Safety and risk evaluation implementation at sheet metal stamping company using HIRARC model

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Abstract. Sheet metal stamping has been identified as one of the most hazardous and high-risk process in the world of manufacturing industries. This project was carried out at a sheet metal stamping company located in Perak which is a precision metal stamping company and is focused on 150 tons and 200 tons stamping only. A systematic analysis based on Occupational Safety and Health (OSHA) standard was used to create a model of Hazard Identification, Risk Assessment and Control (HIRARC) at the stamping department to determine hazardous process/areas for department operation and maintenance of observation, safety analysis, workplace inspection, safety checklist and high-risk investigation. Initial risk assessment was conducted by classifying the hazards in three types of level, such as High, Medium and Low. The severity of hazards was calculated to estimate the likelihood it will happen and to decide which process/area needs to be applied control measures implemented in the departments. The risk assessments were repeated, and the results were analyzed. From the analysis of risk assessment shows that a reduction of 17% from the high-risk level of 150 tons and 27% at 200 tons. Safety and health are very important to prevent the occurrence of accidents.

1. Introduction
Manufacturing industry has been identified as one of the most hazardous industries in many parts of the world manufacturing [1]. Industrial workers have to face the risks of fatality or major accident with a low level of safety in the industry [2]. This project will be required in advanced in a big company of the sheet metal industry to assist in order to bring success in this research. The study and experiences contribute to the identification of the safety problem in production safety layout of the department. This project will be held at a sheet metal stamping company located in Perak. The company performs prototyping, precision metal stamping as well as mechanical and product assembly. The factory is 12,891 square meters consist of 500 workers and 8 departments: Stamping, Numerical Control Turret (NCT), Assembly, Tooling, Supply Chain, Warehouse, Finance and Sales. For this project, the scope of work will cover stamping department, which have 150 tons and 200 tons (same department) and 600 tons stamping machine. The case study will cover only for layout 150 and 200 tons of stamping machine which the production line area is less size than 600 tons. The safety of the workers must give an attention to provide the best facilities and productivity of the industries [3]. In addition, the cases are general in the manufacturing line [4]. This research focuses on the sheet metal industries which have its safety level and risk requirement for the material handling. This project is proposed to improve the risk by observing before implement safety requirement and others safety
factors at the production line and comparing the performances at stamping department to achieve the project goals for improvement of safety facility performance for the long term of the production.

2. Methodology

2.1. HIRARC Assessment
There are several stages involved to complete this project. First stage is the factory visit to sheet metal stamping company. The main manufacturing process is stamping process. Suitable department had been chosen to continue the project and go through the process and anything that related to the objective of the project. Survey and observation of safety level have been done to record the data and identify the hazard analysis.

2.2. Classification of Work Activities
Next stages for this project are going through the flowchart of HIRARC process. First step in this process was observing and classifying the work activities. The department was observed to collect the data of their work activities. Thus, identifying the specific area which has a high level of risk. Work activities are classified by its stage of production, moving vehicle, production space area or workers’ space area, machine handling and worker safety protection. The task of work is defined such as loading, packing or others that related to the working department.

2.3. Identify Hazards
Hazards can identify their safety, environmental, health and analyze of estimating risk. To gain the data hazards, the working machine identifies its process, transportation of dies to the machine, packaging and manual handling of machines. The observation through 150 and 200 tons can be used to calculate the level of risk. Hazardous condition is highlighted to the activities performed. Table 1 shows work activities by its hazard’s identification at the department.

| Hazard Identification   | Work Activities                                           |
|-------------------------|-----------------------------------------------------------|
| Mechanical              | • Vehicle movement, such as a forklift                   |
|                         | • Moving head crane                                      |
| Manual handling         | • Passing sheet metal to another stamping machine        |
|                         | • Defect check and data output recorded                  |
| Energy                  | • Expose to the electricity                             |
| Work Environment        | • No safety lines                                       |
|                         | • Moving overhead crane                                 |
| Equipment               | • Unprotected machine                                    |
|                         | • Unseen movement machine                               |

2.4. Risk Assessment
A risk assessment will be represented in varying ways to show the results of analysis for making a decision on risk control. The analysis of the risk uses likelihood and severity rating of the situation will be represented in a percent graph effective communication of the data collected by the department. Likelihood value is based on surveys or questions at the end the categories of likelihood as shown in Table 2. In Table 3, Severity is divided into five and the analysis uses likelihood and severity, the method and the results are represented in percentage. Equation 1 shows the formula to calculate risk percentage of risk level at the department.
Table 2: Rating Situation of Severity

| Likelihood | Situation                                      | Rating |
|------------|------------------------------------------------|--------|
| Most likely | The most likely result of hazard               | 5      |
| Possible   | As good a chance of occurring and is not unusual | 4      |
| Conceivable | Might be occur at sometimes in the future      | 3      |
| Remote     | Has not been known to occur after many years   | 2      |
| Inconceivable | It’s practically impossible and has never occurred | 1      |

Table 3: Rating Situation of Likelihood

| Severity  | Situation                                      | Rating |
|-----------|------------------------------------------------|--------|
| Catastrophic | Numerous fatalities, irrevocable property damage and productivity | 5      |
| Fatal     | Approximately one single fatality major property damage if the hazard is realized | 4      |
| Serious   | Nonfatal injury, permanent disability          | 3      |
| Minor     | Disabling but not permanent injury             | 2      |
| Negligible | Minor abrasions, bruises, cuts, first aid type injury | 1      |

Risk percentage = \( \frac{\text{Total Risk Calculated}}{\text{Total Maximum Risk}} \times 100\% \)  \( (1) \)

Next observations, calculation and surveys at the department were identified to calculate percent of risk level. The process were observed by week, and the risk are calculated again based on the performances of workers. All the data were recorded by HIRARC form to see how many risk minimization can be increase. The observation data were finalized to identify the risk and hazards for the next step of the methodology. All the activities are recorded before implement the safety precaution at the department. Based on Figure 1, the HIRARC form is used to recognize the name of the company, location and the date review of project process. This documentation is referring to calculate the risk of the workstation.

![HIRARC Form](image)

**Figure 1:** HIRARC Form for Risk Control Record and Progress
3. Result and Discussion

After the process implementation and data collection, the risk was calculated and the level of risk at the workplaces was identified. Based on the HIRARC form, it shows the progress of the observation until it is completed. The data were interpreted by using graph of 150 tons, 200 tons and also graph of total percentage of improvement at the department to shows the percent improvement. From Figure 2, the graph is describing the improvement of hazard identification at 150 tons. This workplace is not in serious of risk level, it is calculated because the workplace is in the same department with 200 tons which is the place was small and crowded. The department sharing walkway line with heavy moving vehicles and others regular movement. Based on the graph, sound above 90 dB gives the high percent of improvement which is 65%. This is due to the workers applied and follows instruction to wear an earplug for hearing protection.

Based on Figure 3, the graph of improvement at 200 tons shows percent improvement of heavy load 35.9%, unprotected machine 39.6% and sound above 90 dB 42.7% gives good results of improvement. This is due to the all the moving machines are protected by the workers. The auto machine was protected by the fences while it is running and the workers wearing earplug with standard personal protective equipment.

Figure 2: Graph of Improvement of Hazard Identification (150 tons)

Figure 3: Graph of Improvement of Hazard Identifications (200 tons)
The data from all aspects at the workstation and department was interpreted in graph to make it clear and easy to read the improvement. Based on Figure 4, the graph of percent of total percent improvement in stamping department was calculated. The data of overall is made to make it precise because 150 tons and 200 tons are sharing in the same department. Before implement, the risk shows at high percent which is 40% at 150 tons while 71.2% at 200 tons. After several investigation and observation at the department, it is drops to 25.3% and 48.8% at 150 and 200 tons respectively for week 1. From the calculation until week 2, it drops again and gives the best result which is below 50% and level of risk. Last result shows 21.5% at 150 tons and 36.8% at 200 tons.

4. Conclusion
As a conclusion, by doing this research, it gives a lot of information about the HIRARC process of safety. The objectives of this project were achieved after a couple of months, several studies and research about OSHA, safety and risk in industries. After doing this project, workers now alert and knows the importance of safety inspection at their workplace and it helps to minimize the risk and improve the level of safety.

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