ORIGINAL ARTICLE

RULA ANALYSIS OF WORK-RELATED MUSCULOSKELETAL DISORDER AMONG POLYPROPYLENE FIBRILLATED YARN INDUSTRY WORKER USING DIGITAL HUMAN MODELLING (DHM)

Kabilmiharbi, N¹, Selamat, F.E¹

¹Mechanical Engineering Department, Universiti Tenaga Nasional (UNITEN), 43000 Kajang, Selangor, MALAYSIA

ABSTRACT

Manual workers in plastics industry are often exposed to work related discomfort and pain while performing their daily task. These exposure leads to common occupational diseases such as Work-related Musculoskeletal Disorder (WMSD) or low back pain (LBP) which in turn will affect their working performance. The main objective for this study is to analyse the working posture of a manual worker that works in a polypropylene fibrillated yarn industry using RULA assessment in CATIA P3 V5R14 software. The subject were selected from the packaging area as the manual handling work are only present in that area. Based on the RULA analysis done by constructing the worker posture in the software, several awkward postures were identified to be high in risk factors. The postures that is high in risk is postures 3 which is due to lifting heavy loads and twisting or turning of the trunk. The postures obtained the final RULA analysis score of 7 and this indicates that changes must be done immediately. It is recommended that the company should increase the ergonomic awareness among the manual workers especially while performing their work and to redesign the working posture for the manual workers.

Keywords: Low Back Pain; Work-related Musculoskeletal Disorder; Rapid Upper Limb Assessment; Manual Material Handling

INTRODUCTION

Malaysia’s economic growth led to a concomitant increase of the development of Malaysian industries in order to increase productivity. With the continual increment of industries’ existence, employees in the industry also increased. From the late 1980s, high-performing economies in the Asian region including Malaysia have been absorbing an increasing volume of workers from the neighbouring countries that are at earlier stages of demographic and economic transition¹. In recent years, the number of foreign operators in Malaysia far exceeded the local operators¹. Foreign workers working in the manufacturing and construction industry and other hazardous work locations in Malaysia are very much prone to sickness, accidents and physical disability². Unfortunately, there are certain employers which are not concerned with their health issues, thus these workers did not get the deserved medical treatment².

Numerous investigations have demonstrated that working conditions, and in particular exposure to the risk of work-related injury and illness, have an impact on health³,⁴. One of the most prevalent health problem caused by work in the modern job market that usually attacked industrial worker is work-related musculoskeletal disorder (WMSD)⁵. Musculoskeletal disorders (MSDs) in the workplace have been studied extensively and it is a common notion that the work itself is a major cause of MSDs⁶. Musculoskeletal disorder refers to health conditions that involve the locomotor apparatus, i.e. muscles, tendons, the skeleton, cartilage, the vascular system, ligaments and nerves, with back pain/injuries and work-related upper limb disorders as the main groups⁶. Work environment contributed to these types of disorders and are made worse by the working conditions or workplace risk factors.

A large range of workplace, individual, and psychosocial risk factors are associated with the development of WMSDs. Individual risk factors include age, gender, education level, anthropometry, muscle strength and physical fitness⁷. Work-related physical factors include the physical demands imposed by performing the task, such as awkward posture during work, bending, static sedentary posture and task demands while work-related psychosocial factors such as work or time spent working to meet deadlines can also contribute to WMSDs⁷. Not only that, in major cities in China, a study found that majority of factory workers were affected by work related musculoskeletal disorders due to long working hours and high mental stress level⁸.

Amongst the above-mentioned risk factors, WMSD occur primarily with workers involved in carrying heavy loads, kneeling, contact stress, vibration, extreme temperatures, twisting hands or wrists, stretching to work overhead or other awkward positions while performing job activities⁹. This includes manual material handling task where manual material handling is defined as transporting or supporting a load including lifting, lowering, pushing, carrying, or moving a load and this type of tasks will cause awkward postures due to the heavy exertion of workload¹⁰,¹¹,¹². Furthermore, manual material
handling is the most common cause of musculoskeletal disorders (MSDs) and low back pain (LBP) since it involves activity such as manual lifting, lowering, bending, pushing and pulling loads13.

Hence, the objective of this study is to investigate on manual material handling work that can affect industrial workers’ health using Rapid Upper Limb Assessment (RULA) analysis. RULA is a subjective observation method of posture analysis that focuses on the upper body, but includes the lower body. RULA was developed as a screening tool for exposure of adults to risk factors for work-related upper limb disorders, and takes into account the repetitive movements and force that may be required for a task14. Furthermore, the problematic posture of the worker that did the manual handing job will be identified, and finally, solutions to the problematic postures will be suggested to prevent working discomfort and increase the level of security for the workers while performing their task.

METHODOLOGY

Focus of the study

The study was done in a local Polypropylene (PP) Fibrillated Yarn and Coloured Cable Identification Tapes manufacturing industry located in Puchong, Selangor. Polysplit Industries Sdn. Bhd. (formerly known as Maju Sanwa Sdn. Bhd.) was incorporated in Malaysia as a private limited company on 20th. January 1984. The chosen subject is from a loading and packaging department and his work scope is to do the loading and packaging of the Polypropylene yarn. The subject had to lift up the Polypropylene yarn which is 20 kilogram while doing the packaging work. The subject was selected for this study based on the unsafe posture that he had to perform while performing his task which are repetitive movements and awkward posture. RULA analysis was used for this study in order to identify the subject’s exposure towards awkward posture.

Observation

Initially, interview session was conducted onto the subject in order to identify the comfort level of the subject during working hours. Then, observation was done on the subject while he is performing his task with the emphasis over each task by using a video recorder and later, the snapshots of the problematic postures was pull together so that a clear observation can be done on the unsafe working postures.

RULA analysis

The selected postures that had been gathered are then remodelled using CATIA P3 VSR14 (Digital Human Modelling Software, DHMS). RULA analysis was chosen for this study due to the nature of the subjects working posture where it mainly involves the movement of the upper part of human body. The important parameters for RULA analysis were logged into the DHMS. RULA is the technique that evaluates the subjects exposure to postures, forces and muscles activities that have been shown to contribute to repetitive strain injuries (RSIs), which focused on the neck, trunk and upper limbs15. At the end, the final RULA score will be obtained for each postures and the scores will identify the required action that should be taken in order to improve the workers working posture.

RESULT AND DISCUSSION

Body Discomfort

Based on the results obtained from the interview given to one of the Polypropylene worker, the subject clearly states that the subject is experiencing some discomfort in doing his job especially on the neck, shoulder, upper back and lower back. Furthermore, the subject also mention that the weight of the Polypropylene yarn is too heavy to be lifted while doing the packaging work.

RULA Analysis

RULA analysis was done after being remodelled using DHMS on 5 postures in order to indicate which posture contributes most to the subjects discomfort and needed to be taken immediate action. Selected postures are as shown in Figure 1. The first posture which is posture 1, shows the subject is tying the PP yarn in order to tidy it up before it is being packed into a plastic. Meanwhile posture 2 is where the subject is packing the PP yarn with a plastic bag by putting the plastic from the topside of the pp yarn. After that, posture 3 is where the subject turns the PP yarn over in order to place in the whole product into the plastic bag before he seals it. Next, posture 4 is where the subject is sealing the product before it will be put on top of a pallet and will be stored inside the warehouse and finally, posture 5 is showing the subject arranging and stacking the products onto a pallet.
<table>
<thead>
<tr>
<th>Posture</th>
<th>Actual Working Posture</th>
<th>Digital Human Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="Actual Working Posture 1" /></td>
<td><img src="image2" alt="Digital Human Model 1" /></td>
</tr>
<tr>
<td>2</td>
<td><img src="image3" alt="Actual Working Posture 2" /></td>
<td><img src="image4" alt="Digital Human Model 2" /></td>
</tr>
</tbody>
</table>
Figure 1. Actual working posture and after DHMS remodelling for each posture

RULA Score

RULA scores for each posture was obtained by analysing the selected postures using the CATIA P3 V5R14 software as shown in Figure 2. Final score indicate which posture contributes most to the subjects discomfort and the action level that needed to be taken immediately. The final RULA score of each posture is as shown in Table 1 together with which action level each posture belongs to. The table shows the score for Posture A which includes the wrist and arm score, Posture B which includes the neck, trunk and leg score, final score and the action that should be taken for each posture.

Figure 2. RULA analysis using CATIA P3 V5R14 software
Table 1: RULA analysis result for every posture

<table>
<thead>
<tr>
<th>Posture</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posture A score (wrist and arm)</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Posture B score (neck, trunk and leg)</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Final score</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Investigate further and change soon</td>
<td>Investigate further and change soon</td>
<td>Investigate and change immediately</td>
<td>Investigate further</td>
<td>Investigate further and change soon</td>
</tr>
</tbody>
</table>

According to Table 1, the final score obtained for posture 1 is 6 which by referring to it indicates that further investigation is needed and changes is required soon. Meanwhile, posture 2 and posture 5 obtain the same final score which is 5 and this also indicates that further investigation is needed and changes is required soon. Next, the final score obtained for posture 3 after doing a RULA analysis using CATIA P3 V5R14 is 7 and this indicates that an investigation and changes are required immediately. Lastly, the final score for posture 4 is 4 and further investigation is needed for this posture without any changes needed.

Based on the summarized results for all the postures as in Table 1, there is only one posture that needs an immediate action which is posture 3. The other three postures, posture 1, 2 and 5 needs further investigation while further investigation without any changes is needed for posture 4. Thus, improvement needs to be done especially for posture 3 followed by posture 1, 2 and 5 in order to make sure that the postures are safe and comfortable for the subject so that the subject can perform better while working. Improvements must be done by the company in order to prevent unwanted cases that can cost the health of their employees.

The main problem for posture 3 is the heavy load that the subject needs to carry and it is also a repetitive work which will cost discomfort on the muscle and nerves for long term duration. The posture is especially hard on the neck and the trunk which includes upper and lower back of the body, thus satisfy the statement given from the subject during the interview session. By referring to the RULA analysis, if it is possible to reduce the load, then the working posture might be acceptable. Besides reducing the load, maybe the work done during posture 3 can be shared amongst two workers. Other than that, PolySplit Industries Sdn. Bhd can design a conveyor with rotating rail. The conveyor will move the PP yarn effortlessly without human’s strength. Then, the worker will push the PP yarn into the rail as shown in Figure 3 below. The product will then be covered with a pink plastic bag. Next, worker will rotate the rail to the opposite way to tie the plastic bag into a knot (Figure 4). A combination of a machine-worker system will lessen the heavy load lifting.

![Figure 3. Pushing the PP yarn into the rail](image-url)
Figure 4. Rail is rotated to the opposite way and the PP yarn is drop down to the floor

CONCLUSION

Based on the investigation results, the working postures practiced by the subject while performing his tasks is unsafe. The main cause is due to the requirement of the job itself where the subject needs to handle heavy exertion load repetitively. Thus, this factor leads to his awkward working postures. Furthermore, the RULA method can be used to evaluate the exposure of individual workers to ergonomic risk factors associated with WMSDs through posture analysis. Based on the RULA results, it is suggested that further investigations and changes of the working postures is necessary to prevent WMSD in the future, which will eventually improve the work efficiency, especially in terms of productivity and job performance. The limitation of this study is the fact that there is only one worker per shift who is performing the above-mentioned processes. The reliability of the results may increase if subjects from other shift are also being considered for the analysis. However, the result of this study is still applicable as it can help to improve the working posture of the identified subject.

REFERENCES


