Identification, Risk Assessment, Risk Control) approach was made with the following explanation:

- 1) Hazard Identification to reveal potential hazards during the metal production process
- 2) Risk Assessment to measure any work risk on the production floor
- 3) Risk Control to manage work risks on the production floor

Hazard Identification Risk Assessment and Risk Control (HIRARC) prevents or minimises work accidents. This method starts with determining the work activity type followed by identifying the hazard source to obtain the potential risk. Risk assessment and control are proposed to reduce exposure to hazards for each kind of work. According to AS/NZS 4360:1999, risk is the chance of occurrence that will impact the target, measured by the law of cause and effect [15]. The risk can be predicted based on the likelihood and consequence values.

Risk assessment is a process of identifying potential hazards that may occur. It functions to ensure that the risk control of the process and the operation are at an acceptable level. The assessments in the risk assessment are Likelihood (L) and Severity (S). The Likelihood level shows how likely the accident is to occur, as seen in Table 2, while Severity shows how severe the impact of the accident is as can be seen in Table 1. The values from Likelihood and Severity would be used to determine the Risk Level [14] in the risk matrix presented in Table 3.

Table 1 Severity Level of AS/NZS 4360:1999 Standard

Level	Criteria	Explanation
1	Insignificant	No injuries or small financial losses
2	Minor	First aid, on-site handling, and moderate financial loss
3	Moderate	Medical treatment, on-site treatment with outside assistance, large financial losses.
4	Major	Serious injury, loss of production capability, handling outside the area without negative effects, significant financial loss
5	Catastrophic	Death, poisoning outside the area with disruptive effects, huge financial loss

Table 2 Likelihood Level of AS/NZS 4360:1999 Standard

Level	Criteria	Explanation
1	Almost certain	Happen in nearly all circumstances
2	Likely	Happen in almost all circumstances
3	Possible	Happen at any time
4	Unlikely	Rarely happen
5	Rare	Only happen under certain circumstances

Table 3 Risk Matrix of AS/NZS 4360:1999 Standard

Level Likelihood	Level Severity				
	1	2	3	4	5
1	H	H	E	E	E
2	M	H	H	E	E
3	L	M	H	E	E
4	L	L	M	H	E
5	L	L	M	H	H

Note: L: Low risk, M: Medium risk, H: High risk , E: Extreme risk [16]

3. Results and Discussion

If left unchecked, several work risks will negatively impact the company's productivity, especially in the metal production process related to OSH management. In this study, the HIRARC (Hazard Identification, Risk Assessment, Risk Control) approach was proposed to analyse the company's work risks as follows.

3.1 Hazard Identification

Hazard identification becomes the first step to analysing an accident's potential source during work. Table 4 below shows the hazard identification.

Table 4 Hazard identification

Workstation	Hazard identification	Risk identification
Casting	High-temperature combustion	Burnt skin
	Hot molten metal	Metallic liquid splash
	Not wearing PPE	molten metal splash

Workstation	Hazard identification	Risk identification
<i>Machining</i>	Uneven casting results	Injured skin
	Metal powder	Irritation of the olfactory organs
	Grinding blade	Skin cuts and abrasions
	Dim light	Object crash
	Noise	Deafening
	Bad working posture	Body aches, sprains
	Not wearing PPE	Injured hands due to material hit
<i>Finishing</i>	Iron powder	Environmental toxins and infertility
	Spray paint	Eye and nose irritation
	Grinding blade	Skin cuts and abrasions
	Manual Lifting	Aches, sprains, injuries

3.2 Risk Assessment

Occupational risk assessment was determined based on the likelihood and severity level based on the AS/NZS 4360:1999 standard. The following are the results of the risk assessment in Table 5.

Table 5 Risk Assessment

Workstation	Hazard Identification	Risk Identification	Likelihood level	Severity level	Risk Level
<i>Casting</i>	High-temperature combustion	Burnt skin	3	3	H
	Hot molten metal	Metallic liquid splash	3	3	H
	Not wearing PPE	molten metal splash	3	3	H
<i>Machining</i>	Uneven casting results	Injured skin	2	2	H
	Metal powder	Irritation of the olfactory organs	2	2	H
	Grinding blade	Skin cuts and abrasions	3	3	H
	Dim light	Object crash	2	2	H
	Noise	Deafening	1	2	H
	Bad working posture	Body aches, sprains	2	2	H
	Not wearing PPE	Injured hands due to material hit	2	3	H
	Iron powder	Environmental toxins and infertility	2	3	H
	<i>Finishing</i>	Spray paint	Eye and nose irritation	3	2
Grinding blade		Skin cuts and abrasions	3	2	M
Manual Lifting		Aches, sprains, injuries	4	2	L

3.3 Risk Control

The next stage after the risk identification and assessment process is risk control by considering the impact that the hazard's sources may cause. The work of risk control can be seen in Table 6.

Table 6 Risk Control

Workstation	Hazard identification	Risk Identification	Likelihood level	Severity level	Risk level	Control
<i>Casting</i>	High-temperature combustion	Burnt skin	3	3	H	Using personal protective equipment
	Hot molten metal	Metallic liquid splash	3	3	H	Using personal protective equipment
	Not wearing PPE	molten metal splash	3	3	H	Using personal protective equipment

Workstation	Hazard identification	Risk Identification	Likelihood level	Severity level	Risk level	Control
<i>Machining</i>	Uneven casting results	Injured skin	2	2	H	Using gloves to have physical contact with the workpiece.
	Metal powder	Irritation of the olfactory organs	2	2	H	Wearing a mask, regulate air circulation,
	Grinding blade	Skin cuts and abrasions	3	3	H	Using gloves when using the grinder
	Dim light	Object crash	2	2	H	Redesigning the lighting system on the production floor.
	Noise	Deafening	1	2	H	Wearing ear protection during the machine operation
	Bad working posture	Body aches, sprains	2	2	H	Developing ergonomic work position
	Not wearing PPE	Injured hands due to material hit	2	3	H	Using a mask, regulating air circulation, and applying the 5S concept.
<i>Finishing</i>	Iron powder	Environmental toxins and infertility	2	3	H	Using a mask and goggles during the painting process
	Spray paint	Eye and nose irritation	3	2	M	Using hand protection
	Grinding blade	Skin cuts and abrasions	3	2	M	Providing appropriate material handling
	Manual Lifting	Aches, sprains, injuries	4	2	L	Using personal protective equipment during the working process

Based on the analysis using the HIRARC method, 11 high-risk levels, 2 medium-risk levels, and 1 low-risk level can be categorised. Therefore, it is necessary to control work risks to ensure the health and safety of workers in metal casting companies. Below are several risk control steps that can be taken.

1. Applying the OSH concept continuously
2. Providing facilities to support OSH systems such as personal protective equipment, masks, gloves, shoes, glasses, and posters
3. Arranging the layout of production and workstations based on the ergonomics concept
4. Providing the training on the importance of OSH among employees/workers
5. Conducting OSH certification on several staffs to grow the OHS culture

4. Conclusion

Based on the risk identification, various potential hazards exist on the production floor, including hot molten metal, metal powder, poor lighting, rough metal casting, noise (engine machine and loud music), and the improper use of machines that may harm the operator. Some causes of work accidents are the lack of attention to the OSH system and incomplete facilities. The suggestions to grow OSH culture are

providing training on the importance of the OSH system, upgrading OSH facilities, and arranging policies related to OSH implementation.

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