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Workers' Safety Awareness Level on Hand Related Injury Accident in Metal Fabrication Industry

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Abstract – *The aim of this paper is to measure the safety awareness level of workers by means of hand related injury accident recorded in Production Department of Metal Fabrication Process Company located in southern peninsular Malaysia. Base on the accident data obtained from year 2008 until 2012, it showed an increasing numbers of accidents involving hand. In year 2008 the rate is 36.3%, year 2009 is 30%, year 2010 is 37.5%, year 2011 is 33.3% and year 2012 is 37.5%. Site observation has been conducted to assess the hazards involve (safety and ergonomic) to the metal fabrication activities being carried out. Survey Questionnaires have been distributed to 80 respondents from different job trade. The Respondent data was analysed to obtain the safety awareness level for each worker's trade.*

Keywords: Hand Injury, Metal Fabrication Industry, Safety Hazards, Ergonomic Risk Factor, Behaviour Safety Checklist, Hand safety procedure

1.0 INTRODUCTION

Hand and wrist injury was defined as any injury occurring distal to proximal wrist crease as well as soft tissues injury to the forearm and fractures of the carpal bones, distal radius and ulna [1]. Historically, accident involving hand has been occurred since more than 30 years ago and it has caused a lot of losses either to organization or the person at work. The industry involved is not limited, and any workplace that having a machine operation oriented, is potential to expose to hand related incident. From that impact, the injured workers will be suffering from several types of disablement while carrying out their routine jobs which end up by changing to other occupation or early retirement. In Malaysia, there was no appropriate Safety System and Engineering Control in mitigating the hand related incident from keeps happening. A study in textile industry stated that, there were severe records of injuries where most of the workers were suffering from disablement [2]. This phenomenon does not stop here, even after 10 years later, even there was a lot of improvement in terms of safety system such as machine guarding being implemented, and accident involving hand is still increasing. The reason why the hand injury involving machinery still occur is due to workers are tend to find short cut or ways to accidentally trap their hand during maintenance or cleaning works [3]. During operating an equipment or machine which has a potential to cause harm, a proper

training should be conducted prior to use the equipment such as working with high pressure equipment. Furthermore, a stringent supervision in the usage of protective equipment and close monitoring on the procurement of equipments which not complying with the safety rules and regulations could prevent hand injury accident [4]. A number of accidents being occurred while operating such equipment and some cases also are not reported, especially in small medium industry. According to the study, injuries are fifth common death among men and sixth most common among women where injuries involving hand are among the most frequent injuries [5]. In terms of improvement plan, due to significant social, psychological and economic consequences, as well as permanent impairment, the study on hand injury prevention is one of the most important area of study [6].

1.1 Background of Hand Injury

Hand injury accident is one of the major contributions in industrial accidents such in manufacturing, construction, agriculture, foods as well as small medium industry. The trend of accident especially in manufacturing is one of the areas that need to focus, mainly on its prevention strategy by means of improvement plan. In small medium industry, a study has been carried out to identify the type and causes of hand related accident in food manufacturing industries [7]. Even the result showed most of the injury is a minor cut but if there is no prevention being taken, the effect will become worse in near future. Hand injuries in oil industries also showed a serious sign and need to be taken up for further improvement. The statistics of hand injuries has been collected and analysed to identify the main contribution towards hand injuries [5]. Besides of other industry, agriculture also plays an important role in developing economic of the country. In agriculture there will be a big numbers of workers involve which will contribute to high accident rate especially hand. A study on agriculture has been carried out to investigate the incident related to hand during farming where the result showed laceration is the most type of injuries followed by fracture [8]. Apart from that, in agriculture the type of tools and machinery used for farming also cause different type of injury pattern [9]. In tourism industry, activities like boating and water sports also exposed to hand injury. Bites and strings from marine life are identified as a factor for hand injury as well as expose to bacteria contain in fresh water or marine environment [10]. A study also has been carried to Textile Industry to identify the type of hand injury and improvement shown by means of acute treatment [3].

For hand injuries by high pressure injection, is identified as common incident occurred to workers involve in blasting & painting, water jet cleaning and plastic injection industry. The severity of the injury is depends on few factors such as the degree of the initial wounding force and the properties of chemicals being injected from the substances being used [11]. Furthermore, high pressure water jet injuries can be categorized as small entry wounds with extensive tissue damage underneath [12] In meat industry, laceration injury to the hand is the main type of injury identified and due to that incident, an improvement towards injury prevention has been studied [13]. Generally, hand injuries accident in manufacturing industry has been most contribute to an accidents where human factors is the main root cause of all accident [14].

1.2 Issues Related to Hand Injury Accident

Most industries in Malaysia were still lacking in mitigating the risk related towards hand related injuries incident due to re-active action by employer. Among those weakness and causes being observed are as follow:

1.2.1Procedures. The procedure on any jobs to be carried out is important and the absence or insufficient of them need to be looked seriously and improve. Such critical activities that involve machineries with a sharp tools or rotating parts, have to be provided with proper instructions to the workers to prevent any incident which might affect the operation of a project. Those issues are observed and found the organization itself is lack of specific procedures and guidelines for their employees because the management assumed hand injury accident is not a big deal to overcome until it becomes a threat to organization. In general, hand injury accidents are the result of stress, inattention, tiredness, use of defective or poorly maintained machinery [15]. But for the multi-national company or oil & gas industry, they are looking at those issues seriously because if they refuse, it would reflect their future business operation. They will organize awareness training and hand safety campaign to all employees in order to reduce the injury rate of hand related incident. As an example in Halliburton, due to high hand injury rate from 2003-2005 and they have came out with a effective Hand & Finger Campaign in mitigating the risk and set the goal on individual responsibility in safety [16].

1.2.2 Injury Rate. Base on a study in Europe, hand injuries are a frequent occurrence and account for 41% of all occupational injuries [15]. In Malaysia, a numbers of accident in overall industry sector shows decreasing, however in manufacturing sector still the main contribution from the total numbers of accident. In 2012, manufacturing sector had 1720 accidents and shown an increasing trend compared in 2011 which was 1459 accidents. Referring to 2012 accident statistics, 1187 accidents were related to hand and finger. (Policy and Research Division, Department of Occupational Safety and Health, Malaysia). Table 1 shows statistics of hand injury rate being compiled for 5 years period, from 2008 until 2012 at metal fabrication process company located in southern Malaysia. From the table it showed, the hand injury accident rate is contributed about one third from the total accident occurred. It also showed no sign of improvement in terms of hand injury cases throughout five years statistics being obtained.

Table 1: Hand Injury Rate

Year	Hand Injury Rate
2008	36.3%
2009	30.0%
2010	37.5%
2011	33.3%
2012	37.5%

1.2.3 Cost of Accident. The management does not aware on the cost incurred when any accident happen in their workplace. They always focus on the progress or result of the project. The direct and indirect cost of hand injury patient has been measured and found the indirect cost is higher than the direct cost [17]. Besides that, in a study carried out revealed that, hand injuries at work were most costly both in terms of health care and cost of lost production [18].

1.2.4 Unreported Accident. Unreported accident on some industries is become part of a trend nowadays in certain industry in Malaysia and other developing countries. A study also revealed that, the developing countries is the most common in under-reporting their occupational accidents and only limited numbers of study investigating its risk factors [4].

1.2.5 Manufacturing Process Complexity. Different type of manufacturing sector has its own process in producing the products. Base on every process, employer shall carry out risk assessment and appropriate control measures to ensure the task is being executed safely. Recent study also revealed that, the employer was challenge to assess all machines and equipment, including guards and safety devices which expose to the top risk of hand accident [19].

Figure 1 illustrates the Metal Fabrication Process flow chart where it shows several process of metal fabrication such metal plate rolling, metal plate cutting, welding, gouging and grinding. To ensure all safety measures is in place, it required to be assessed closely to avoid any accident especially involving hand.

2.0 METHODOLOGY

The methodology being used for this study is a Quantitative method. It was done through performing Risk Assessment in fabrication process activities, analyze Accident Data and Survey Questionnaire. Site visit has been conducted at Production Department of metal fabrication process to assess the activities and identify the tasks which most contribute to hand injury. It was followed by prioritization of risk according to the jobs identified. Five years accident data in the metal fabrication process company is collected and analyzed. The data from 2008 until 2012 has been studied and sorted to identify the total numbers of hand injury accident. When the total numbers of hand injury is obtained, the main contribution factors towards the hand injury will be identified. A questionnaire survey will be conducted at workplace which twenty sets of questions will be issued at four fabrication bays. The structure of the questions are divided into five categories; Human, Machine, Environment, Management and Personal Protective Equipment. The Questionnaires will be using a Likert type format which the rating scales from 1 (Strongly Disagree) to 5 (Strongly Agree). The target group for this questionnaire survey is Supervisor, Foremen, Welder, Fitter and General Worker. All the data has been analyzed using SPSS software. Figure 2 shows a Methodology Flow chart for this study which showed about overall process of data collection.

3.0 RESULTS AND DISCUSSION

From the site survey and observation conducted at the production department of metal fabrication, all the key process has been identified in order to assess the hazards of each critical process.

Table 2 describes eight key activities in metal fabrication process which classified as prone to hand injury if no control measures being taken. The activities are grinding, cutting, welding, gouging, polishing, high pressure cleaning, blasting and painting. The safety hazards being identified are entanglement, flying materials, dust, fumes, heat, radiation, electrocuted, noise, overshooting and paint fume. Direct hazards will cause workers to get injured directly from the exposed hazards during carrying out jobs without affect surrounding working environment. When workers involve in entanglement, flying materials and overshooting hazard, they will directly cause injury either to the hand or other parts of the body. Same goes to electrocuted where the workers would experience burns to the hand when expose to faulty electrical system. Indirect hazards will tend workers to avoid something generated from the activities and unable to response accordingly which might in contact to nearby machinery. When dust, fumes, heat, radiation and noise are exposed to workers, they will tend to avoid

such hazards spontaneously. From that action, it will cause workers in contact to nearby tools or machinery and lead to hand injury.

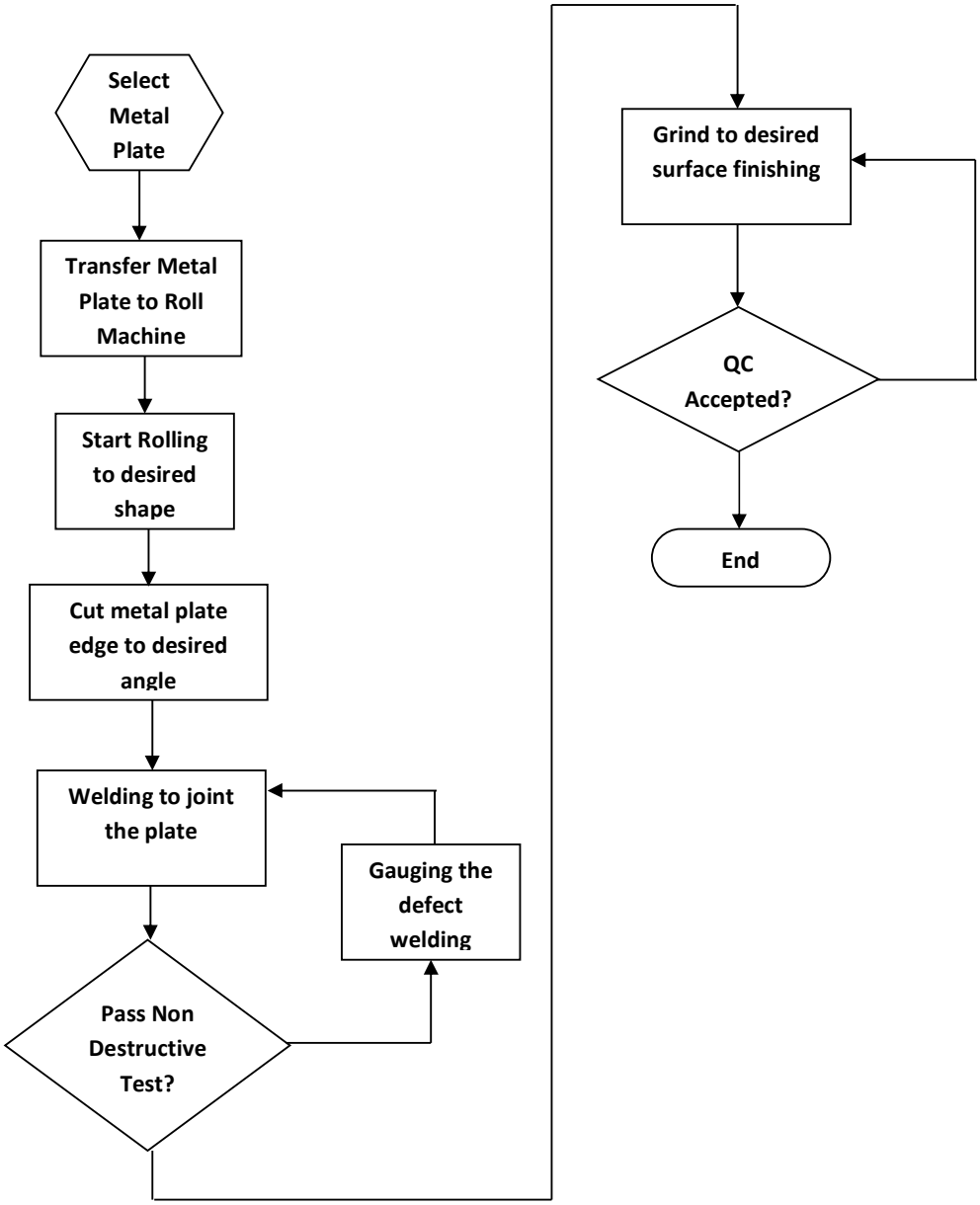

Figure 1: Metal Fabrication Process

Table 3 describes eight types of tools and equipment being used in metal fabrication which contribute to Ergonomic Risk to workers. Tools being assessed are lathe machine, metal cutter, gas cutter, welding generator, gouging gun, power / hand tool and blasting gun. Ergonomic Risk Factor being identified are Static Loading, Awkward Posture, Contact Stress, Heat, Dusty and Chemical Vapour. Ergonomic Risk is identified as one of the contribution towards hand injury accident when the activities are carried out more than 2 hours continuously. Workers would felt stress, exhausted and lose concentration. Even hand injuries was rarely threaten life, it would affect the quality of life which lead to absence from

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duty and unemployment [20]. Example of Ergonomic Risk Factor is Contact Stress while handling power tools. The workers hand will experience numbness and might lose grip which lead to tools slipping. Furthermore, static loading, awkward posture, heat and chemical vapour exposure also observed as contribution factor towards hand injury due to exhaustion and lose of concentration.

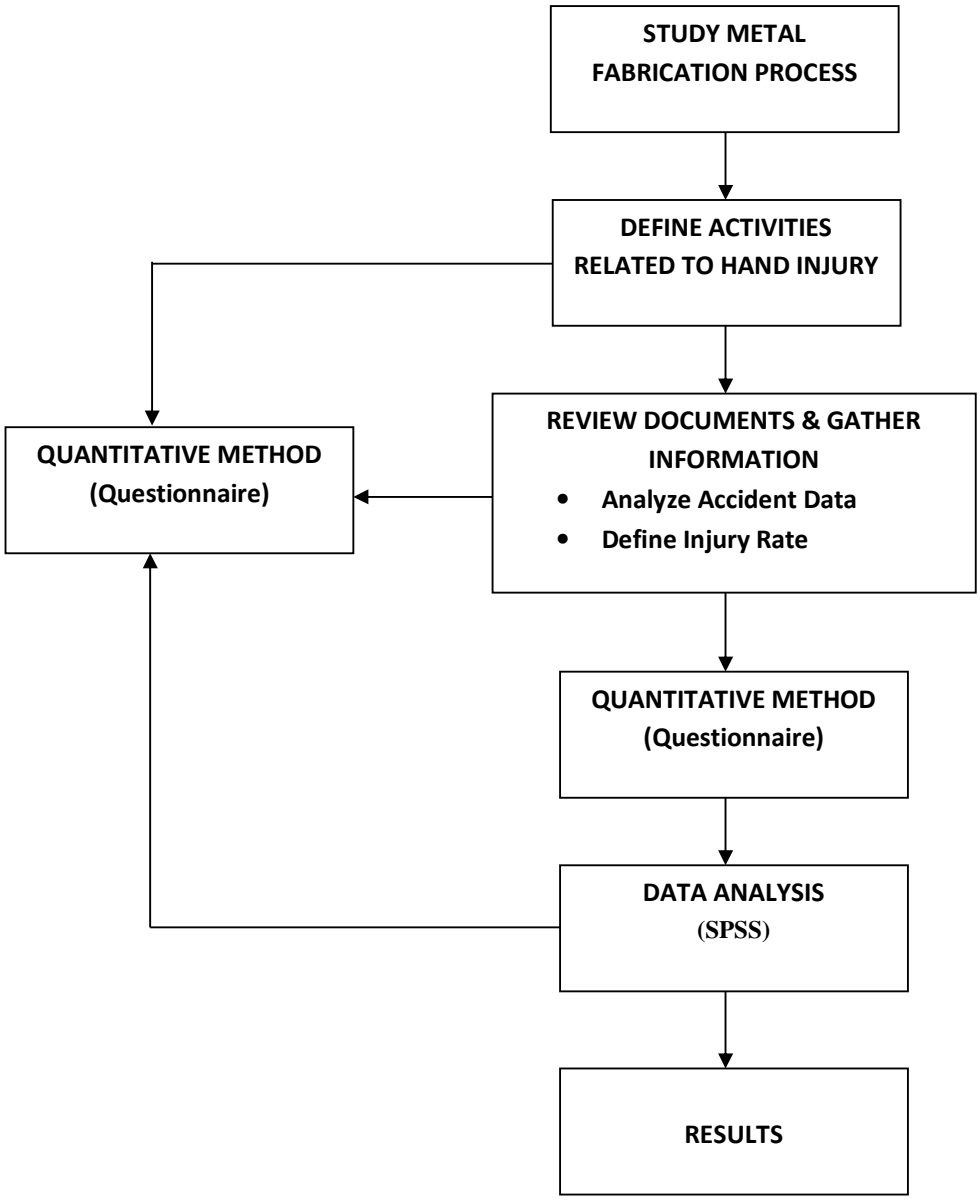

Figure 2: Research Methodology Flowchart

Table 2: Metal Fabrication Activities and Hazards

Activity	Safety Hazards
Grinding	Entanglement, Flying Materials, Dust
Cutting	Entanglement, Flying Materials, Dust
Welding	Fumes, Heat, Radiation, Electrocuted
Gouging	Fumes, Heat, Radiation, Electrocuted, Noise
Polishing	Flying Materials, Dust
High Pressure Cleaning	Flying Materials, Overshooting
Blasting	Flying Materials, Overshooting, Dust
Painting	Paint Fume

Table 3: Tools and Machinery versus Ergonomic Risk Factor

Tool & Machinery	Ergonomic Risk Factor
Lathe Machine	Static Loading, Awkward Posture
Metal Cutter	Contact Stress, Awkward Posture
Gas Cutter	Contact Stress, Awkward Posture, Static Loading, Heat
Welding Generator	Awkward Posture, Static Loading, Heat
Gouging Gun	Awkward Posture, Static Loading, Contact Stress, Heat
Power tool/Hand tool	Awkward Posture, Static Loading, Contact Stress
Blasting Gun	Awkward Posture, Static Loading, Dusty
Painting Gun	Awkward Posture, Static Loading, Chemical vapor

Table 4 describes total numbers of accident occurred at metal fabrication process company for 5 years. From the data gathered, the hand injury rate can be obtained which is useful to analyse the characteristic of hand injury accident. In 2008, the total accident cases were 11, in 2009 the total accident cases were 10, in 2010 the total accident cases were 16, in 2011 the total accident cases were 18 and in 2012 the total accident cases were 16. According to the numbers of accident recorded, it showed an increasing accident trend even slightly decrease in 2012.

Table 4: Total Accident at Metal Fabrication Process

Year	Total Accident
2008	11
2009	10
2010	16
2011	18
2012	16

Table 5 describes hand injury rate at Metal Fabrication Process Company from 2008 until 2012. In 2008, from 11 accidents recorded, 4 accidents were hand injury accident and it contributed 36.3% from annual accident statistics. In 2009, from 10 accidents recorded, 3 accidents were hand injury accident and it contributed 30% from annual accident statistics. In 2010, from 16 accidents recorded, 6 accidents were hand injury accident and it contributed 37.5% from annual accident statistics. In 2011, from 18 accidents recorded, 6 accidents were hand injury accident and it contributed 33.3% from annual accident statistics. In 2012, from 16 accidents recorded, 6 accidents were hand injury accident and it contributed 37.5% from annual accident statistics. The injury rate being obtained will be the basis of this study for further improvement in reducing hand injury rate.

Table 5: Hand injury Accident versus Total Accident

Total Accident (Year)	Hand Injury Accident (%)
11 (2008)	4 (36.3%)
10 (2009)	3 (30.0%)
16 (2010)	6 (37.5%)
18 (2011)	6 (33.3%)
16 (2012)	6 (37.5%)

Based on the data being analysed from Survey Questionnaires, the overall Respondent awareness level on safety in fabrication process is determined. According to Respondents feedback, the state of knowledge on workplace safety compliance can be determined. It will described in percentage using Pie Chart according to accident contribution factor; Human, Machine, Workplace Environment, Management and Personal Protective Equipment. The level of awareness is measured by taking an average percentage on the degree of awareness either from the Positive approach or Negative Approach.

Human Factor: Figure 3 shows the safety awareness percentage for Human Factor which Supervisors (73%), Foremen (60%), Welders (67%), Fitters (79%) and General Workers (78%). The average percentage for Human Factor is 72%. The result shows that most of the workers still aware on the safety compliance in workplace. It is just about 28% of the workers do not aware and failed to adhere to workplace safety requirements.

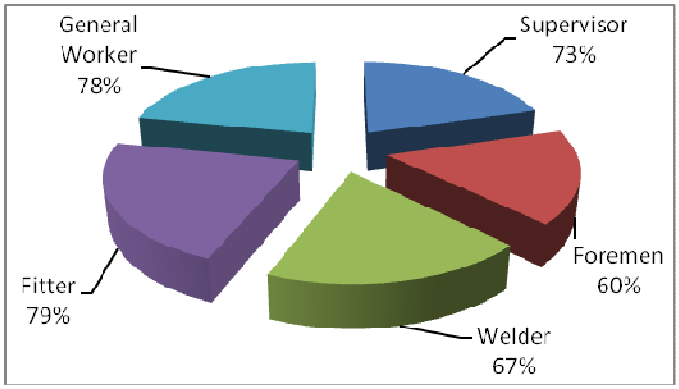

Figure 3: Human Factor Awareness Level

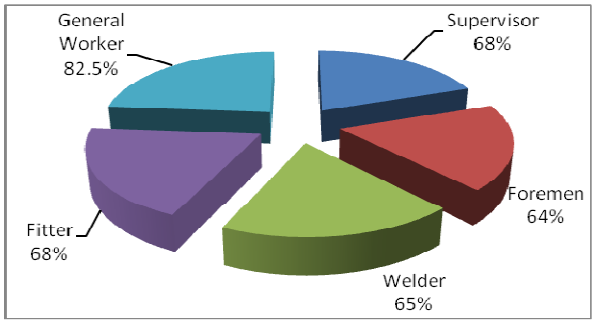

Figure 4: Machine Factor Awareness Level

Machine Factor: Figure 4 shows the safety awareness percentage for Machine Factor which Supervisors (68%), Foremen (64%), Welders (65%), Fitters (68%) and General Workers (82.5%). The average percentage for Machine Factor is 70%. The result shows that most of the workers still aware on the safety compliance in workplace. It is just about 30% of the workers do not aware and failed to adhere to workplace safety requirements.

Workplace Environment Factor: Figure 5 shows the safety awareness percentage for Workplace Environment Factor which Supervisors (85%), Foremen (70%), Welders (77.5%), Fitters (77%) and General Workers (79%). The average percentage for Human Factor is 78%. The result shows that most of the workers still aware on the safety compliance in workplace. It is just about 22% of the workers do not aware and failed to adhere to workplace safety requirements.

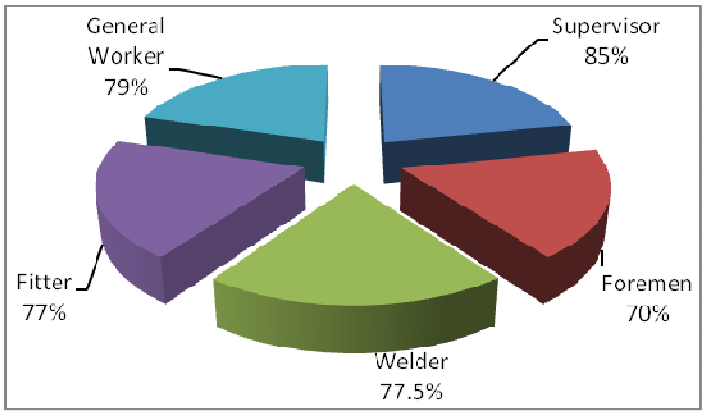

Figure 5: Workplace Environment Factor Awareness Level

Management Factor: Figure 6 shows the safety awareness percentage for Management Factor which Supervisors (77.5%), Foremen (52.5%), Welders (77%), Fitters (76%) and General Workers (80%). The average percentage for Management Factor is 73%. The result shows that most of the workers still aware on the safety compliance in workplace. It is just about 27% of the workers do not aware and failed to adhere to workplace safety requirements.

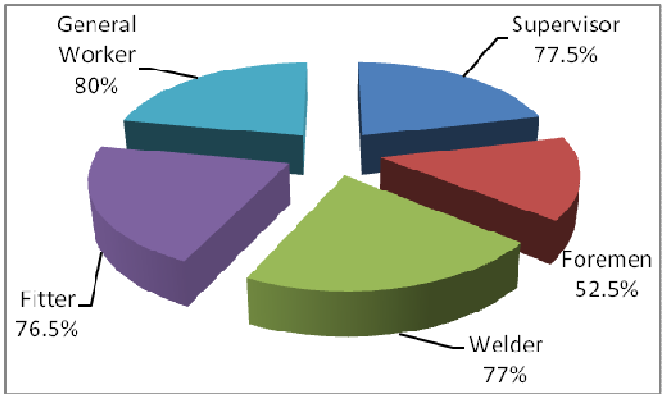

Figure 6: Management Factor Awareness Level

Personal Protective Equipment Factor: Figure 7 shows the safety awareness percentage for Personal Protective Equipment Factor which Supervisors (82.5%), Foremen (68%), Welders (79%), Fitters (81%) and General Workers (71%). The average percentage for Human Factor is 76%. The result shows that most of the workers still aware on the safety compliance in workplace. It is just about 24% of the workers do not aware and failed to adhere to workplace safety requirements.

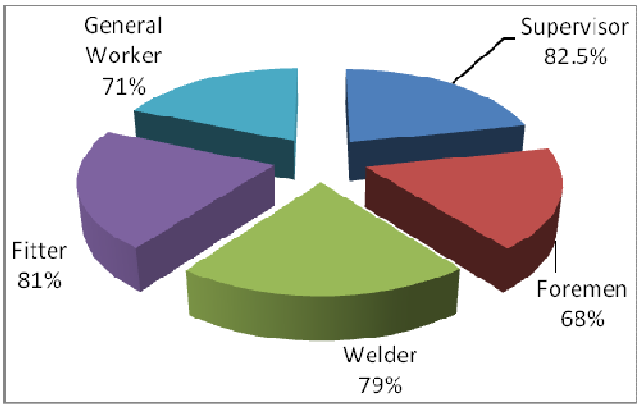

Figure 7: Personal Protective Equipment Factor Awareness Level

4.0 CONCLUSION

From the study being carried out, the safety awareness level of all workers in workplace has been obtained through five years accident data recorded and respondent questionnaires feedback. The average awareness for all accident contribution factors (human, machine, workplace environment, management, PPE) is 74% where it showed the safety compliance of workers is still reliable. Furthermore, it could be concluded that there is still has a potential room for improvement to overcome hand injury accident in metal fabrication process. However, if no actions being taken to instil safety rules, it might become weak and the risk will keep increases.

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