Strength Capabilities and Subjective Limit of Repetitive Manual Insertion Task

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Abstract
Manufacturing industry sector is one of industrializing parties that gives significant contribution in achieving the vision of 2020 in Malaysia. The ability of human works is compulsory in letting the industry to be successful in producing products. Unfortunately, many of painful afflictions of musculoskeletal system as Musculoskeletal Disorders (MSDs) are associated with the working posture. Ergonomic play an important role to give comfort ability to the workers who work at any manufacturing industry. Nowadays, there are so many companies that ignore about the ergonomic of their workers. They tend to push the worker to achieve the output of the company rather than think about comfort ability to the workers on the workstation. This project is conducted to investigate the subjective limit for repetitive manual handling tasks according to workstation area and body posture for workers and the pain or discomfort experienced by the workers while undertaken the task. Also the improvement of the body posture was made. The method used in this study included observation, questionnaire, company visit, interview and Rapid Upper Limb Assessment (RULA). RULA has been used in this study to assess the posture of the worker while handling the tasks before and after the improvement posture. After making the improvement, scores for body posture was reduced to the safe level.

Keywords: Musculoskeletal Disorders, Workstation Design, Repetitive Manual Handling, Body Posture, Rapid Upper Limb Assessment
Introduction

Repetitive work is a form of manual handling. The injuries that occur usually affect the muscles, tendons and other soft tissues. When the work mainly involves using the arms and hands it will easy to get numbness, tingling and loss of muscle strength. Typical examples may include production line work such as assembly, packing, wrapping and so forth. Repetitive manual work may also occur when there is a frequently lifting movement such as moving bricks or shoveling sand. Mital et al. (2000) gave the opinion about the concepts of repetitive works. Repetitive work refers to similar work tasks performed again and again. Repetitive work at upper extremity is considered one of several physical work load factors, associated with symptoms and injuries of the musculoskeletal system which known as Musculoskeletal Disorders (MSDs) problem. Other factors that influenced repetitive works are static loads, postures and exertion of external forces. Dennis et al. (2004) had done the study about the hand intensive repetitive tasks. They found out that for hand intensive repetitive tasks, the emphasis of the assessment on identifying which of the risk factors (force, repetition, awkward postures, contact stress and muscular fatigue) are significant enough to warrant reduction. If the task involves any of the following features, then it may pose a risk of MSD.

The good workstation is a workstation that allows the operator to do their job comfortably. An ergonomic workstation can give big impact to the operator to manage their work without being injured. Every company has their own problem. Some of problem that was identified is regarding ergonomic problem. The ergonomic risk factors on many companies are repetitive work, force exertion and body posture. Repetitiveness is probably the risk factor of greatest importance in many jobs in industry. It can give long period effect which is chronic effect to the workers. The operators do their work repetitively by using their hands and it may harm the operator for long period. The highest risk occurs when the same type movement is frequently repeated by the same joint. The example of body posture is static postures and movements. Static posture is considered in critical when the body segment being held in an intermediate position within the joint range for a prolonged period of time. The body posture that usually gives a problem to the workers is static posture. The operators used to work at same workstation without movement and stand for prolonged period of time. This usually happen at final assembly of the production line.

Therefore, the aim of this project is to investigate and analyzed the workstation area, body posture and experience on the body discomfort to all workers while undertaken repetitive manual handling task. Besides, project is carried out to propose the body posture method in order to reduce the pain experience for the workers.

Methodology

A wiring harness manufacturer in Pahang, Malaysia was selected to perform the data collection. This project is focus on the subjective limit for repetitive manual handling task. Five workstation and 100 workers were recruited as subjects in the study. The questionnaire is distributed to the operator at production line. The questionnaire was divided into two sections which is; part A are about demographic information. The second section part B was asking about the pain experience while undertaken the task include the discomfort at the hold body. The selected subjects represented more than 80% of the total production workers of five workstations which is conveyor, kitting, grommet, taping and layout workstation. The categories of the operator are divided into five parts which are gender, age, weight, height and process. In this
survey, the repetitive manual handling task of the operator is observed whether they are achieved good level of comfortable or not. Figures 1a to 1c shows the body posture while workers undertaken the task on five workstation in layout process.

Fig. 1a: Layout Workstation

Fig. 1b: Conveyor Workstation

Fig. 1c: Taping Workstation

Fig. 1d: Kitting Workstation

Fig. 1e: Grommet Assembly Workstation
Computer Aided Three-dimensional Interactive Application (CATIA) is software that used in this project to analyze the body posture of the workers while handling the jobs. From CATIA software, the person was developed according to the picture taken by the company. There is Rapid Upper Limb Assessment (RULA) analysis in CATIA that will used to make the analysis. The score of posture for each workstation was produced by using RULA analysis. RULA analysis in CATIA made the analysis of body posture easier compared to the RULA worksheet. Carayon (2012) found out that Rapid Upper Limb Assessment (RULA) is a quick survey method that can be used as part of an ergonomic workplace assessment where MSDs are reported. RULA assess biomechanical and postural loading on the neck, shoulders, and upper limbs and was designed to assess sedentary work. It allocates scores based on the position of groups of body parts with additional scores for force or load and muscle activity. RULA has been used majorly to look at static work postures.

Results and Discussion

The finding result from the work comfort of the workers showed that the highest percentage at Grommet Assembly workstations which male workers 50% and female works 20% of discomfort. Table 1 shows the percentage work comfort at 5 workstations.

<table>
<thead>
<tr>
<th>WORKSTATION</th>
<th>WORK COMFORT (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FEMALE</td>
<td>MALE</td>
<td>FEMALE</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>CONVEYOR</td>
<td>15</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>KITTING</td>
<td>45</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>GROMMET ASSEMBLY</td>
<td>15</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>TAPPING</td>
<td>40</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>LAYOUT</td>
<td>45</td>
<td>35</td>
<td>10</td>
</tr>
</tbody>
</table>

From the result in the table 1, the highest percentage of the worker who did not satisfy with the current workstation is 50 percent which is for taping and grommet assembly workstations. The workers at these workstations tend and feel more discomfort compare to other workstations. In addition, the female workers felt discomfort compare to male workers due to the number of female workers are higher than male workers.

The structure of the grommet assembly workstations was quite dangerous compare others. The machine can make the worker easy to expose an accident. Therefore, the workers at this workstation had the higher percentage of accidents.

In terms of body injured, the works at the taping process had the highest percentage of the workers. The female workers tend to have more body injured compare to the male workers. The procedure of doing the job at this workstation seems like to use more strength at the hands part. The workers did not wear the glove and personal protective equipment (PPE) while handling the job so that the probability to have an injured was higher. The discomfort feeling for upper body was experienced by the female workers in this workstation. The workers need to bend their body while doing their job.
The taping process also need the worker to stand for prolonged period of time while conduct the job. So, the lower body of the worker is affected. The lower part of the body easy to expose to the injury because it involved with prolonged standing. The female workers tend to have health problem at this workstation due to the process at this workstation involved awkward posture and standing for prolonged period of time. The workers keep doing the same process by using their hand that can affect chronic injury. Salvendy (2012) said that the repetitive motion or overuse loading can cause chronic injury to tendon tissues.

According to the criteria of pain experience, the most workstation that needs to undergo the improvement is taping workstation. The process at this workstation needs the workers to standing for the long period of time. The workers also bend their body for several times in order to conduct the job. As we can see from the result, the body posture of the taping process mostly in wrong posture.

Bridger (1995) claimed that the existence of strong physiological component suggests that ergonomic intervention based solely on the analysis of posture and workstation layout would be insufficient on its own. Physiological and organizational analysis would be necessary. Hence, the postures of the worker need to analyze first in order to reduce ergonomic risk factors. Pradanos et al. (2011) have done the study about the RULA method. They found out that the continued or repeated adoption of painful positions while working generates tiredness and in the long run can cause disorders in the skeletal muscle system.

From the data analysis regarding the level of pain at certain parts body, the highest number of worker in worst pain category is at taping workstation for the whole body. The data shows that the kitting workstation has the highest number of worker for fairly pain. The part of body for the fairly pain is foot. The workers need to standing for the whole day while doing the job. So, the most part that give an impact for this situation is foot. The workers that experienced light pain have the highest number of worker at layout which is shoulder part. The layout process needs the worker to move the body according to the layout of the product. So, the shoulder part plays an important role in order to conduct this process.

The body posture analysis using RULA analysis for all workstations is made. Then, each of the body posture is improved in order to overcome the MSDs problem among the workers. The improvement is also made using RULA analysis. Appendix is shows body posture for each of the workstation before and after improvement. The improvement is made in order to reduce the score of RULA and awkward posture of the workers as well. The improvement of the body posture for each workstation is summarized in table 2.

<table>
<thead>
<tr>
<th>Workstation</th>
<th>RULA Score Before Improvement</th>
<th>RULA Score After Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Layout</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Taping</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Conveyor</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Kitting</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Grommet</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Assembly</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
According to RULA score, layout, and conveyor workstation is in worse condition because the score of body posture analysis is high. But referring to the result of the questionnaire the worse workstation is in taping workstation. It is because when people stand in a long period of time the muscle will face with a problem. Hence, according to the muscle result as shown in Appendix A and B, the muscle score for taping, conveyer, and grommet assembly workstation is in red condition.

Conclusion

This study has performed muscle activity measurement in the left and right erector spinae, left and right tibialis anterior, and left and right gastrocnemius of workers at metal stamping process lines and handwork section in a metal stamping company. All workers performed their tasks in standing position for prolonged time periods. The measurements of muscle activity were conducted at three working sessions: beginning of workday, middle of workday, and end of workday. During beginning of workday, the two groups of workers show a significant difference in myoelectric level in the right erector spinae, right gastrocnemius, and left tibialis anterior. On the other hand, the two groups of workers did not show any significant difference in myoelectric level during the middle of the workday and end of the workday. Therefore, this study concluded that muscle activity of the workers was determined by the work load and duration of standing.

Recommendation

The suggestion for future works has been made in order to reduce ergonomic problem at the company. Hence, training on the proper posture that should company used in order to conduct the job. The training session will help the worker to work in a good posture and avoid ergonomic problem as well; Postures should be printed and posted at appropriate locations of the workstations that will remind the workers of the proper posture for conduct the job; the required force, repetition and duration of the jobs for the worker should be examined and the workload for each worker must be balanced.; the workstation must be redesign in order to make the worker did not use bad posture during conduct the job. The workstation must be design according to the posture that I already made the improvement.

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References


Appendix

Layout Workstation

Before improvement

Right side

Left side
After improvement

Right side

Left side
Taping Workstation  
Before improvement
After improvement

Right side

Left side
Conveyor Workstation
Before improvement

Right side

Left side
After improvement

Right side

Left side
Kitting Workstation
Before improvement

Right side

Left side
After improvement

Right

Left side
Grommet Assembly Workstation
Before improvement
After improvement

Right side

Left side