



Proposed Improvements to Reduce the Risk Work Accidents on CV HB with FMEA and HAZOP Method

Martin Julian Sugianto¹, Revaldo Alexander Reggy², Hana Aulia Fadhilah³,
Dustin Benedict⁴, Paulus Sukpto^{5*}

¹⁻⁵Universitas Katolik Parahyangan, West Java, Indonesia

*Corresponding Author : paulus@unpar.ac.id

Abstract. A company called CV HB makes socks based on what its customers want. Bandung is home to CV HB. Several machines, including Santoni, Dakong, Obrass, Stock Steam, and others, are employed in CV HB's sock production process. Numerous personnel who are in charge of running the machinery and performing other production tasks are also a part of the production process. The execution of health and safety protocols has yet to be well-executed in the production sector. The organization saw 24 workplace accidents between 2019 and 2023, including injuries from needles and blades, hands stuck in machinery, brain injuries from machines, slipping down stairs, and many more incidents. In order to address health and safety concerns at CV HB, the research attempts to pinpoint the root causes of workplace mishaps and offer suggestions for enhancement. Hazard and Operability Review (HAZOP) and Failure Mode and Effects Analysis (FMEA) were the methodologies used in the investigation. A few suggestions for improvement for the chosen departments are using material handling tools during the material retrieval process, posting warnings about machines with sharp parts, requiring protective gear like masks and gloves, designing foam padding for sharp machine parts, and installing fans.

Keywords: Accidents, FMEA, HAZOP, Risk, Safety

INTRODUCTION

Manufacturing is converting raw materials into semi-finished or finished commodities to create products with added value (Mangkunegara, 2016). Occupational Safety and Health (OSH) is an essential manufacturing factor. Occupational safety and health is an idea and endeavor to guarantee workers' physical and mental welfare to preserve workers' safety and welfare so they can attain maximum productivity and health (Hasibuan et al., 2020). In order to reduce the risk of work-related illnesses and accidents, which can harm employee well-being, medical expenses, and productivity, occupational safety and health are necessary in the manufacturing sector.

From 2017 to 2022, there was an increase in the number of work accidents in Indonesia, according to the Social Security Administering Agency (BPJS) for Employment in the Data Indonesia. id website (Pratiwi, 2023). Figure 1's graph illustrates the rise in work-related

accidents in Indonesia. While there were initially just 123,040 work accidents in 2017, this number increased steadily until 2022, when it peaked at 265,334 work accident cases. 2022 there will be 13.26% more accidents than in 2021, when there were 234,270 cases. It is evident from this that this is connected to Indonesia's rise in work-related accidents.



Source: dataindonesia.id

Figure 1. Work Accident Data in Indonesia

Law Number 1 of 1970 concerning Occupational Safety (Kementerian ESDM, 1970) contains the Occupational Safety and Health legislation in Indonesia. The regulation covers the following topics: every worker has the right to be protected from harm while performing their job; every worker in a work environment has the right to have their safety ensured; every production resource must be used safely and effectively; and the development of norms must be realized in laws that contain work safety provisions that are in line with the advancement of industrialization, society, engineering, and technology.

The topic of this study will be occupational safety and health in a manufacturing industrial company, specifically in the case of CV HB, a factory that makes socks. Several divisions are present at CV HB, including material retrieval, sock manufacture, sock sewing, sock turning, sock steaming, inspection, and packaging. There are several work-related issues and accidents at CV HB, most caused by various circumstances, including human mistakes, technical faults, and other causes. The company had to spend Rp 27,880,932 since 24 work accident instances were reported between 2019 and 2023. The company's management stated that this affected the company's finances and could lower income. Therefore, studies were conducted to identify the contributing elements to work-related incidents at CV HB and offer suitable recommendations for improving occupational health and safety issues.

LITERATURE

According to Handhih (2021), a work accident is considered an uncertain event due to the unpredictability of its timing, but it nevertheless results in losses. Numerous aspects, including worker factors, technique factors, equipment, and management, might naturally contribute to the likelihood of a work accident (Ervianto, 2012). Causes of work accidents that come from inside the human race are called worker factors or human factors. Workplace accidents that result from improper work practices or procedures are caused by method factors, often known as work factors. Poor machine performance or mistakes made when operating machinery are examples of equipment-related factors. Not only that, but this element category also includes the absence of protective gear. Workplace laws, such as a deficiency of occupational health and safety policies, contribute to work accidents: management factors. Aside from that, Whandhih (2021) claims that dangerous workplace conditions (unsafe conditions from the work environment) and unsafe activities (unsafe acts from humans) are the two leading causes of work accidents.

Work accidents can have several detrimental effects, including long-term health effects and injuries, high medical expenses, lost productivity and production, psychological effects on employees, harm to the company's reputation, and, in the worst-case scenario, a lawsuit against the company. Given the adverse effects, precautionary measures are required to avoid work accidents in the production environment. These include identifying high-risk job types, educating employees, overseeing work implementation, providing work protective equipment, and performing routine maintenance and inspections at the workplace (Ervianto, 2012).

The process of studying, creating, putting into practice, overseeing, and carrying out ongoing assessments of programs and services aimed at enhancing the physical and mental health of employees at work and safeguarding workplaces from dangerous behaviors, hazardous situations, and violence is known as occupational health and safety, according to the National Institute for Occupational Safety and Health in the Ministry of Manpower (2018). According to Kuswana (2014), occupational health refers to the state where employees are free from physical or mental illnesses that their jobs or the workspace may bring. While performing their jobs at work, employees should be in a safe environment free from harm or loss (Kuswana, 2014). A worker's safety and health are guaranteed and protected by efforts to identify hazards and prevent work accidents, as stated in Government Regulation Number 50 of 2012 of the Republic of Indonesia. FMEA stands for Failure Mode and Effects Analysis, an analytical technique used to detect, analyze, and remove work processes to prevent errors from leading to failures before they affect customers (Stamatis, 1995). According to Yumaida (2011), another way to define FMEA is

as an assessment technique for examining potential system or work process faults that may arise and then be rectified by prioritizing them. The three assessment components of the FMEA technique are occurrence, detection, and severity. The assessment of the significance of the consequences of a failure or accident is known as the severity aspect. The frequency at which a process's root cause manifests itself is correlated with its occurrence. Evaluating the likelihood of identifying possible reasons for a failure type is known as the detection aspect. An RPN, or risk priority number, will be determined by summing the scores from the three components of the evaluation criteria. The severity, occurrence, and detection values are multiplied to create the risk priority level or RPN. When suggesting changes or necessary preventive measures, the greater the RPN value attained, the higher the importance.

A technological risk analysis technique called Hazard and Operability Review (HAZOP) is employed to assess the security of new systems or any operational issues (Suardi, 2015). Group analyzers use the Hazard Analysis and ZOP test to find possible risks in a system running outside established normal limits. HAZOP is a structured process evaluation tool used to analyze an operation or process in a system to determine whether deviations from the process could result in undesirable events or accidents. To put it another way, this method is used as a preventive measure to ensure the system can operate smoothly and safely (Juliana, 2008).

METHOD

Failure Mode and Effects Analysis (FMEA) and Hazard and Operability Review (HAZOP) were the methodologies used in this study. Using the FMEA technique, each department's control procedures or detection methods are first identified, along with the process description, failure method, probable failure impacts, and possible reasons for failure. Based on these findings, the causes and effects of work accidents that transpire in every department at CV HB will be roughly understood. Assessing severity, occurrence, and detection should then come next. Staff members from every department evaluate to ensure that individuals who genuinely comprehend or perform the tasks are evaluating these three factors. The RPN value, or Risk Priority Number, should then be located. The departments that need to be prioritized are identified using the Pareto approach after the RPN findings are sized from largest to smallest as a priority sequence.

Subsequently, HAZOP method processing will be carried out by departments that are part of the 80/20 Pareto concept. For every department prioritized for improvement, a more detailed understanding of accidents, their causes, and their effects will be achieved by analyzing

HAZOP's parts, guidelines, resultant differences, potential issues, and remedies. Improvement recommendations aim to lower the probability of work accidents when the causes of accidents and their effects on the departments at CV HB are understood.

DISCUSSION

Material retrieval, sock making, sewing, sock turning, steaming, inspection, and packaging are the seven departments that makeup CV HB. In the beginning, the FMEA method was used to conduct the research. Under the FMEA technique, each department's control or detection procedure is performed first, along with the description, failure, possible causes, and potential effects of failure. Next, weighting is applied to the severity, occurrence, and detection values using a range of 1 to 10. The RPN value is found for each department by multiplying the severity, occurrence, and detection values once all of these values have been obtained. The severity, occurrence, detection, and RPN value data are summarized in Table 1.

Tabel 1. Recapitulation of FMEA Results

No	Department	Severity (S)	Occurrence (O)	Detection (D)	RPN	Cumulative
1	Material Retrieval Department	6,5	5,5	5	178,750	178,750
2	Sock Making Department	5,25	6,5	5	162,094	340,844
3	Sock Sewing Department	5,25	6,5	5	162,094	502,938
4	Packaging	2,5	4,5	3	33,750	564,188
5	Sock Steaming Department	3,5	4,5	3	47,250	611,438
6	Inspection	3	4	3	36,000	647,438
7	Sock Turning Department	3,5	5	4	61,250	681,188

All RPN values are then sorted from largest to smallest, and added up to form a cumulative form. Then the Pareto 80/20 concept will be used, where improvements are made to departments that are included in the 80% cumulative RPN percentage. Figure 2 shows the results of the Pareto Bar Diagram.

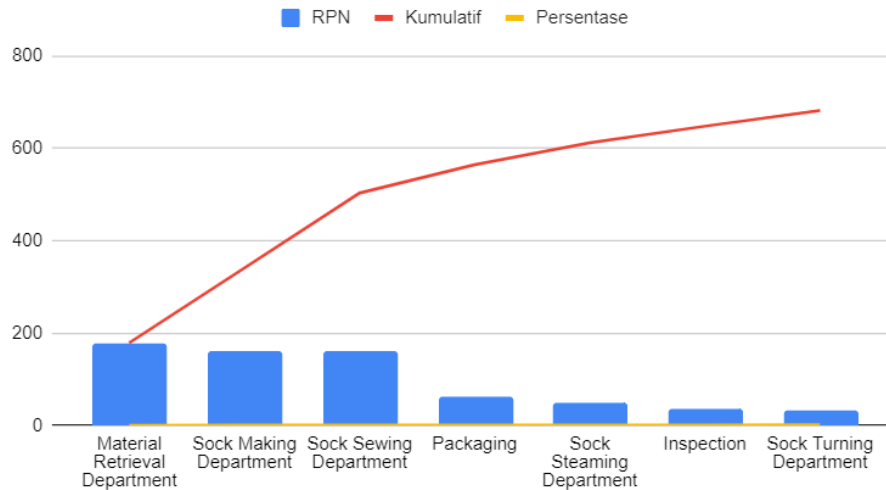


Figure 2. FMEA Pareto Diagram

Since the Pareto principle calls for improvements to be implemented at a cumulative percentage of 80%, the Material Retrieval Department, Sock Making Department, Sock Sewing Department, Packaging Department, and Sock Steaming Department will all receive improvements based on Figure 2. Potential hazards were found by the HAZOP approach following the analysis of the likelihood that CV HB would fail and the evaluation of each failure's risk through the use of the FMEA technique. A more thorough option for identifying possible failures or hazards is to use the FMEA and HAZOP methodologies. Department identification, factors to be evaluated, guide words, resulting differences, potential problems, and changes to be addressed are all carried out in the HAZOP strategy. The output of HAZOP techniques is shown in Table 2.

Tabel 2. HAZOP Results

<i>System / Process Component</i>	<i>Factor Analyzed</i>	<i>Guide-Word</i>	<i>Resulting Difference</i>	<i>Potential Problem</i>	<i>Remedy</i>
Material Retrieval Department	Quantity of load lifted	A little	Low amount of material movement	Worker slips from ladder	Use of material handling tools to pick up material
				Workers need to pick up materials frequently, which can cause fatigue	
		A lot	Movement of large amounts of material	Workers fall while lifting loads	
				Workers crushed by cardboard	
				The worker sprained his foot while lifting a load	

Sock Making and Sock Sewing Department	The quantity of socks made in one production batch	A little	Production of socks in low quantities in one batch	Workers were cut and scraped from machines	Creating warnings regarding machines that have sharp parts	
				Workers need to produce in large batches, so fatigue can occur		
		A lot	Production of socks in high quantities in one batch	The worker hit his head while fixing the thread	The worker's finger goes into the machine	Determination of the obligation to use protective equipment (gloves)
						Providing foam padding at the end of the machine
Packaging	Quantity of sock packaging in one production batch	A little	Packaging of socks in low quantities in one batch	Workers need to pack socks in large batches, which can cause fatigue	Determination of the obligation to use protective equipment (gloves)	
		A lot	Packaging of socks in high quantities in one batch	Finger punctured by tag gun		
Sock Steaming Department	Machine plate temperature	Low	The plate is not hot	-	Determination of the obligation to use protective equipment (heat-resistant gloves and masks)	
		Tall	The plate is hot (above normal)	Hit by a hot plate on the machine, resulting in injury		
				Respiratory disorders	Provision of fans	

Several work accident impacts are acquired from the HAZOP data, and recommendations for changes or remedies specific to each department's accidents are also identified. Five departments at CV HB—material retrieval, sock making, sock sewing, packaging, and sock steaming—have improvements suggested for them based on the Pareto concept's findings. Regarding material handling in the Material Retrieval Department, the first option suggests using material handling equipment. Manual forklift hand stackers are the recommended method of material handling. Because it features a pair of iron bars up front that can be raised and lowered using a hydraulic principle, a manual forklift hand stacker machine can help take up and move things. The second suggestion is to create posters alerting people to the existence of machinery with sharp edges in the departments responsible for making and sewing socks. It is known in both areas that using sewing machines with sharp parts is directly associated with operators; as such, posters serving as warning signs must be created. In the sock sewing and sock manufacturing departments, the third suggestion would mandate the use of anti-cut gloves as hand protection. Employees at CV HB do not wear protective gloves when using machinery

because the company has no policies addressing acceptable attire or provision of safety gear. They are advised because anti-cut gloves can protect hands and skin from being cut by sharp pieces of machinery. The fourth suggestion for the Sock Making Department is to develop and supply foam cushioning for the machine's end. In order to keep the worker's head from colliding with the end of the machine, a protective device for the machine frame's end was designed utilizing foam. The foam material is sufficiently thick and soft and may shield the head from collisions and safeguard the machine's end. The fifth suggestion in the department responsible for sock steaming would mandate using masks and heat-resistant gloves as protective gear.

In this department, socks are laid out on an iron plate to evaporate; the iron plate is heated in a steam machine to a temperature of 120 degrees. In addition, the heated socks may encourage workers to breathe in air too frequently, which could lead to long-term respiratory issues due to the heating of the sock material. As a result, wearing heat-resistant gloves and medical masks is advised. A plan for the positioning of the fans in the Sock Steaming Department is included in the sixth proposal. The Sock Evaporation Department should have a fan added, as advised by CV HB. In order to allow the fan to fully reach and strike the iron plate that has just emerged from the evaporation machine, it can be mounted on the wall in the top proper position of the device. In addition to lowering the risk of worker injuries from hot iron plates, this can also help cool the iron plate.

CONCLUSION

Many issues with work accidents at CV HB were discovered via observations and interviews. We used the FMEA and HAZOP techniques to search for these factors. The study on CV HB was able to draw several conclusions after going through the procedures of data collecting, data processing, and analysis. Several work-related incidents were discovered at CV HB, and multiple reasons were identified in each department. Some identified reasons included improper lifting postures for materials and loads, heavy lifting, machine-related mishaps, a lack of safety gear and attire rules, and awkward workstation arrangements. Mistakes made by people or technological issues like using a machine can cause inevitable mishaps. The research successfully created suggestions for enhancements to solve occupational health and safety issues in CV HB once it was completed. The research's recommendations include the following: using machine foam pads, utilizing masks, utilizing anti-cut gloves, creating warning posters, utilizing manual hand stack forklifts as material handling aids, utilizing fans along with advice on where to put them, and using gloves against heat exhaustion. The wind. It is envisaged that CV HB

would be able to employ the modifications that have been suggested by research to address work accident issues on CV HB.

BIBLIOGRAPHY

- Ervianto, W. I. 2014. *Manajemen Proyek Konstruksi*. Yogyakarta : ANDI.
- Hasibuan, A., Purba, B., Marzuki, I., & Jamaludin. 2020. *Teknik Keselamatan dan Kesehatan Kerja*. Jakarta: Yayasan Kita Menulis.
- Juliana, A. I. 2008. *Implementasi Metode Hazops dalam Proses Identifikasi Bahaya dan Analisa Risiko Pada Feedwater System di Unit Pembangkitan Paiton PT. PJB*. Surabaya: Politeknik Perkapalan Negeri Surabaya.
- Kementerian ESDM. 1970. UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 1 TAHUN 1970 TENTANG KESELAMATAN KERJA. [Online] Tersedia: <https://jdih.esdm.go.id/peraturan/uu-01-1970.pdf>. [18 Oktober 2023]
- Kementerian Ketenagakerjaan. (2018). National Occupational Safety and Health (POS) Profile in Indonesia. [Online] Tersedia: https://www.ilo.org/wcmsp5/groups/public/---asia/--ro-bangkok/---ilo-jakarta/documents/publication/wcms_711991.pdf [18 Oktober 2023]
- Kuswana, W. S. 2014. *Ergonomi K3 Kesehatan Keselamatan Kerja*. PT. Remaja Rosdakarya : Bandung.
- Mangkunegara, A. P. 2016. *Manajemen Sumber Daya Manusia Perusahaan*. Bandung : PT. Remaja Rosdakarya.
- Pratiwi, F. S. 2023. RI Alami 265.334 Kasus Kecelakaan Kerja hingga November 2022. *DataIndonesia.id*. [Online] Tersedia: <https://dataIndonesia.id/tenaga-kerja/detail/ri-alami-265334-kasus-kecelakaan-kerja-hingga-november-2022>. [18 Oktober 2023]
- Stamatis, D. H. 1995. *Failure Mode and Effects Analysis : FMEA from Theory to Execution Second Edition*. Milwaukee : ASQ Quality.
- Suardi, R. 2015. *Sistem Manajemen Keselamatan dan Kesehatan Kerja*. Jakarta : PPM.
- Whandhah. 2021. Upaya Mengurangi Resiko Kecelakaan Kerja di Atas Kapal KM. Asia Putra. *UNIMAR AMNI*.
- Yumaida. 2011. *Analisis Risiko Kegagalan Pemeliharaan Pada Pabrik Pengolahan Pupuk Npk Granular*. Depok : Universitas Indonesia.