



Occupational Safety and Health Analysis with *JSA* Method and *HAZOP*

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Abstract

Aulia Karya workshop is a small and medium business which is a company involved in the manufacturing industry, and in the workplace there is a very large potential hazard, namely shortness of breath due to inhalation of welding fumes, and explosions of nitrogen and oxygen gases. The purpose of this study is to analyze potential hazards using the Job Safety Analysis (JSA) method and to identify the causes of operational disturbances using the Hazard and Operability Study (HAZOP) method at Aulia Karya workshop. using Job Safety Analysis (JSA) and Hazard and Operability Study (HAZOP) methods. data that used is work accident data. Based on data processing carried out the value of the frequency of work accidents (frequency rate) in the 12 months of 2020/2021 namely the number of work accidents of 0.002 per thousand working hours.

Keywords: Job Safety Analysis, Hazard and Operability Study, Aulia Karya Workshop, Work Accident, Frequency Rate

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1. Introduction

Occupational safety and health (K3) is a very important part for workers both in companies and in workshops. The implementation of K3 in workshops has a great influence on improving the quality of the workshop. In the implementation of K3 in welding workshops, obstacles can occur, for example, minimal knowledge of workers about K3, limited budget for workshops to carry out K3, and low awareness of workers to carry out K3 in their work activities. The use of PPE in daily work can also be included in counseling about K3 in carrying out activities, especially in carrying out the welding process. Observation of the Implementation of Occupational Health and Safety in the welding process that has been carried out in the welding workshop. For one day, it was generally concluded that the owners and workers of the welding workshop had increased their understanding and usefulness of the importance of occupational health and safety when carrying out the welding process. The use of personal protective equipment has also been understood and applied in welding activities so that workers can carry out their activities safely, comfortably and with peace of mind, which will produce welding results that are in accordance with the targets desired by customers.

Aulia Karya Welding Workshop is a small and medium enterprise which is a company engaged in the manufacturing industry, and in its workplace there is a very large potential for danger, namely shortness of breath due to inhaling welding fumes, and nitrogen and oxygen gas explosions. From the work process in the company, almost all work is done manually, only a few jobs are done using machines. Work accidents still often occur, including being hit by objects, hands being trapped, body parts being burned by sparks. In addition to HAZOPS, there is also a *Job Safety Analysis* (JSA) method which is one of the main steps in analyzing hazards and accidents in an effort to create work safety, so that a picture of the direct cause and root of the problem that is less than adequate can be known [1]. Thus, the recommendations from this study will be able to provide suggestions for improvements for the company. The study aims to be in Aulia Karya Workshop with a case study approach, data collection is carried out through in-depth interviews. The informants of this study consist of the head of the bureau, workers. Based on the background above, the author is interested in conducting research with the aim of analyzing occupational safety and health in the Aulia Karya workshop, to reduce the occurrence of work accidents in the workshop.

From the work process and accident cases above, it is necessary to identify hazards regarding what risks may occur and the impact of the hazards in accordance with the main target of the K3 program, namely managing risks to prevent work accidents or unwanted events. Identification of these hazards can reduce the chances of work accidents because hazard identification is related to the factors causing work accidents. This identification can be done with HAZOPS (Hazard Operation Study). HAZOPS is an analysis technique to find potential hazards from a structured and systematic assessment of the production or operation process through identification and evaluation of problems that may pose a risk to employees or work equipment, so that the potential for accidents can be minimized. [2-4]. This study was conducted by Dini Retnowati from the hazop method approach obtained 5 sources of hazards that emerged where the source of the material *conveyor hazard* had the highest risk level so that it was given priority to be repaired [5]. The proposal from the results of this study is to conduct K3 training, conduct work supervision, and carry out maintenance on machines and equipment. [6], [7]. The conclusions produced in this study are: there are 4 sources of danger that are classified as high risk, 16 sources of danger that are classified as medium risk, and 2 sources of danger that are classified as low [8]. It is necessary to measure the level of risk of work accidents in order to reduce the level of work accidents, especially in the Casting 2 section with the Job Safety Analysis (JSA) technique approach [9]. Shows that the station requires several proposals for Sterilizer improvements in the form of repairs to machines or equipment, personal protective equipment and alternative replacement of safer machines or equipment [10]. One of the K3 programs is to identify the types of work accidents and efforts to prevent work accidents using the Job Safety Analysis method [11]. Hazards in the work of making tofu products include physical hazards and ergonomic hazards. Control recommendations are given based on the control hierarchy, namely elimination, *engineering control*, *administrative control* and personal protective equipment [12]. Factors causing potential work hazards are workers who carry out activities unintentionally, high temperatures, and worker negligence in using PPE [13]. The results of this study found that four potential hazards were identified with a medium hazard classification due to human error factors [14], [15]. It was concluded that occupational safety and health problems were resolved using different methods such as HAZOPS, JSA and K3. With different research locations such as CV. SS, PT. PDAM Tirta Kencana Samarinda, PT. Surya Toko, PT. XYZ, PT. ST, Loading and unloading service company, Sari Takwa home industry tofu making work.

2. Methodology

This type of research is Qualitative. Qualitative research uses a risk matrix that describes the probability value and consequence value of an event expressed in the form of a low to high risk range. This qualitative approach is carried out as an initial step to determine the risk of a work activity. This approach is carried out if the data needed is incomplete and unavailable. The data in this study are secondary data obtained directly from the field.

The stages of data processing using the JSA and HAZOPS methods carried out in this study are:

1. Collecting the results of various types of work accident data.
2. The data processing process is to calculate the types of work accidents from employees who experienced work accidents during October 2021 - September 2021.
3. Recapitulation of work accident results.
4. Make a list of all objects (machines, work equipment, materials, work processes, work systems, work conditions, etc.) that exist in the workplace.
5. Estimate of the frequency of accidents or illnesses in the workplace.
6. An estimate of the severity of the possible accident or illness that may occur.
7. Determine the risk level.
8. Create a priority scale of assessed risks for control.
9. Create a risk assessment record

3. Results and Discussion

3.1 Data Collection

In this study, data collection was carried out by reviewing the location directly so that researchers can make direct observations. In addition to direct observation, data collection was also carried out through interviews with the company to obtain the information needed in this study, the data can be seen in the following table:

Table 1. Number of Work Accidents 2020/2021

BULAN	JUMLAH
Oktober	1
November	1
Desember	-
Januari	-
Februari	2
Maret	1
April	2
Mei	-
Juni	1
Juli	1
Agustus	1
September	1
TOTAL	11

Table 2. Work Accident Data October 2020 – September 2021

No	Name	Day / Date	Accident
1	David	Monday, October 5, 2020	Blistered feet
2	Anto	Saturday, November 14, 2020	Leg sprained due to being hit by iron
3	Bobby	Friday, December 25, 2020	Eyes hit by metal fragments
4	Haris	Wednesday, February 10, 2021	Hand hit by grinder
5	Sun	Wednesday, August 25, 2021	Eyes hit by metal fragments
6	Irsal	Saturday, September 11, 2021	Feet burned

Table 3. Potential Hazards in Each Division/Work Unit

Work unit	Potential Dangers
a. Welding Operator	- Exposed to hot fire - Electric shock - Blistered hands
b. Drilling Operator	- Hit by drill bit - Hit by drilling debris - Hand injured by drill
c. Grinding Operator	- Exposed to the grinding wheel - Hands scratched by the grinding wheel - Exposed to sparks from the grinding wheel

3.2 Research Results

To determine working hours during a certain month period, the following formula is used:

$$\text{Total Working Hours per person} = (\text{JKT} \times \text{HK} \times \text{JK}/\text{H}) - (\text{HH} \times \text{JK}/\text{H}) \quad (1)$$

Information:

JKT = Number of workers

HK = Working days JK/H = Number of working hours in a day

HH = Number of days lost.

JHK = Number of Days in a Month – (Number of Sundays + Number of National Holidays)

1. People Working Hours (*man hours*) in October 2020 – September 2021

- a. Number of workers : 6 people
- b. Number of days in 12 months : 365 days
- c. Number of weeks : 48 days
- d. Number of national holidays : 35 days
- e. Number of working days : 365 – (48 + 35) = 282 days
- f. Total working hours : (6 x 282 x 8) – (45 x 8) = 13,176 working hours

Calculation of the accident frequency rate (FR), namely the number of accidents for every thousand working hours, can be measured using the accident statistics formula as follows:

$$\text{FR} = (\text{Number of accidents} \times 1,000) / (\text{Total working hours}) \quad (2)$$

Occupational accident frequency (FR) in 12 months

$$= (7 \times 1,000) / 13,176 = 0.53 \text{ times}$$

FR value = 0.53

This means that in the 12 months of 2020/2021 there were 0.53 work accidents per thousand workers.

The severity of the accident (SR) is the total number of lost work days per 1,000 hours worked. So the formula is as follows:

$$\text{FR} = (\text{Number of lost work days} \times 1,000) / (\text{Person hours worked}) \quad (3)$$

Severity of accidents (SR) in the first 12 months of 2020/2021 = (48 x 1,000) / 13,176 = 3.64 times

The SR value = 4.032 indicates that during the 12-month period of 2020/2021 there was a loss of working time of 3.64 times per thousand hours of work.

The accident frequency (FR) and the accident severity (SR) figures can be converted into one *Frequency Safety Indicator* (FSI) using the following formula:

$$\text{FSI} = (\text{Frequency Rate} \times \text{Saverity Rate}) / 1000 \quad (4)$$

State level indicator (FSI) in 12 months 2020/2021 = (0.53 x 3.64) / 1000 = 0.002

After identifying hazards or work accidents, then take action to control work accidents which are outlined in the *job safety analysis sheet* as in the table below:

Table 4. *Job Safety Analysis* in the Production Section

JSA No.		
Bagian : Produksi	Mandor : Farid	Analisis Oleh : Rangga Aulia
APD yang digunakan : sarung tangan, safety shoes, safety glasses, masker, helmet		
Unit Kerja	Potensi Bahaya	Pengendalian
Operator pengelasan	- Terkena api panas - Tersentrum	a. Menggunakan sarung tangan b. Membuat SOP c. Menggunakan safety shoes d. Berhati-hati dan mengikuti prosedur
Operator mesin bor	- Tangan terkena mata bor - Mata terkena serpihan besi	a. Menggunakan masker b. Menggunakan sarung

		tangan c. Menggunakan <i>safety shoes</i> d. Membuat SOP
Operator mesin gerinda	- Tangan tereserpet mata gerinda - Mata terkena serpihan logam	a. Menggunakan sarung tangan b. Membuat SOP c. Menggunakan <i>safety shoes</i> d. Mengikuti prosedur e. Menggunakan <i>protective glasses</i>

After conducting an analysis of potential job hazards at the Aulia Karya Workshop. Efforts to prevent work accidents can be done in the following ways:

1. Read the work procedures carefully
2. Be more careful in working
3. Follow the directions given before work begins
4. Use personal protective equipment such as: safety shoes, safety glasses, masks, gloves, masks and helmets.

Several work accident control measures that have been described in the *Job Safety Analysis sheet* are efforts to prevent work accidents at the Aulia Karya Workshop.

After the data is collected, the data is processed to determine the flow of the job handling process and conduct analysis using the Hazop method. The following is a description of the hazard identification process:

1. List all objects present in the workplace.
 - a Machine
 - a) Welding or welding inventor is a machine used to perform welding exercises both outside and inside, as long as it has a power source to control the weld.
 - b) Grinding is a machine used to sharpen or cut work objects.
 - c) A drill is a tool used to make holes in work objects such as iron, wood and so on.
 - b Work Equipment The work equipment includes:
 - a) Pliers
 - b) Welding wire
 - c) Odeng
 - d) Hammer
 - c Material
 - a) Iron / stainless
 - b) Light steel

Table 5. Hazard Identification at Aulia Karya Welding Workshop

No	Proses/Aktivitas	Temuan Hazard	Resiko
1	Pengelasan	APD seperti topeng las, sarung tangan, sepatu safety	Asap las, Luka bakar
2	Menggerinda	Tidak menggunakan APD seperti sarung tangan, baju kerja dll, dan kurang teliti dalam proses pemotongan	Terkena serpihan gerinda, Terkena patahan mata gerindra
3	Pengeboran	Tidak menggunakan sarung tangan baju kerja dll, dan kurang teliti dalam proses	Jari terkena mata bor

Risk assessment can be done by looking at the possibility (*likelihood*) and severity (*consequences*) and then finding the level of danger.

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Table 6. Likelihood Scale

Tingkat	Kriteria	Deskripsi Kriteria
4	Sering (<i>Frequent</i>)	kemungkinan terjadi sangat sering dan berulang
3	Agar Sering (<i>Probable</i>)	kemungkinan terjadi beberapa kali
2	Jarang (<i>Occasional</i>)	kemungkinan terjadi jarang
1	Agak Jarang (<i>Remote</i>)	kemungkinan terjadi kecil tapi tetap ada

- b. Conducting Severity Ranking (*Consequences*) The *Consequences Scale* shows the level of severity of the consequences of an accident that occurs.

Table 7. Consequences Scale

Tingkat	Kecelakaan	Deskripsi kecelakaan
5	Bencana	Kecelakaan yang akan menyebabkan kematian
4	Fatal	Kecelakaan yang mengakibatkan kematian tunggal
3	Cedera Berat	Kecelakaan yang mengakibatkan luka berat
2	Cedera Ringan	Kecelakaan yang mengakibatkan luka ringan
1	Hampir Cedera	Kecelakaan yang mengakibatkan hampir celaka

- c. Determining the Risk Level After estimating or assessing the *likelihood level* and *consequences* of the occurrence of diseases or accidents that may arise, the risk level of each *hazard* that has been identified and assessed can then be determined.

The method for determining the risk level can use a matrix such as the following:

Table 8. Risk Assessment Matrix

Consequences	Skala	Likelihood			
		Frequent	Probable	Occasional	Remote
		4	3	2	1
Catastrophic	5	20 Urgent	15 Urgent	10 High	5 Medium
Fatal	4	16 Urgent	12 High	8 Medium	4 Low
Critical	3	12 High	9 Medium	6 Medium	3 Low
Marginal	2	8 Medium	6 Medium	4 Low	2 Low
Negligible	1	4 Low	3 Low	2 Low	1 Low

From the process or activities carried out in the workshop, an assessment of the risks and control of the existing risks can be carried out. The following are the hazard findings at the Aulia Karya Welding Workshop:

- Working without using PPE such as welding masks, welding glasses, gloves, safety shoes.
- The cable is peeled off due to welding sparks and exposure to other hot objects.
- Working at heights without using PPE such as *Body Harness*
- Not using PPE such as gloves, work clothes, etc., and not being careful in the cutting process

The following is the risk assessment process at Aulia Karya Welding Workshop:

- From the data obtained, the estimated frequency or frequency of accidents or illnesses in the workplace, namely hands being scratched by sharp work objects, is categorized as frequent, which is given a value of 4 (four).
- After assuming the frequency estimates, then calculating the estimated severity of the possibility of accidents and illnesses occurring are categorized as minor injuries (marginal), namely accidents that cause minor injuries or illnesses and can immediately return to work or do not cause permanent disability which is given a value of 2.
- Determine the risk level. After each hazard has been identified and assessed, then the way to determine the risk level can use a matrix. The results obtained from the frequency of occurrence can be categorized as frequent *which* is given a value of 4 (four) then the severity level is categorized as a minor injury (marginal) which is given a value of 2 (two). And the results of the risk level are determined using a matrix and the results obtained are with a frequency value of 8 (eight) and are categorized as a medium level of danger.
- After determining the risk level, a risk priority scale is created for each potential hazard identified, then the following potential hazards are obtained:

Table 9. Determination of Risk Level

No	Proses / Aktivitas	Risiko	Peluang (L)	Dampak (C)	Score (S)	Risk Level
1	Pengelasan	asap las	4	3	12	High
		Terkena benda panas				
		Luka bakar				
2	Pengeboran	Terkena mata bor	2	3	6	Medium
		Terkena serpihan logam				
3	Menggendra	Terjadinya kecelakaan	2	3	6	Medium
		Terkena serpihan logam				
		Terkena patahan mata gendra				

3.2 Discussion

In the analysis of work accidents that have been carried out, many disrupt the production process for the company. This occurs due to the lack of policies based on work safety standards applied by employees or workers. Such as many workers who do not care about the use of personal protective equipment. The number of personal protective equipment is limited, so that not all workers get the personal protective equipment they need. Workers lack concentration in doing their jobs and Lack of worker knowledge about the importance of using work safety equipment. At the hazops hazard analysis stage, several hazards were found at the welding risk level, sore eyes due to exposure to welding fumes, exposure to hot objects, and can cause burns. Furthermore, in grinding activities, the danger of being hit by splinters and being hit by broken grinding wheels was found. In drilling activities, there was an accident where the hand was scratched by the drill bit, hit by splinters.

4. Conclusion

The conclusions obtained from the research conducted are: The number of work accidents in the 12 months of 2020-2021 increased due to employees being negligent in their work and a lack of understanding, especially regarding the use of personal protective equipment while working. he causes of work accidents at the Aulia Karya Workshop are the lack of general knowledge about the importance of work safety and health, and the lack of use of personal protective equipment while working, not being careful while working, and being negligent while working can result in minor or major work accidents. Identifying the hazards of work accidents that occur in the Aulia Karya Welding Workshop using the Hazop method is by observing every object in the welding workshop such as machines, work equipment, work systems and work conditions. Then periodic checks are carried out to determine the unfitness of a work object to be used. Controlling the risk of accidents at the Aulia Karya Welding Workshop using the Hazop method is by using PPE provided by the workshop such as welding helmets, masks, welding gloves, shoes, work clothes, and body hermes when doing a job.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	W
Rangga A	✓	✓			✓	✓		✓	✓
Ulia			✓	✓	✓			✓	✓

Conflict of Interest Statement

Authors state no conflict of interest.

Informed Consent

We have obtained informed consent from all individuals included in this study.

Data Availability

The data that support the findings of this study are available from the corresponding author, [R], upon reasonable request.

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