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Job safety analysis and risk assessment on gas analyzer in vocational automotive workshop

Gusman Arrosyid Saputra[1], Rusdi Febriyanto[2]*, Afitro Adam Nugraha[1], Andreas Edi Widyartono[1], Lukman Wijanarno[1], I Gusti Nyoman Kesawa[1], Ajib Rosadi[1]

[1] Automotive Engineering, Politeknik Astra, Jakarta, Indonesia
[2] Heavy Equipment Maintenance Engineering Technology, Politeknik Astra, Jakarta, Indonesia

* Corresponding author: rusdifebriyanto27@gmail.com

Abstract

The implementation of occupational safety and health (OHS) in vocational automotive workshops is essential to ensure safety for all parties involved. Potential hazards that can arise in the workshop environment, such as hazardous gas leakage when using a Gas Analyzer, noise, fire, and poor air circulation, require proper identification and control. This study aims to analyze the potential for work accidents and conduct a risk assessment on the use of Gas Analyzer in vocational automotive workshops. The methods used in this research are Job Safety Analysis (JSA) and Risk Assessment. JSA is conducted to identify potential hazards and formulate preventive measures, while Risk Assessment is used to assess the level of risk based on the impact and likelihood of occurrence of hazards. The findings show that there are 10 hazards identified as potential accidents. Some significant potential work accidents, such as gas leaks, exposure to hazardous gases, and the risk of explosion due to use in areas without adequate ventilation. Based on the risk assessment, accidents due to exposure to exhaust heat is a critical risk that requires immediate preventive action. This study emphasizes the importance of work safety management through the implementation of SOPs and proper use of personal protective equipment (PPE) to reduce the risk of accidents

Keywords: automotive workshop, gas analyzer, job safety analysis, risk assessment, work safety

1. Introduction

The Vocational higher education as higher education aims to prepare students with practical skills and knowledge to work in a particular field (Hermanto et al., 2019). The vocational education environment is designed to be as similar as possible to the work environment that students will face. So students must be prepared to think and work according to job needs and trained to be accustomed to the same methods, tools, and machines as those used in the workplace (Vachruddin et al., 2023). One important aspect of vocational higher education is having a workshop or laboratory that is used in learning activities that use tools and machines (Pangestu & Sukardi, 2019). This aspect must be supported by occupational safety and health that is applied in the workshop area for everyone involved in the learning and improvement process (Wahyuni et al., 2024).

Potential threats to occupational safety and health are generally related to the workplace or production workshop, prominent problems include: the location of the workshop is very close to the classroom and office, so there is a risk of environmental disturbances such as noise, fire hazards, and air pollution. For example, having a machine workshop near the classroom will cause noise disturbances from the use of production tools and machines (Schulte et al., 2023). A narrow workspace that is close to the classroom and office also risks inadequate air circulation and comfort in the workspace.

One of the risks of air pollution is when a gas analyzer is used to test vehicle emissions to determine the content of vehicle exhaust gases, such as HC, CO2, O2, and CO (Jokubyniene & Liebuviene, 2023). The working principle of the gas analyzer is to take a gas sample from the probe, and then compare it with standard gas. Accurate analysis of the composition of vehicle exhaust gases can help maintain optimal performance and more environmentally friendly emissions. But at the time of testing it can cause occupational safety and health hazards, especially because of exposure to toxic gases due to leaks in the system or gas samples, workers can be exposed to these hazardous gases (Salvi et al., 2017).

Therefore, the creation of job safety analysis and risk assessment is very much needed to identify and control the hazards that may occur when using gas analyzers to test vehicle emissions in vocational automotive workshops. This analysis is very important to ensure worker safety, prevent accidents, and minimize environmental impacts by identifying, analyzing, and evaluating potential hazards associated with the use of gas analyzer equipment.

2. Methodology

This In this study, the Job Safety Analysis (JSA) and Risk Assessment (RA) methods were used. The former is used to identify, analyze, and suggest preventive measures for hazards. The second, risk assessment method assesses risks by considering the degree of magnitude of impact and likelihood of the hazard occurring. Figure 1 shows the data collection and processing process. The flow of data processing and collection shown in Figure 1.

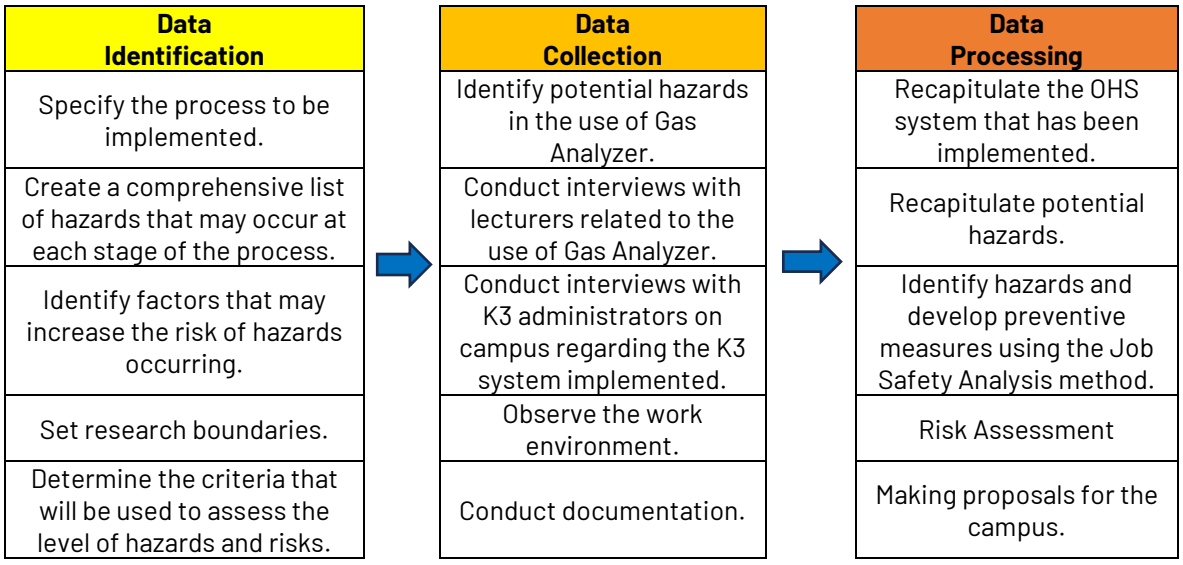

Figure 1. Flow of data processing and collection

In the data identification process, the first step taken in data collection is of course determining the specifications of the process to be carried out. This step aims to find out what potential hazards are contained in the process to be carried out with this can also reduce the potential for these hazards. The next step is to make a complete list of hazards that will be applied by the campus. This step aims to find out the OHS system implemented by the campus and as a

reference for determining the precautions in the hazard list. The next step is to identify factors that can increase the risk of hazards. Of course, this step aims to ensure that the campus OHS system can implement prevention. The next step is to define the research boundaries, work areas and types of activities. This step aims to help identify problems, helping to focus on one problem. The last step is to determine the hazard level assessment criteria. This step aims to modify the risk management process to enable effective risk assessment. The following can be seen in Figure 2.

Figure 2. Identify potential hazards in the use of gas analyzer

In the data collection process, the first step taken in data collection is to identify potential hazards in the use of gas analyzers. This step aims to find out the potential hazards that exist when using a gas analyzer this can also reduce the potential hazards that will occur. The next step is to conduct interviews with lecturers related to the SOP for the use of gas analyzers. This step aims to find out the SOP for the use of gas analyzers applied by the campus and as a basis for determining preventive measures. The next step is to interview the K3 management on campus regarding the K3 system implemented by the campus. Of course, this step aims to ensure that the campus OHS system can implement prevention. The next step is to observe the work environment. This step aims to help collect OHS risk data. The last step is to conduct documentation. This step aims to recap data on the development of the report. The following can be seen in Figure 3.

			Risk Scoring Matrix				
			Risk Impact (*Consequence*)				
			1	**2**	**3**	**4**	**5**
			Insignificant	*Minor*	*Moderate*	*Major*	*Fatal/ Catastrophic*
			Temporary Pain and Not Requiring Treatment	Pain that Requires Some Medication	Need for Hospitalization	Broken Bones, Severe Injuries	Permanent Disability Even Death
Possible Occurrence (Likelihood)	Almost Impossible to Happen	**1** *Rare*	**1**	**2**	**3**	**4**	**5**
	Unpredictable But Possible	**2** *Unlikely*	**2**	**4**	**6**	**8**	**10**
	Maybe it happens occasionally for some reason	**3** *Possible*	**3**	**6**	**9**	**12**	**15**
	May Happen 2 - 3 Times In A Period Of Time	**4** *Likely*	**4**	**8**	**12**	**16**	**20**
	Very Likely to Happen and Repeatedly	**5** *Almost Certain*	**5**	**10**	**15**	**20**	**25**
Risk Assessment = Impact x Likelihood of Occurrence							

Figure 3. Risk scoring matrix
Source: NHS National Patient Safety Agency (2008)

As part of the data processing process, the first step was to recapitulate the campus safety and hygiene system, particularly with regard to pollution. The recapitulation of potential hazards is the next step that is very important for safety and health. The next step is to find the hazards and create preventive measures using safety analysis techniques. To speed up the identification process, the next step is a risk assessment to determine the level of hazard associated with each process. The final step is to make proposals for the improvement of learning support facilities on campus.

According to the risk assessment reference matrix, risks are assessed based on the magnitude of the impact and the likelihood of the risk occurring. The risk assessment is carried out by multiplying the value of the level of impact caused by the value of the level of probability of the risk occurring (Permana & Nugroho, 2022). For example, if a work accident is very likely to occur repeatedly and cause temporary illness without treatment, the risk assessment will be as follows:

Risk Score = Impact Level Value × Probability Level Value
Example:
Risk Score = (5) × (1)
Risk Score = 5

To determine the priority scale of risk prevention, the scores that have been obtained are used as a reference. Risk priority categories were created based on the score and color mapping in the Risk Assessment matrix (Indriyanti & Prastawa, 2024). These categories can be seen in Table 1.

Table 1. Table risk rating

No	Category	Description	Color Code
1	Critical	Score 13 - 25	
2	Serious	Score 7 – 12	
3	Moderate	Score 4 – 6	
4	Minor/ Tolerate	Score 1 – 3	

Source: NHS National Patient Safety Agency (2008)

Based on the preceding assessment of possible risks, a potential hazard with a score of 5 indicates that the potential accident is in the moderate category, which is highlighted in yellow. This category suggests that, while the danger cannot be disregarded, it can be managed in a reasonably straightforward manner and does not require immediate care. With a clear awareness of the amount of risk that may occur, different mitigation steps may be done to reduce the effect that may be created, so that safety and health in the work environment can be maintained appropriately (Radite & Fahma, 2015).

The next stage is to prepare a proposal for preventive measures as a tangible execution of preventative efforts against recognized dangers in the practice area, after the completion of a thorough assessment and the acquisition of a clear assessment priority scale. The creation of thorough Standard Operating Procedures (SOP), which will operate as guides for carrying out everyday tasks, is one of the ideas. To ensure that everyone is aware of the procedures that must be followed in order to minimize risks, it is also crucial to support the application of the SOP with the provision of simple and easy-to-understand instructional illustrations.

3. Result and Discussion

Based on the observation, the Gas Analyzer was chosen as the work that needs to be studied with the JSA method. In the use of Gas Analyzer, the work is divided into several stages. Starting from the preparation of tools, choosing a work location, setting up tools, taking samples, checking results, cleaning, and documenting activities. Of the seven work steps, the potential work accidents identified can be seen in Table 2.

Table 2. Table of identified hazards

No	Potential Work Accidents Identified	Preventive Measures
1.	Gas leakage from the appliance.	- Check all parts of the tool before use. - Make sure there are no cracks or leaks in the hoses and connectors. - Perform a visual and functional check of the equipment before use. - Replace damaged or leaking components.
2.	Undetected leaks can lead to exposure to harmful gases.	- Ensure emergency exit access is available and clear
3.	Use in unventilated areas may cause gas buildup.	- Choose a work location that is well ventilated and free from sources of fire.
4.	Turning on the appliance near a fire source may cause a fire and explosion.	- Make sure the surrounding area is free from fire sources and flammable materials. - Follow the manual instructions when starting the appliance and ensure that the appliance is in good condition.
5.	Taking samples without protection may result in direct exposure.	- Wear appropriate personal protective equipment (PPE), such as masks and gloves. - Ensure that gas detection equipment is working near the sampling site
6.	Exposure to harmful residual gases when using the appliance	- Wear appropriate personal protective equipment (PPE), such as masks and gloves.
7.	Hit while the car is running	- Ensure the vehicle is in parking brake condition
8.	Slip due to AC water	- Ensure the work area is clean and dry.
9.	Exposure to hot exhaust temperatures	- Wear appropriate personal protective equipment (PPE), such as masks and gloves.
10.	Ear irritation due to exhaust sound	- Wear appropriate personal protective equipment (PPE), such as earplugs.

The solutions presented in the Table.2 Identified hazards are proposals discussed by FGD and approved by a team of Lecturers and Instructors of automotive workshop vocational training. Solution development is carried out by means of FGDs in order to obtain solutions that are objective and in accordance with the automotive workshop vocational policy. For example, the use of PPE in an orderly manner, this solution can be done by checking the completeness before work and supervising workers during work by lecturers and instructors. The solution is in accordance with the vocational policy of the automotive workshop because these actions should be carried out by lecturers and instructors. The following can be seen in Table 3.

Table 3. Table of risk assessment

No	Potential Accidents	Types of Hazards	Risk Assessment		
			Impact Level Value	Propensity Score	Risk Score
1.	Gas leakage from the appliance.	Chemical Hazard	2	2	4
2.	Undetected leaks can lead to exposure to harmful gases.	Chemical Hazard	2	2	4
3.	Ears irritated by exhaust sound.	Physical Hazard	3	1	3
4.	Use in unventilated areas may cause gas buildup.	Area Hazard	3	3	9
5.	Turning on the appliance near a fire source may cause a fire and explosion.	Electrical Hazard	4	3	12
6..	Taking samples without protection may	Chemical	2	3	6

No	Potential Accidents	Types of Hazards	Risk Assessment		
			Impact Level Value	Propensity Score	Risk Score
	result in direct exposure.	Hazard			
7.	Exposure to harmful residual gases when using the appliance	Chemical Hazard	3	3	9
8.	Got hit while the car was running.	Mechanical Hazard	4	3	12
9.	Slipped on liquid chemicals.	Physical Hazard	2	3	6
10.	Exposure to hot exhaust temperatures.	Thermal Hazard	4	5	20

Based on identification using Job Safety Analysis (JSA), there are 10 Hazards identified as potential work accidents in Vocational Automotive Workshops. The 10 identified Hazards are analyzed using risk assessment. The results of the risk assessment indicate that the risk of exposure to exhaust gas heat must be given immediate and intensive preventive measures first because it is included in the critical category (red). The serious (orange) category totaling four should be considered next, potential events such as Use in an unventilated area, turning on the tool near the source of fire, Exposure to harmful residual gases, and being hit by a car when it starts. The moderate risk group (yellow) totaling four also requires risk reduction measures after the risk is addressed, risks such as, gas leakage, undetected leakage, taking samples without protection, and slipping. While the minor/tolerate (green) risk category in the form of disturbed exhaust noise also needs to get prevention and monitoring measures.

4. Result and Discussion

The conclusions obtained from this research include: Potential work accidents in the Vocational Automotive Workshop can be identified using Job Safety Analysis (JSA). Potential work accidents that have been identified with this method include gas leaks, undetected gas leaks, use in unventilated areas, areas close to fire sources, taking samples without PPE, being hit, slipping, ear disturbance. While some precautions that can be proposed through the JSA method include making sure there are no cracks or leaks in hoses and connectors, and doing work in open areas. The Risk Assessment method can be used to provide an overview of the level of risk posed by the hazards identified by the Job Safety Analysis method. The level of risk resulting from the assessment is used to determine the priority of risks that must be prevented. Starting from the highest to the lowest level. Based on the results of the risk assessment, there are several hazards classified as serious categories that have the potential to cause disability to most parts of the body. The risk of exposure to exhaust heat must be given immediate and intensive preventive action first because it is categorized as critical (red). The serious (orange) category of four must be considered next, potential events such as Use in an unventilated area, turning on a tool near a source of fire, Exposure to harmful residual gases, and being hit by a car when it starts. The moderate (yellow) risk group of four also requires risk reduction measures once the risk has been addressed, risks such as, gas leaks, undetected leaks, taking samples without protection, and slipping. While the minor/tolerate (green) risk category in the form of disturbed exhaust sound also needs to get preventive measures and monitoring.

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