# The Analysis of Occupational Health and Safety Risks in Engineering Workshop Using the Hazard Identification Risk Assessment and Determining Control (HIRADC) Method

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**Abstract.** The potential for work accidents can occur in any work activities. Work accidents can be caused by unsafe conditions and unsafe actions. Several accidents occurred related to the works in the engineering workshop such as injuries, scratches, and being crushed by heavy materials that can occur accidentally caused by a lack of knowledge of work safety. This study aims to identify the potential for work accidents that occur in engineering workshop, and the actions taken to prevent them. The research was conducted at Family Workshop (engineering workshop for repairing vehicles) in North Sumatra. The steps taken include identifying potential sources of accidents and efforts to control these risks using Hazard Identification, Risk Assessment, and Determining Control (HIRADC) method. The results showed that the sources of hazards in the workshop had been identified, the risks of hazards in the workplace had been assessed, and efforts for control had been determined. There are 14 potential accident hazards contained in 10 work activities in workshop. Evaluation of the risk rating for potential hazards is classified as extreme, high, moderate, or low. Risk control is very effective in reducing the risk of accidents through the implementation of Occupational Health and Safety (OHS) risk control hierarchy method.

**Keywords:** HIRADC Method, OHS, Risk Control, Engineering Workshop

## 1 Introduction

Work in the workplace has potential hazards that can be caused by unsafe actions or unsafe conditions. These potential hazards need to be identified to obtain preventive measures with the aim of reducing and eliminating work accidents and minimizing the incidence of diseases resulting from the work. The strategy that can be done is through providing knowledge about Occupational Health and Safety (OHS) as a guarantee of safety and health protection for workers [1]. Data collection on work accident cases that occurred in Indonesia has been carried out by the Indonesian Employment Social Security Administration (BPJSK), showing the occurrence of work accident cases increasing from year to year in the 2017-2020 period [2]. A total of 123,040 cases of work accidents in 2017 and 173,415 cases in 2018, became 182,835 cases in 2019, and 221,740 cases in 2020. Work accident cases increased by 21.28% in 2020 compared to the previous year.

The impact of this work accident is the emergence of work discomfort, production delays, and financial losses, namely the costs claimed for treatment and post-accident welfare [3]. An understanding of occupational safety needs to be possessed by workers and employers

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to reduce the risk of accidents, which is done through control of occupational health and safety risks that are implemented in the world of work. This control must be carried out on an ongoing basis to create healthy human resources, a safe workplace, control the work environment, manage accidents and occupational diseases, and increase knowledge of safety and health in the workplace [4]. Identification of sources of danger in the workplace needs to be done through observation of work activities, work behavior, and workplace situations [5]. Control of the level of risk from accidents or occupational diseases must also be evaluated to determine the appropriate priority of action in solving OHS problems [6, 7].

Enterprises (MSMEs). Work accidents and their consequences tend to be ignored due to the lack of information and knowledge about OHS, plus the limited protective equipment for business actors in implementing occupational health and safety [8]. One of the business units that have potential hazards in their work activities is the automotive repair shop (engineering workshop). Work in the workshop is closely related to the use of machines and equipment that has a lot of risk of accidents. Accidents can occur through the implementation of routine work, periodic maintenance, or repair of motor vehicles. The work has a potential occupational accident hazard if it does not carry out occupational health and safety procedures properly [9]. The application of Occupational Health and Safety in the workplace needs attention in small and large scale workshops [10]. An assessment of the risk of occupational health and safety hazards, and determining the appropriate control measures must be known by workers to be able to anticipate, prevent, and deal with the risk of accidents [11]. Prevention and overcoming of occupational health and safety problems is a priority in reducing cases of accidents and diseases that occur in the workplace [10]. This study aims to identify potential hazards in the workplace, conduct an assessment, and control the risks found to create safe workplace conditions and a safety climate for workers. Identification of potential hazards is carried out using the Hazard Identification Risk Assessment and Determining Control (HIRADC) method.

## 2 Research Method

The research is classified as a mix method, as a combination of qualitative descriptive approaches to identify hazards and control risks, and quantitative descriptive research to assess risk. The problem solving method used in this study is Hazard Identification Risk Assessment and Determining Control (HIRADC) [12]. Research data were collected through observation and interviews with workshop owners and workers based on the Occupational Health and Safety Management System – Guidelines and Requirements for the implementation of OHSAS 18001:2007 and Risk Management AS/NZS 4360:1999. Hazard identification is carried out by describing all potential hazards found, both unsafe actions and unsafe conditions based on the results of observations and interviews [13]. Furthermore, a risk assessment is carried out on the hazards found following the reference table for the definition and risk classification [14]. Sequentially, the qualitative measurement of consequence and likelihood is using Table 1, and a qualitative risk analysis matrix that describes the level of risk is shown in Table 2. The final step in the HIRADC method is risk control by considering the OHS risk control hierarchy to analyze actions that can be taken in prevention and treatment. hazards in the workplace [15]. The OHS risk control hierarchy includes elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE).

**Table 1.** Qualitative measurement criteria (1-5) for the components: (A) Consequence, and (B) Likelihood.

| A. Consequences Criteria | | |
|---|---|---|
| Level | Description | Description of measurement results |
| 1 | Insignificant | No injuries, low financial loss |
| 2 | Minor | First aid treatment, on-site release immediately contained, medium financial loss |
| 3 | Moderate | Medical treatment required, on-site release contained with outside assistance, high financial loss |
| 4 | Major | Extensive injuries, loss of production capability, off-site release with no detrimental effects, major financial loss |
| 5 | Catastrophic | Death, toxic release off-site with detrimental effect, huge financial loss |
| B. Likelihood Criteria | | |
| Level | Description | Description of measurement results |
| 5 | Almost certain | Is expected to occur in most circumstances |
| 4 | Likely | Will probably occur in most circumstances |
| 3 | Possible | Might occur at some time |
| 2 | Unlikely | Could occur at some time |
| 1 | Rare | May occur only in exceptional circumstances |

Source: Australian/New Zealand Standard, 1999

**Table 2.** Qualitative risk level analysis matrix and color description to illustrate the level of risk: Low Risk (L), Moderate Risk (M), High Risk (H), and Extreme Risk (E).

| **Likelihood** | **Consequences** | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 5 | High Risk (H) | High Risk (H) | Extreme Risk (E) | Extreme Risk (E) | Extreme Risk (E) |
| 4 | Moderate Risk (M) | High Risk (H) | High Risk (H) | Extreme Risk (E) | Extreme Risk (E) |
| 3 | Low Risk (L) | Moderate Risk (M) | High Risk (H) | Extreme Risk (E) | Extreme Risk (E) |
| 2 | Low Risk (L) | Low Risk (L) | Moderate Risk (M) | High Risk (H) | Extreme Risk (E) |
| 1 | Low Risk (L) | Low Risk (L) | Moderate Risk (M) | High Risk (H) | High Risk (H) |

Source: Australian/New Zealand Standard, 1999

## 3 Results and Discussion

The results of observations and interviews with workshop owners and workers involved in the workshop (classified as Family Workshop), have collected adequate data on

Occupational Health and Safety Risks in Engineering. The collected data has been processed and analyzed using the HIRADC method. Sequentially the research results are grouped into three parts, namely hazard identification, risk assessment, and determining control, which are briefly explained in the following discussion.

### 3.1. Hazard Identification

The initial stage of the occupational health and safety analysis using the HIRADC method is to identify hazards. At this stage, observations are made of the steps of car repair work in engineering workshop, aiming to see if there are potential hazards from each step of the work as shown in Figure 1.


**Figure 1.** Potential hazards to the car repair work: (a) the work of raising the car to the car lift, (b) electrical conditions, and (c) using a grinding machine.

Identification of potential hazards shows that there are 14 points identified from as many as 10 work steps. Danger occurs in the step of raising the car into a lift, a source of electric current, and using a grinding machine. When loading a car into a car lift, there was a potential danger of falling cars that could fall on workers, especially if the car and lift were not positioned properly (Figure 1a). The potential for this accident is very large due to the narrow space for workers to move. The next potential comes from a power source from electrical equipment in the form of sockets and cable plugs (Figure 1b). Electricity is needed as a current source for workshop work, and lighting systems. In general, the lighting in the workshop is not bright enough due to dirt from the smoke, which is a source of danger for workers. Other cases such as peeling of the protective layer of the cable, the arrangement of cables that are not neat are also potential hazards in the workshop. Workshop work using grinding machines is a potential source of accidents in the workshop (Figure 1c). Potential hazards can occur if workers do not use personal protective equipment (PPE) properly, which poses a risk to work safety. The rotation of the grinding wheel can cause injury if it hits the hands, debris will cause irritation and swelling if it gets into the eye, and can be very fatal.

### 3.2. Risk Assessment

Risk assessment is carried out by considering two dimensions, namely likelihood and consequences. The next stage is a risk analysis based on that assessment. The results of hazard identification and risk assessment on occupational health and safety in the workshop are summarized in Table 3.

**Table 3.** Results of hazard identification and risk level assessment: Low (L), Moderate (M), High (H), and Extreme (E) for the Consequence (C) and Likelihood (L) components.

| Work Step | Potential Hazard | OHS Risk | Likeli-hood | Conse-quence | Risk Level |
|---|---|---|---|---|---|
| Disassembling engine components | 1. Not being careful when disassembling the engine body | The hand is pinched during disassembly | 2 | 2 | L |
| | 2. Large and heavy machinery, and work equipment used | The legs are hit by objects that fell during the process | 1 | 3 | M |
| Adjusting the car engine valve | Valves and work equipment used | The hand is pinched during adjustment | 2 | 2 | L |
| Lifting the car to the car lift | 1. The car can fall if the position of the car part does not fit with the car lift | 1. Body parts are injured in the long term when the car falls and hits the workers | 1 | 3 | M |
| | 2. The space at the bottom of the car is narrow | 2. The head hit the lift pole or the bottom of the car being lifted | 3 | 2 | M |
| Changing the engine oil | Engine oil spills or drips on the workshop floor | Slipped causing injury to the workers body | 3 | 3 | H |
| Locking bolts or engine oil compartment cover | The bolt lock is not strong enough so that oil can seep | Slipped causing injury to the workers body | 2 | 2 | L |
| Turning on the grinding machine | Condition of sockets and plugs | Burns caused by electric shock | 2 | 3 | M |
| Using a grinding machine | 1. Not wearing PPE gloves when working with grinding machine | 1. The hand is injured from being hit by the grinding blade | 2 | 4 | H |
| | 2. Not wearing PPE goggles when working with grinding machine | 2. The eye area is irritated and swollen due to being exposed to pieces of the material being worked on | 2 | 3 | M |
| Jacking up the car according to the stable rubber part to be replaced | The jack drops suddenly or automatically when the end of the jack does not match the pedestal of the vehicle | Body parts are seriously injured/injured when the car falls and hits the workers | 1 | 3 | M |
| Cleaning the housing | 1. Dust from the brake pad housing | 1. Respiratory diseases, such as cough, lung | 2 | 3 | M |

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| of brake pads using nitrogen | which is the residue from the brake pad asbestos | disease, or asbestosis if working with inhalation of dust for a long time | | | |
| | 2. Dust from the brake pad house | 2. The eye area is irritated and swollen from material debris | 2 | 3 | M |
| Lowering the car from the lift | The vehicle falls if the pedestal or the position of the car with the lift is not suitable | Body part injured | 1 | 3 | M |

### 3.3. Determining Control

Risk control is carried out to minimize the level of risk that comes from sources of potential hazards that can result in work accidents or illnesses for workers. Risk control is carried out to minimize or even eliminate potential hazards with the aim of creating safe conditions for workers. Risk control is carried out following the OHS risk control guidelines. Risk control consists of analysis of control measures, including elimination, substitution, engineering controls, administrative controls, and use of personal protective equipment (PPE), as summarized in Table 4.

**Table 4.** The OHS risk control efforts in work to ensure work safety in workshop.

| Work Step | Potential Hazard | Risk Level | OHS Risk Control Actions | Hierarchy of OHS Risk Control |
|---|---|---|---|---|
| Disassembling engine components | 1.Not being careful when disassembling the engine body | L | Make standard and fixed work procedures for each work activity | Administrative Controls |
| | | | Wear mechanical gloves when working | PPE |
| | 2.Large and heavy machinery, and work equipment used | M | Use material handling equipment | Engineering Controls |
| | | | Wear mechanical gloves and safety shoes when working | PPE |
| Adjusting the car engine valve | Valves and work equipment used | L | Make standard and fixed work procedures for each work activity | Administrative Controls |
| | | | Wear mechanical gloves when working | PPE |
| Lifting the car to the car lift | 1. The car can fall if the position of the car part does not fit with the car lift | M | Following the procedures for using a car lift and proper placement on the car frame, Make a safety sign so that there are no unauthorized workers/people passing around the work area | Administrative Controls |
| | | | Wear work clothes and work helmets | PPE |

| | | | | |
|---|---|---|---|---|
| | 2. The space at the bottom of the car is narrow | M | Make a warning sign so that workers are careful when moving | Administrative Controls |
| | | | Wear work clothes and work helmets | PPE |
| Changing the engine oil | Engine oil spills or drips on the workshop floor | H | Clean the work floor with sand and soapy water until the oil spill disappears/clean | Elimination |
| | | | Make a schedule for workers to clean up the workplace after work | Administrative Controls |
| | | | Wear slip-resistant safety shoes | PPE |
| Locking bolts or engine oil compartment cover | The bolt lock is not strong enough so that oil can seep | L | Re-check the bolt lock in tight condition | Elimination |
| | | | Make standard work procedures for every work activity | Administrative Controls |
| | | | Wear slip-resistant safety shoes | PPE |
| Turning on the grinding machine | Condition of sockets and plugs | M | Install the electrical system inside the wall | Elimination |
| | | | Replace the socket and plug cable with a new one | Substitution |
| | | | Design and install cable protector/cable duct | Engineering Controls |
| | | | Make work procedures for the preparation and maintenance of electrical systems and grinding machines | Administrative Controls |
| Using a grinding machine | 1. Not wearing PPE gloves when working with grinding machine | H | Make a standard operating procedure for the use of PPE that is mandatory at work | Administrative Controls |
| | | | Wear cut-resistant gloves to protect hands during grinding | PPE |
| | 2. Not wearing PPE goggles when working with grinding machine | M | Use a face shield or goggles to protect the face when grinding | PPE |
| Jacking up the car according to the stable rubber part to be replaced | The jack drops suddenly or automatically when the end of the jack does not match the pedestal of the vehicle | M | Periodically check and calibrate the jack used | Engineering Controls |
| | | | Follow the procedures for using the jack and proper placement on the car frame,<br>Make a safety sign so that there are no unauthorized workers/people passing around the work area | Administrative Controls |
| | | | Wear work clothes and work helmets | PPE |
| Cleaning the housing of brake pads using nitrogen | Dust from the brake pad housing which is the residue from the brake pad asbestos (risk to respiratory | M | Perform periodic checks and cleaning of the brake pads | Elimination |
| | | | Use a face shield and mask when carrying out the cleaning process on the brake pads housing | PPE |

| | | | | |
|---|---|---|---|---|
| | system and vision/eyes) | | | |
| Lowering the car from the lift | The vehicle falls if the pedestal or the position of the car with the lift is not suitable | M | Follow the procedures for using a car lift and proper placement on the car frame,<br>Make a sign so that there are no unauthorized workers/people passing around the work area | Administrative Controls |
| | | | Wear work clothes and work helmets | PPE |

The risk control that has been prepared will become an action protocol that must be obeyed and used by family workshop businesses. By implementing this OHS protocol, work safety and a comfortable working environment are created to produce optimum work productivity [16]. The implementation of the Occupational Health and Safety system and reducing the impact of potential hazards found in car repair shop will have a double impact, including creating conducive working conditions, high work productivity, safety for workers, and creating efficiency by reducing unexpected costs.

## 4 Conclusions

Work in the workshop has a potential hazard if it does not apply the principles of work safety. The results showed that fourteen potential hazards from ten steps of car repair work had been identified at the Family Workshop. The results of observations, interviews and assessments of potential hazards and risks found three parts of potential hazards with a low level, nine potential hazards with a moderate level, and two potential hazards with a high level. Risk control is carried out on fourteen potential hazards as an effort to create a climate of safety and health in the workplace, and prevent accidents and diseases caused by work.

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