Volume-3, Issue-3, March-2019: 187-195
International Journal of Recent Innovations in Academic Research ISSN: 2635-3040

Reduction of Musculoskeletal Disorder (MSD) Through Manual Lifting Hoist at XYZ Manufacturing

Engr. Joel R. Cornejo

Batangas State University, JPLPC-Malvar
Malvar, Batangas, Philippines
Instructor, College of Engineering and Computing Sciences
Corresponding Author E-mail: cornejo.joel@yahoo.com

Received: March 11, 2019; **Accepted:** March 18, 2019; **Published:** March 22, 2019

Abstract: Ergonomics is the application of specific principles, methods and data drawn from a variety of disciplines to the development of engineering systems in which people play significant role. The researcher focused on how to avoid awkward postures made by the workers who transport raw materials from the receiving area to the classifying area. The goal of this study is to reduce the level of risks that might affect to the Musculoskeletal Disorders (MSDs) of the workers. Therefore, the researcher apply the Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and the Ovako Working Posture Analysis System (OWAS). Ergonomically designed lifting hoist will be suited for all the workers who experience of physical risk factors during performing their tasks. Through the proposed manual lifting hoist, the productivity of classifying raw materials increase because transport workers do not need to help in lifting process and all the delay occurs in lifting process are minimized. Using these ergonomic tools the researcher collected the output data of the ergonomic designed hoist. The assessments of RULA, REBA, and OWAS indices the scores of 4, 2, and 1 respectively, further proved that the proposed ergonomic lifting hoist reduce the risk of the workers from lifting and transportation.

Keywords: Ergonomics, Musculoskeletal Disorder, Risk Factors, Awkward Posture, Workstation.

Citation: Engr. Joel R. Cornejo. 2019. Reduction of Musculoskeletal Disorder (MSD) Through Manual Lifting Hoist at XYZ Manufacturing. International Journal of Recent Innovations in Academic Research, 3(3): 187-195.

Introduction

Over the years, the global competitiveness and with changing technology continuously create a new industrial opportunity which can be identified by improved load materials. These can make work easier to perform and will allow work to be done smooth in less time and with less energy, effort, and fatigue, with less cost per unit. Just like any other companies around the world, they aim to meet all specific demands and provide producing quality product that will suit to their client needs. Ergonomics involved design process where the design begins with an understanding of the user's role in the overall system performance and that systems exist to serve their users, whether they are consumers, system operators, production workers, or maintenance crews.

The resultant design incorporates features that take advantage of human capabilities as well because proper ergonomic design is necessary to prevent repetitive strain injuries and other musculoskeletal disorders, which develop over time and can lead to long-term disability. The goal of this study is to reduce the level of risks that might affect to the MSDs of the workers. Therefore, the researcher applied the Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and the Ovako Working Posture Analysis System (OWAS).

The researcher chose to propose an ergonomically designed hoist to eliminate the awkward postures and the pain they are experiencing and reduce the high risk factors present in some of Work-Related Upper Limb Disorders (WRULDs), such as tendonitis, carpal tunnel syndrome, osteoarthritis, vibration white finger and thoracic outlet syndrome have well-defined signs and symptoms, while others are less well-defined, involving only pain, discomfort, numbness and tingling.

Statement of the Problem

The main objective of this study was to minimize the manual lifting of raw materials by reducing the human force requirement in order to lift the materials that hinders the worker to work efficiently.

1. What is the current status of XYZ Manufacturing in producing plastic twines in terms of:
1.1 Process;
1.2 Condition of workers;
2. What job risks of workers are present due to manual lifting of raw materials?
3. What action will be done on having the ergonomic assessment (RULA, REBA and OWAS) evaluate the possible risks in transporting raw materials?
4. What improvement could be proposed by the researcher in order to reduce that pain of the workers?
5. How does the proposed equipment reduce the pain of the workers caused by awkward postures and manual lifting?

Related Literature

According to Jukka Takala (2016) of the European Agency for Safety and Health at Work, musculoskeletal disorders (MSDs) are the most common work-related health problem in Europe, affecting millions of workers. Across the EU27, 25% of workers complain of backache and 23% report muscular pains. MSDs are caused mainly by manual handling, heavy physical work, awkward and static postures, repetition of movements and vibration.

The risk of MSDs can increase with the pace of work, low job satisfaction, high job demands, job stress and working in cold environments. MSDs are the biggest cause of absence from work in practically all Member States. In some states, MSDs account for 40% of the costs of workers' compensation, and cause a reduction of up to 1.6% in the gross domestic product (GDP) of the country itself. MSDs reduce companies' profitability and add to the social costs of governments. Many problems can be prevented or greatly reduced through employers complying with existing safety and health law and following good practice. However, there are specific actions that have to be taken if MSDs are to be tackled effectively.

In the study of Tadesse and Meshesha (2017) entitled "Design and Development of Portable Crane in Production Workshop: Case Study in Bishoptu Automotive Industry, Ethiopia", portable crane uses a hydraulic system to lift a heavy loads applying only small force. The main advantage of the project is having detail design of the mechanism in the production workshop of Bishoftu Automotive Industry; Ethiopia is that it is portable, moveable, and easy

for operation. In this project we designed and produced a portable crane which can lift a heavy load with a maximum capacity of 3 ton. The crane has two loaded side bars to make the base and two links (i.e. Vertical column and boom) connected each other by using pin joint.

The crane uses four wheels, of which two of them in the front are connected to the base using permanent joint and the rear wheel is connected to the base using roller. Since the crane operates hydraulically there is piston cylinder device which is connected to the vertical column and boom for lifting up and down the objects. The maximum carrying capacity 3 ton, and maximum lifting height is estimated as greater than greater than 2.96m from the ground run by using 3KW electric motor rotating 2830/3620 rpm.

Based on the study of Nicolay and Walker (2015), "Grip strength and endurance: Influences of Anthropometric Variation, Hand Dominance, and Gender" in the International Journal of Industrial Ergonomics. Studies of grip strength typically examine maximum force during a single repetition, but this type of exertion is relatively rare in the workplace, where tasks frequently involve repeated forceful dynamic grasping or prolonged static holding.

This study examined grip strength and endurance in three experiments: single-repetition, 10-repetition, and 30-second static hold. The relationships between anthropometric variation and grip performance were assessed for 51 individuals, aged 18-33. Grip strength and relative endurance may both contribute to the risk of work-related accidents and cumulative musculoskeletal injury. Because grip force and endurance are unrelated, ergonomists should consider which factor is most important and appropriate for their design and research goals.

Bao *et al.*, (2014) entitled "Force measurement in field ergonomics research and application". addressed the issue of quantifying forceful exertions of lifting, pushing/pulling, pinch and power griping with several commonly used methods (direct measurement, force-matching, ergonomist estimation based on observation and workers self-report). The aims were to study differences of ergonomists in making decisions of collecting forceful exertion data, ability of the studied force quantification methods in detecting exposure differences between jobs, and relationships between measurements obtained by different methods. Seven hundred and thirty-three (733) subjects participated in the study, and 2482 forceful exertions were quantified with the selected force quantification methods.

Dublon's study (2016) entitled "An Ergonomically designed workstation for the workers of the Winders Department of LES Product Company, INC" has to eliminate the postural stress analysis using the ergonomic assessment RULA, REBA and Nordic questionnaire. The study was related in terms of using the same ergonomic assessment that helps to eliminate risk exposures of the workers. Oledan (2017) conducted the study entitled "Assessment of Workplace and Ergonomic Redesign of Workstation: An Approach to Provide Worker's Health & Safety at Light Provider" which focused on the significance of ergonomics and facility planning as a key instrument to prevent Musculoskeletal Disorder (MSDs) and to provide optimum space to organize equipment. The study was related in terms of providing an ergonomically designed tool using ergonomic assessments.

Materials and Methods

This research development study intended to design and construct an ergonomically designed hoist carrier.

This project was designed for a safer, easier and to refrain from the possible fracture that may occur to the worker from lifting and transporting the raw material manually. It composed of long arm hydraulic jack, wheels, and hook.

Figure 1 shows the conceptual paradigm for the flow of the research. The input model includes knowledge and experience to share additional information that will broaden their idea of what problems of the company they are facing. Equipment and materials needed in lifting were designed especially for the workers in order to reduce their pain in lifting.

The process consists of RULA which is conducted to measure the level of risks of the workers and their assessment while performing the job. It also consists of utilization that used to employ the congested path of the worker in transferring raw materials. The output of the study reduced the risk of manual lifting and multiplied the productivity of the workers.

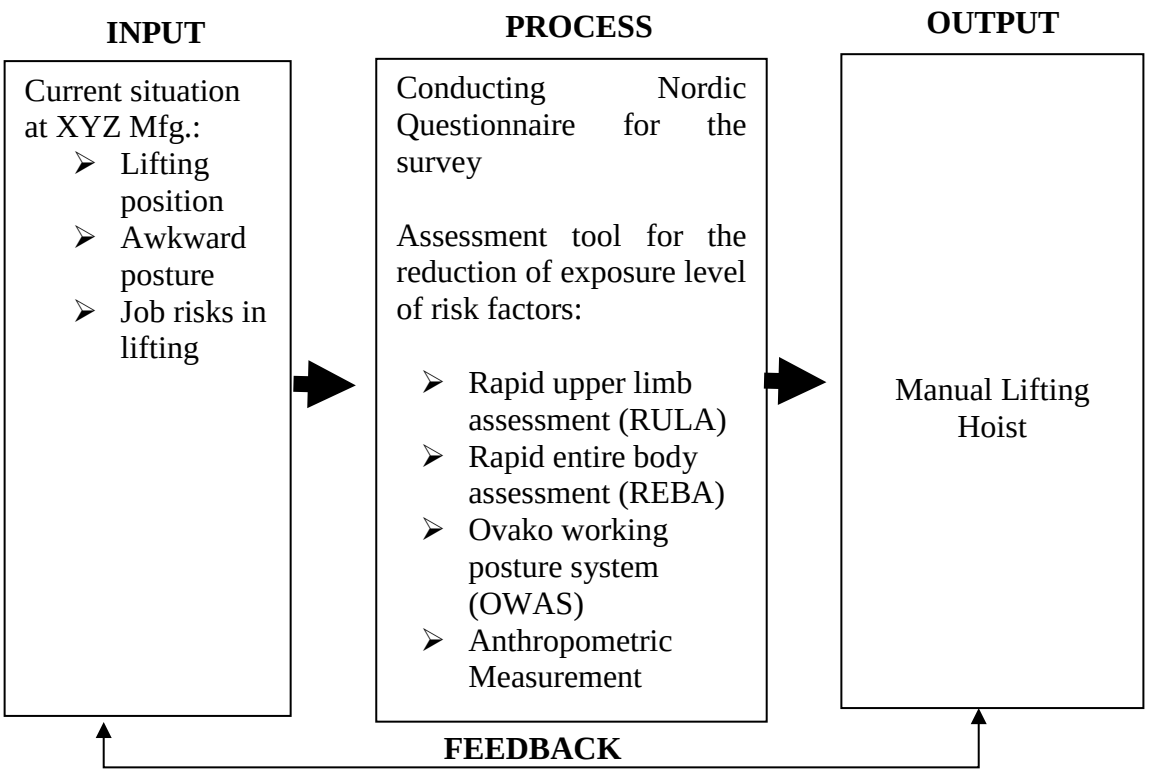

Figure 2.1. Conceptual Paradigm

Results and Discussion

1. Current Status in terms of:

1.1 Process

The production process of plastic twines starts with the receiving of raw materials which are delivered from different areas in Laguna and Batangas. Manufacturing process starts from receiving area or segregation where they segregate each raw resource according to its kind. After segregating, the raw materials will be transported by the worker who manually lifts the jumbo sack weighing 31kgs to 70kgs with the help of other workers then transport it straight to classifying area.

In this section, plastics are separated by color and transport again to another area to be ground. Materials are repeatedly transported to one area to another through lifting which exposes the workers to the possible risks and may affect their health.

1.2 Condition of workers

1.2.1 Lifting Position

Lifting operations were observed by the researcher in conducting their study at XYZ Manufacturing. Specifically at the process of transporting the raw materials, the current lifting position observed is incorrect while the safety requirement is met. Incorrect lifting methods however can lead to major accidents and fatalities. The process of carrying out correct and safe lifting operations involves a range of requirements which must be considered during the planning of any lifting operation.

1.2.2 Awkward Postures

Carrying out sacks ranging in the weight of 30- 70 kilograms must ensure that good posture is observed. In XYZ Manufacturing, transport workers suffer in pain specifically at the wrist or hand, elbow, neck and lower back.

2. Job risks experienced by the workers in manual lifting of raw materials

The researcher encountered different risk factors resulting to musculoskeletal discomfort of workers lifting the raw materials in order to transport it to the next process. Also, the workers experienced those risk factors due to improper lifting procedure and performing awkward posture in doing work.

In Figure 2.1, fifteen workers have been surveyed by using Nordic-Based Questionnaire. The graph presented the ache, pain, discomfort, and numbness that workers experienced for the last twelve months. Researcher observed and gathered data, they identified that there is a high risk factors in lower back, neck and wrists because of the factors affecting in performing their job such as having the long exposure at the risks of musculoskeletal disorder.

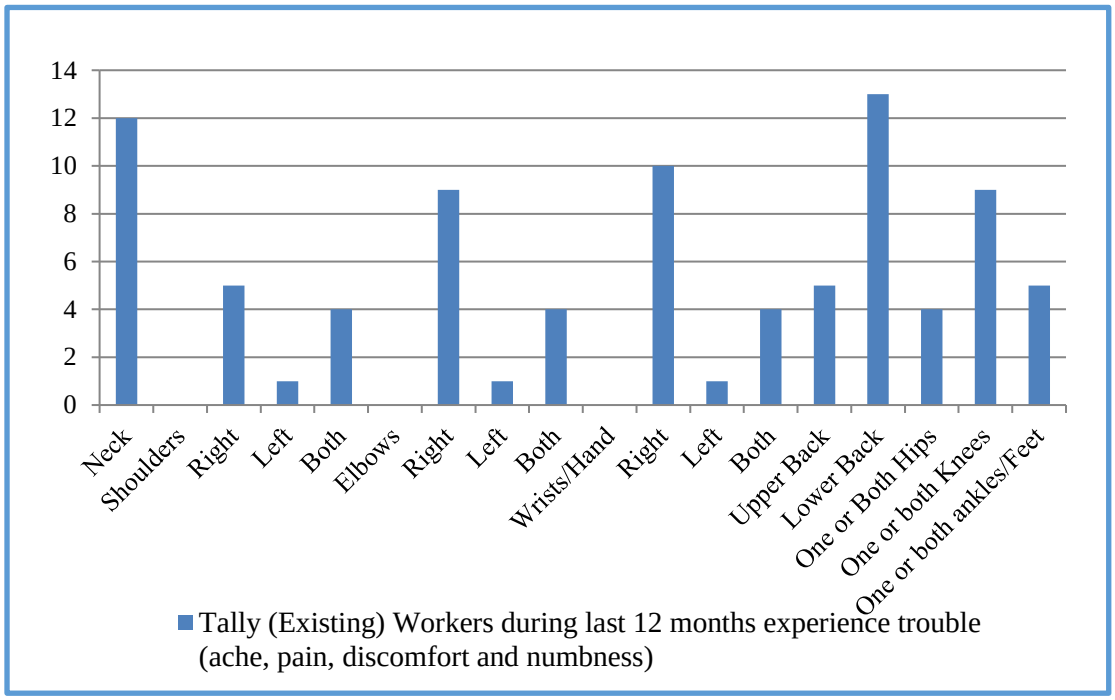

Figure 2.1. Nordic Questionnaire Result (Ache, Pain, Discomfort and Numbness Experienced by the Workers during the Last Twelve Months)

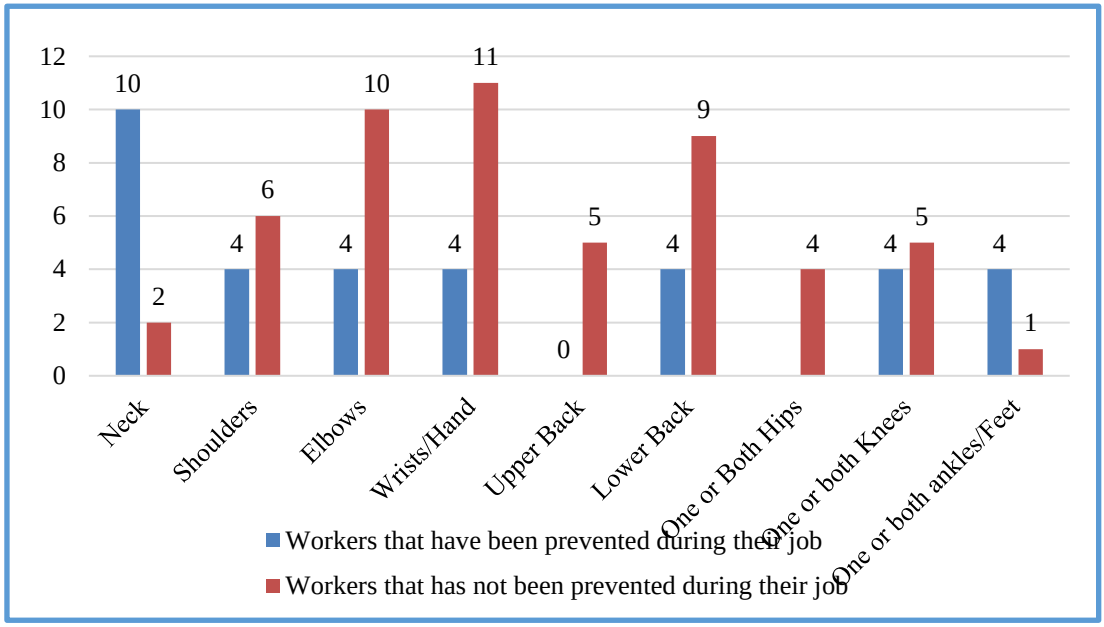

Figure 2.2. Nordic Questionnaire Result (Workers that have been prevented from doing their normal work due to troubles experienced from doing their job during the last twelve months)

In Figure 2.2, fifteen workers have been surveyed by using Nordic-based Questionnaire. The graph shows that the workers were prevented from doing their job for the last twelve months. Based on the gathered data, there is a high risk encountered by the workers in neck, shoulder, elbows, wrist, lower back and hips/ thighs. Workers are prevented in performing the job due to awkward postures they execute while transporting the raw materials.

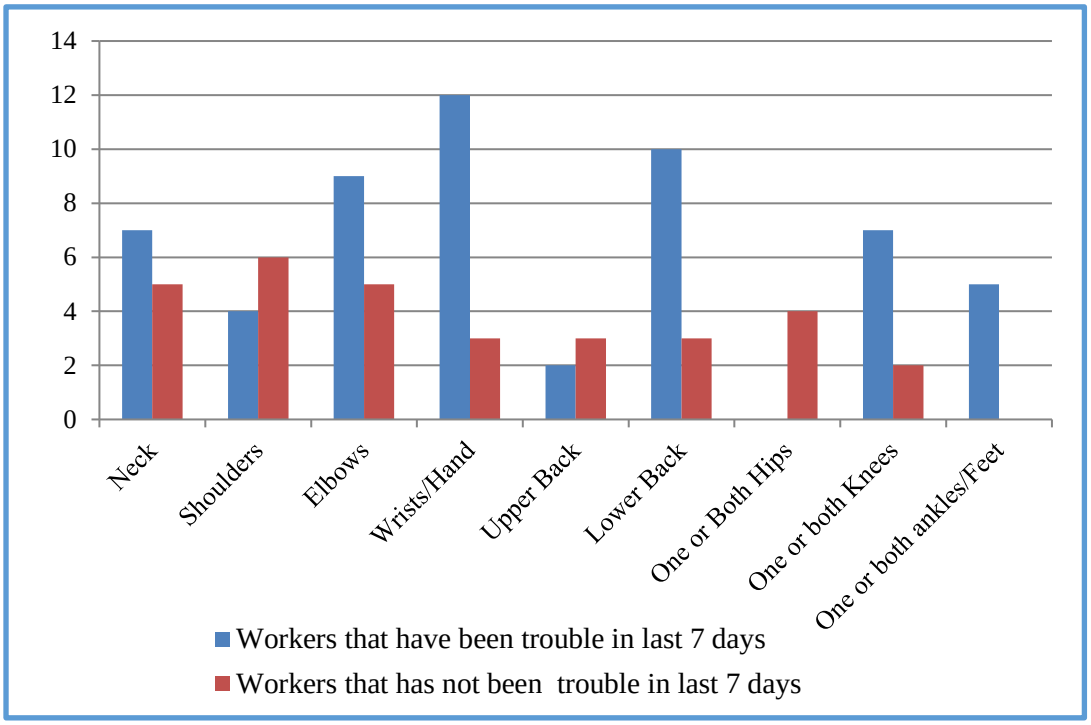

Figure 2.3. Nordic Questionnaire Result (Workers that have been trouble experienced from doing their job in last 7 days)

In Figure 2.3, fifteen workers have been surveyed by using Nordic-based Questionnaire. The graph shows the workers that have been trouble experienced from doing their job in last 7 days. Based on the gathered data, there is a high risk encountered by the workers in neck, elbows, wrists/ hand, lower back and hips/ thighs, knees and ankles/ feet. Transport workers appear to face those troubles because of the pain and discomfort while executing awkward postures.

3. Evaluation of transport workers to the possible risks using ergonomic assessment (RULA, REBA, and OWAS)

Table 3.1 shows the action needed for the assessment by the ergonomic tools used (RULA, REBA, and OWAS). As noticed in the illustration, scores in every ergonomic assessment shows high risks present in the current condition of the transport workers.

Table 3.1. Ergonomic Assessments for Current Condition of Transport Workers

Ergonomic Assessment	Score	Action Needed	Annotations
RULA	7	Investigation and changes are required immediately.	It has a RULA score of 7 because the upper arm is abducted and shoulder is raised; the arm is working across midline; the wrist is bent and twisted; body is bent; and load is more than 22 lbs.
REBA	9	High risk. Investigate and implement change.	It has a REBA score of 9 because the wrist is bent from midline, and the trunk is bent.
OWAS	2	Corrective actions required in the near future.	It has an OWAS score of 2 based on the bent position, arms above shoulder level and above 20kg load of the worker.

4. Design and Development of Ergonomic Lifting Hoist

The researcher created a resolution of how they would lessen the high risk factors present in the current situation of the transport workers. Based on the data gathered by the researcher, ergonomically designed lifting hoist is the optimum solution.

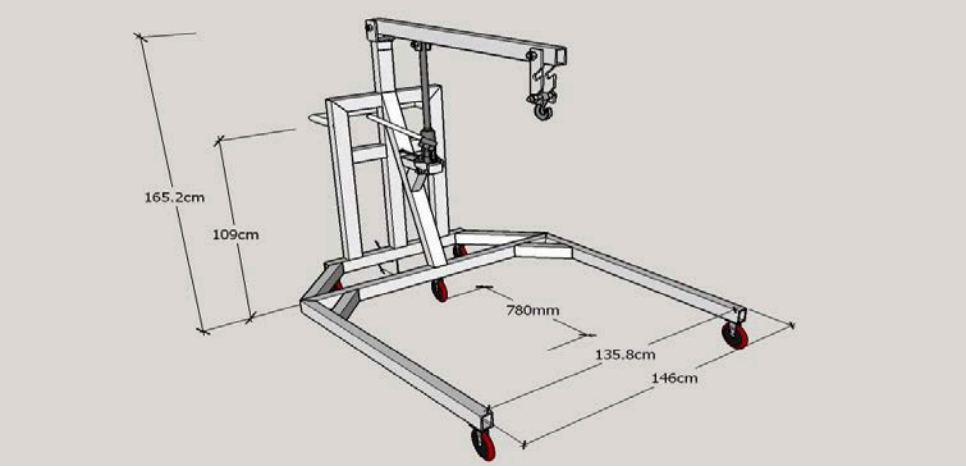

Figure 4.1 Schematic Diagram of the Ergonomically Designed Lifting Hoist

Figure 4.1 shows the schematic diagram of the Ergonomically Designed Lifting Hoist. It has a hook were the jumbo sack will be placed and a hydraulic lift jack to support the lifting arm to lift then transport without force exertion.

The design of the lifting hoist is based on the height measurements of the workers in transporting raw material process. The collected anthropometric measurements of the workers are used to come up with the 109 cm height of handle and 165.2 cm height of the prototype.

5. Impact of the Ergonomic Lifting Hoist

In order to eliminate the manual lifting, the researcher used the same ergonomic assessment to test the impact of the prototype. It is used to prove whether the objective of this study is accomplished. Data were collected and analyzed using the ergonomic assessments such as RULA, REBA and OWAS. ErgoFellow Software was used while conducting the assessment. The workers were asked to use the ergonomically designed lifting hoist. In no doubt, the researcher strongly looked after that the fabricated lifting hoist is effective and appropriate in performing the task. The lifting hoist provides ease not only to the one who transport the raw materials but also to the other workers who help in lifting the jumbo sack. The researcher believed that that output reduced the risks factors such as awkward postures, and lifting load related with the task.

Table 5.1. Ergonomic Assessments for the Improved Condition of Transport Workers

Ergonomic Assessment	Score	Action Needed	Annotations
RULA	4	Further investigation is needed and changes may be required.	It has a RULA score of 4 because the upper and lower arm are corrected; the wrist is not bent and twisted; and the body is straightened.
REBA	2	Low risk, changes may be needed.	It has a REBA score of 2 because the wrist is not bent from midline, and the body is straightened.
OWAS	1	No actions required.	It has an OWAS score of 1 because the body is not bent and arms are both below shoulder level.

Table 5.1 presents the results of the ergonomic assessments for the improved condition of the transport workers. As observed from the table above, the implementation of the Ergonomic Lifting Hoist has great impact in reducing the risks factors associated in the certain process.

It is highly evident that the awkward postures have been eliminated and making the transport workers more comfortable while performing their job. Also in doing this task, only the transport worker is needed for lifting the jumbo sack and do not disturb other workers with their own job. This ergonomic equipment integrated result as much in favor to the scores in the assessment tool.

Conclusions

After the results of the study had been evaluated, the following conclusions were drawn:

1) The existing process in performing their task can cause the risk factors. The workers are uncomfortable doing their task. When the workers are on the lifting process, they take unnecessary break for stretching to be relieved from fatigue.
2) Through the result of Nordic Survey Questionnaire, it was evident that workers are exposed to high risk factors such as unrelieved continuous motion and prolonged awkward posture while doing their job, thus preventing them from doing their job well and efficiently.
2) The assessments made on the lifting and transporting process revealed that existing workstation causes musculoskeletal disorder to the workers. The lifting and transporting process based on the ergonomic assessments such as REBA, RULA, and OWAS with indices of 9.0, 7.0 and 2.0.
4) An Ergonomic lifting hoist in the workstation was designed and developed, which has a 109 cm handled based on the data gathered in the workers.
5) The integration of the Ergonomic workstation in the new process eliminated the awkward posture since the workers are comfortably working with the new process. REBA with a score of 2.0; RULA with a score of 4.0; OWAS with a score of 1.0 were determined.

References

1. Bao, S., Spielholz, P., Howard, N. and Silverstein, B. 2009. Force measurement in field ergonomics research and application. International Journal of Industrial Ergonomics, 39(2): 333-340.

2. Dublon, L., Maglonzo, M. and Monserrate, E. 2016. An Ergonomically designed workstation for the workers of the Winders Department of LES Product Company, INC, De La Salle University- Manila, Philippines.

3. Jukka Takala. 2016. European Risk Observation Report, European Agency for Safety and Health at Work. https://osha.europa.eu/en.

4. Nicolay, C.W. and Walker, A.L. 2005. Grip strength and endurance: Influences of anthropometric variation, hand dominance, and gender. International Journal of Industrial Ergonomics, 35(7): 605-618.

5. Oledan, J.L., Osing, J.L., and Vesli, O. 2017. Assessment of Workplace and Ergonomic Redesign of Workstation: An Approach to Provide Worker's Health & Safety at Light Provider. Batangas State University- Lipa Campus, Philippines.

6. Tadesse, M. and Meshesha, T. 2017. Design and Development of Portable Crane in Production Workshop: Case Study in Bishoptu Automotive Industry, Ethiopia. American Journal of Mechanical Engineering, 5(2): 41-50.