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Reduce Musculoskeletal Disorders Injury during Manual Handling in Tooling Parts Manufacturing Industry

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ABSTRACT

Manual handling is a physical activity that almost everyone needs to carry out in the workplace. However, if a person is required to handle heavy loads such as lifting, pushing or pulling, this may lead to Musculoskeletal Disorders (MSD) discomfort and injury. This research aimed to investigate ergonomic risk factors during manual handling activities in a manufacturing company. 14 respondents working in a production area were involved in this study. Questionnaire, direct observation at site, interview, Ergonomic Risk Assessment (ERA) such as Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) have been used as instruments to collect and analyse the data. Most of the respondents are technicians working around manual lifting of heavy loads of 11 kg and above of dies and raw material. The results show that lower back, foot, fingers and wrist contributed to their MSD symptoms. The most significant MSD was at the lower back where 100% respondents have experienced daily pain due to awkward posture, twisting and bending when lifting heavy loads manually into the machine. As for suggestions, engineering control such and administration control can be used to reduce or prevent MSD injury during manual handling.

Keywords:
Ergonomic risk factors, musculoskeletal discomfort , manual handling

1. Introduction

News of accidents at workplace are often heard, watched and read. In fact, some people might have also experienced such accidents themselves. What is bizarre is that the accidents have occurred not for the first time but lessons have not been learned through these happenings. As a result, people feel that these accidents are common, which are something that will happen anyway and are inevitable in the working environment.

Ergonomic Plus defined musculoskeletal disorders (MSD) as injuries and disorders that affect the human body's movement or musculoskeletal system such as muscles, tendons, ligaments, nerves, discs, blood vessels. Meanwhile, World Health Organization (WHO) stated musculoskeletal disorders definition as health problem of the locomotors apparatus such as muscles, tendons, ligaments,

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skeleton, cartilage, and nerves. MSD includes all form of ill-health ranging from light, transitory disorders to irreversible, disabling injury. MSD affects the bones, muscles, ligament, and tendons of the lumbar spine associated with physical work, manual handling and vehicle driving activities involving lifting, twisting, bending, static posture and prolonged seating (Department of Occupational Safety and Health Malaysia) [1]. MSD injuries involve strain that may develop or accumulate over time, which are often caused by repeating the same motion over and over. This will affect the muscles, bones, tendons, nerves, and tissues.

Identification of ergonomic risk factor (ERA) is to be carried out by every organization, especially those with employees involved with manual handling and lifting of heavy loads. Without ERA, employees do not know that the task actually would lead to occupational diseases such as MSD. Awkward posture during manual handling of heavy load can contribute to MSD. Therefore, employees working in the risk need to get training and knowledge related with ergonomic risk and manual handling where this can affect their health since employers and the management have the overall control of Occupational Safety and Health (OSH) awareness of employees to prevent occupational illness. Employer should create work activities and risks assessment to provide safe and healthy working atmosphere. Marie-Eve Chiasson et al. emphasized measuring exposure to ergonomic risk factors is an important MSD prevention tool for ergonomists [2]. MSD are class of disorder-involved damage to muscles, tendons, ligament, peripheral nerves, joint, cartilage, bones and/or supporting blood vessels. MSD can occur in any of the body parts such as a neck, shoulders followed by back, lower limbs and upper limbs [3].

This research focused on the workers as highlighted in dotted red line shown in Figure 1. The division of Dies and Parts Engineering in the tooling parts manufacturing industry, namely XYZ Sdn. Bhd. was selected for this study since that each of the sections involves manual handling with higher risk and can cause serious accidents to employees and others if not handled in a safe manner.

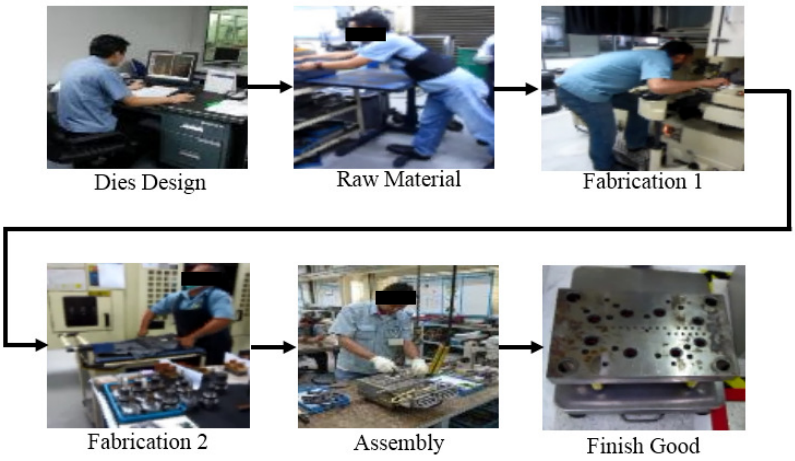

Fig. 1. Parts and Dies Engineering Process Flow

The most common manual handling activity in Dies and Parts Engineering is lifting of dies and parts that occurs every day such as using a body to exert force to handle, support or restrain any object, and includes not only lifting and carrying but also repetitive tasks. On average, employees spent eight hours a day and more in the workplace. Thus, the workplace has a significant impact on the life and health of each person. An employee had experienced discomfort and pain; however this

was not reported to the superior at an early stage when the symptoms appear due to other factors such as sports activities or lifestyle practiced and leakage of ergonomic knowledge.

In 2015, the XYZ Sdn. Bhd. received a report from Occupational Health Doctor (OHD) concerning work-related ergonomic illness. The first report was in Jun 2015, a diagnosis showing Prolapsed Disc due to manual handling of raw material and dies, where the employee has started operating the profile and jig grinding machine since 1998 until present. Due to this, the employee was hospitalized for 3 months including physiotherapy. The second report was in July 2015, in which the employee has been diagnosed with torn supraspinatus tendon in the right shoulder due to manual handling of dies since 1989. The employee has been hospitalized and underwent physiotherapy for 2 months. The third report was in May 2015 where the employee has been diagnosed with De Quervain's Tenosynovitis in the left hand due to manual handling and parts inspection since 2001. The employee has received clinical treatment and physiotherapy.

This research is expected to help employers and the management to achieve the main goal in business, which is to profit from the sales of products manufactured with good quality. However, occupational safety and health factors should remark that the risk of industrial accidents and occupational diseases such as MSD could be avoided; and indirectly reduced rate of sick leave and increased production rates and productivity can be achieved eventually. Ergonomic analysis gives to employees such as operators where the critical ergonomic concern remains to continual improvement of human-centered workplaces for ergonomics, efficiency in operations and safety aspects [4]. This research also gives some recommendation to be used to reduce the possibility to get MSD. Previous studies show that the workers were lack of knowledge in regards to ergonomics and manual material handling (MMH) [5-7]. Increased awareness of safety and health culture of excellence is needed to succeed in the global market challenges.

2. Methodology

2.1 Number of Respondents

The respondents for this study are employees of Parts & Dies Engineering. It consists of 14 (out of 15) employees. Respondents for this study are working in production areas where they have potential to be involved with lifting heavy loads manually.

2.2 Data Collection

The methodology used in the data collection for this study includes questionnaires, interview, and observation at the site.

2.2.1 Questionnaire

The questionnaire consists of three sections to obtain information on the background of the respondents, occupational health and safety management and factor of MSD symptoms.The questionnaire was modified from Cornell Musculoskeletal Discomfort Questionnaires (CMDQ). Each of the questionnaires is based on Likert Scale as shown in Table 1. The Five-point scores range from strongly disagree (1) to strongly agree (5). A summary of CMSQ questionnaire scoring is shown in Table 2. The Five-point scores ranges from never (1) to every time every day (5).

Table 1
Range of Likert Scale

Strongly Disagree (SD)	Do Not Agree (DNA)	Moderate (M)	Agree (A)	Strongly Agree (SA)
1	2	3	4	5

Table 2
A questionnaire adopted from Cornell Musculoskeletal Discomfort

Never	1-2 time/week	3-4 time/week	Every day	Every time every day
1	2	3	4	5

2.1.2 Observation study

Observation study was conducted using Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA). RULA assessment is a tool developed to assess the exposure of individual employees to ergonomic risk factors associated with upper limb MSD. The RULA's ergonomic appraisal tool considers the need for biomechanical and postural load tasks/work demands on the neck and hand. Meanwhile, Rapid Entire Body Assessment Worksheet (REBA) is designed to evaluate each of the following parts of the body: wrist, forearms, elbows, shoulders, neck, trunk, back, legs and knee. Both tools of evaluation were carried out by interviewing employees to gain an understanding of the task and demands, as well as to observe employee's movements and postures.

2.2 Ergonomic Risk Factors

Activities involved in the processes of Received Material, Dies Milling, Dies Profile, and Dies Maintenance in the respective sections were evaluated with regard to ergonomic risk factor [8]. All processes involving manual handling are shown in Table 3.

Table 3
Ergonomic Risk Factor Evaluated by Process

Section	Process	Description
Raw Material	Received material	Transferring materials such as steel and aluminum for making parts and dies
Fabrication 1	Dies Milling	Transferring dies into milling process
Fabrication 2	Dies Profile	Setting up dies into profile grinding machine
Assembly	Dies Maintenance	Dies maintenance at press department

2.3 Data Analysis

For the questionnaire, descriptive analysis using Microsoft Excel 2013 was used to describe the mean and percentage table, while for observation study; RULA and REBA were used to assess the ergonomic risk factor by referring to ergonomic expert. For the parameters, this research is focussed on manual lifting, OSH management, MSD discomfort on body parts and level of risk assessment.

4. Results and Discussion

For demographic information, most of the employees performed manual handling is male where 78.6% of them are technicians. For the length of services, 28.6% of respondents have served between one year to three-year, 21.4% served between 20 to 25 years, and 14.3% have served between 8 and 11 years, 12 and 15 years and 26 to 30 years.

Each employee has different in physical, strength and ability. Factory and Machinery Act, 1967 in Section 12 mentioned that "No person shall be employed to carry or move any load so heavy''. A male employee carrying a weight load between the knuckle and elbow height closed to his body is recommended to carry 25 kg and 16 kg for women [9].

For manual lifting, it is found that 78.6% of employees have been lifting weights between 6 kg to 100 kg manually, while 50% have used the time of 6 hours on average daily and 92.8% have been involved with manual lifting and have been doing this work between 3 to 25 years (Figure 2).

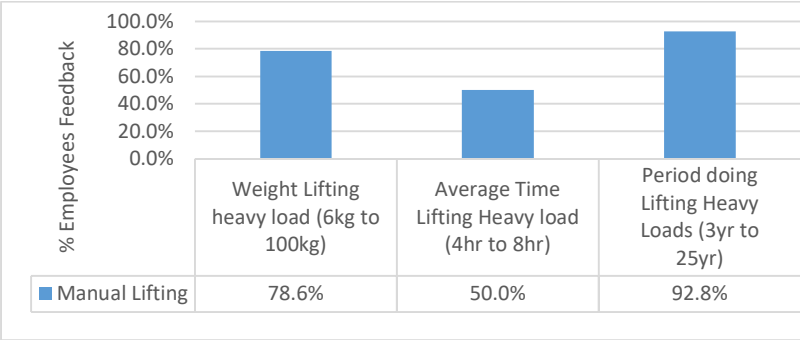

Fig. 2. Manual Lifting of Loads Handled Manually (n=14)

Occupational Safety and Health Act requires employers to provide training to employees who perform heavy loads lifting. Figure 3 show that 74.2% employees have not received MMH training. According to [10], ergonomic expertise gained knowledge through specific training and applying assessment methods for evaluating workstations. Training is seen as the core element in an ergonomics intervention [11]. Therefore, it is necessary for employees to receive appropriate training and basic knowledge of ergonomic assessment techniques and methods.

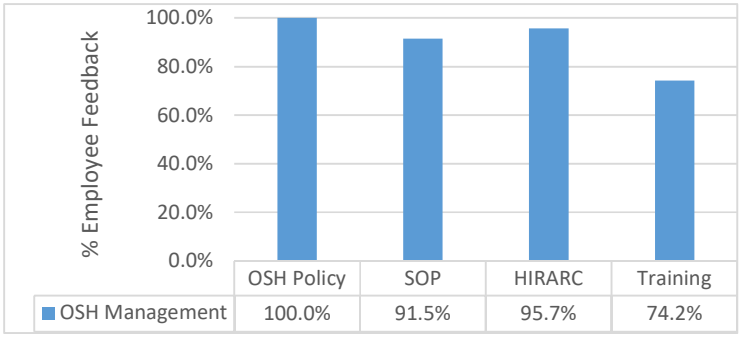

Fig. 3. Distribution of respondents by OSH Management (n=14)

Figure 4 shows the MSD distribution on body parts. 100% of employees had experienced both pains in the lower back of body and foots. According to [5], MSD discomfort arises from the method practiced by the employees, as well as pain on the upper and lower back for those work on MMH.

Refers to ergonomic risk factors, one of which is awkward posture, such as twisting of the body, side bending, overreaching contributes to lower back pain when employees need lifting the raw material into the machine and assemble dies back that having a problem. Observation on site found that foot pain because of wearing safety shoes without consideration of flexible and comfortable. Discomfort on the fingers due to task require the employee to touch with tool and object such as dies assembly, transfer material and changing/remove of dies contribution to contact stress.

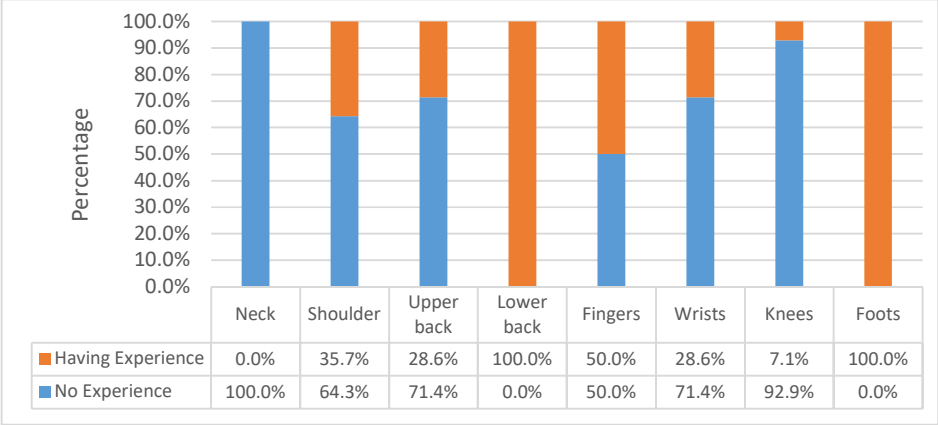

Fig. 4. Musculoskeletal Discomfort on Body Parts (n=14)

For the risk assessment, Table 4 shows the level of risk is different between the works performed by each technician, range from low to high. Received raw material process shows a high risk level and followed by dies milling and dies maintenance. The risk assessment is to eliminate or reduce hazard in the workplace which can cause harm to employees and others [12].

Table 4
Level of Ergonomic Risk

Section	Process	Risk Level		Priority
Raw Material	Received raw material	Repetition	Low	High
		Force	High	
		Posture	High	
Fabrication 1	Dies Profile	Repetition	Low	Low
		Force	Low	
		Posture	High	
Fabrication 2	Dies Milling	Repetition	Low	Moderate
		Force	High	
		Posture	Medium	
Assembly	Dies Maintenance	Repetition	High	Moderate
		Force	High	
		Posture	Medium	

The results also indicate that the following ergonomic risk factors may contribute to MSD such as Excessive Force, Awkward Posture, Contact Stress, External Factors, Static Posture, Forceful Exertion and Repetitive Motion. Ergonomic risk assessment has been conducted together with Ergonomics

Excellence Centre (EEC) from National Institute of Occupational Safety and Health (NIOSH) to identify ergonomic risk factors in four sections as described in Table 5 and Table 6.

Table 5
Ergonomic Risk Factor at Dies and Part Engineering

Section	Process	Activities	Task descriptions	Ergonomic Risk Factor	Remarks
Raw Material	Received raw material	Transferring materials such as steel and aluminum for making parts and dies	Employees are attend to transfer 2 type of raw material that is steel and aluminum block in and out via using portable lifter jack. The employee will adjust the height of the lifter jack first and then will pull and push manually the material from/to than table.	Excessive Force	Sustained force to push and pull raw material from/to table
				Awkward Posture	Technicians need to adopt bending and overreaching to perform the task
				Contact Stress	No hand glove and the side corner of raw material is very sharp
				External Factors	The working environment expose to noise
				Static Posture	Nil
				Forceful Exertion	Nil
				Repetitive Motion	Nil
Feb. 1	Die Profile	Setting the part for Profile Grinding Machine	The employee need to set the parts carefully into the profile machine	Excessive Force	Nil
				Awkward Posture	Task required twisting, slightly overreaching and bending
				Contact Stress	Nil
				External factors	The working environment expose to noise
				Static Posture	The employee need to standing in static posture with minimal leg movement
				Forceful Exertion	Nil
				Repetitive Motion	The employee do hand repetitive motion

Table 6
Ergonomic Risk Factor in Dies and Part Engineering

Section	Process	Activities	Task descriptions	Ergonomic Risk Factor	Remarks
Feb. 2	Die Milling	Transferring raw material into Milling Machine	Employees need to lift the raw material into the machine for the milling process.	Excessive Force	Nil
				Awkward Posture	Minor bending and twisting is detected when perform the task
				Contact Stress	Direct contact stress to hand (not wearing glove)
				External factors	The working environment expose to noise
				Static Posture	Nil
				Forceful Exertion	Required manual lifting of transferring dies into machine
				Repetitive Motion	Nil
Assembly	Die Maintenance	Die Assembly	The task-required technician to assembly and disassembly back the die that have a problem. Sometimes they need to flip over the die to troubleshooting the problem of the die.	Excessive Force	The force required is very high
				Awkward Posture	Bending and twisting of body, shoulder raised
				Contact Stress	Exposure to the direct pressure and stress at hand
				External factors	The working environment expose to noise and tool vibration
				Static Posture	Nil
				Forceful Exertion	Required manual handling during dies assembly
				Repetitive Motion	Less repetitive of motive during die assembly

The study also found that in the Dies Maintenance process whereby dies assembly activities are performed, the job requires the technicians to assemble and disassemble the dies with lots of problems. Sometimes the technicians need to flip over the dies when troubleshooting is required, and this requires highly excessive force.

Based on the finding of this research, engineering and administrative control is proposed as the best practices in industry and hierarchy of control for the organizations. In engineering control, overhead crane is recommended [13]. Overhead crane is equipment which allows lifting and moving

heavy materials from one location to another in an appropriate manner. The overhead crane is required as it's related to efficiency as overhead cranes are more efficient rather than using a group of employees to lift and move material. Manufacturers of dies and parts can align their processes and procedures by introducing overhead cranes to automate lifting, moving, and unloading materials at their convenience. Furthermore, it's related to safety and health because it can be used to lift and transfer materials in extreme environments and can handle heavy loads, corrosive or hazardous materials. Overhead crane can be placed to help employees move heavy objects and it can help in reducing the recurrence of injuries and MSD illness. For administrative control, job rotation and ergonomic and manual handling training are suggested. Job rotation is structured exchange of employees between different jobs, requiring employees to rotate between workstations or different jobs at specified intervals [14]. It increases the variety of tasks required when workers take on more tasks, increase physical demands and add variations in employment. Rotating people as frequently as possible is practical between work tasks. Ideally, two hourly rotate between tasks would provide some meaningful change in muscle loads. It is highly recommended for 2-hour rotation is implemented in the process. Job rotation should be implemented for tasks that are found to be medium and high in contribution to repetition risk.

In addition, ergonomic and manual handling training module based on the tasks in the company is proposed to educate the employees about proper manual handling activities and ergonomic principle. With this training, the employees could have some basic awareness on conducting their task in a safe manner. Some of the employees are performing the task in inappropriate posture or inappropriate manner because of lack of knowledge and awareness. Besides, engineers should be well versed with ergonomic principles so that they can implement it during the design stage itself. Moreover, training and education on the application of principles of general safety such as work practices, equipment safety and method of handling load can help in reducing workplace accidents involving the transfer, handling and storage of materials. Whether moving materials manually or mechanically, employees need to know and understand potential hazard associated with the task and how to control or minimize hazard at workplace. Combine both engineering and administration control can reduce or eliminate non-value tasks, conditions and potentially hazardous to workers should analysed in order to avoid accidents, injuries and fatalities [4].

5. Conclusion

In overall, this study has shown that MSD injuries caused by manual handling in Part and Tooling Manufacturing Industry can be prevented by identifying the factors of risk and assessing the level of risk during manual handling. Ergonomic risk factors are elements contributing to MSD hazards. Exposure to ergonomic risk factors in the workplace can cause or contribute to the risk of developing MSD. The ergonomic risk factors include as excessive force, awkward posture, contact stress, external factors, static posture, forceful exertion and repetitive motion. Awkward posture such as bending and twisting of the body and raised shoulder, contact stress related to direct pressure and stress on the fingers, forceful exertion required during manual handling for die assembly, repetitive motion when dealing with less repetitive of motive during dies assembly and external factors contributed by the working environment that exposes the employees to noise are among the problems. The finding show that lower back, foot, fingers and wrist contributed to their MSD symptoms. The most significant MSD was at the lower back where 100% respondents have experienced daily pain due to awkward posture, twisting and bending when lifting heavy loads manually into the machine. Engineering control such as using overhead crane and administration control such as job rotation and

ergonomic and manual handling training are suggested to reduce or prevent MSD injury during manual handling.

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