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Design and Development of Ergonomic Workstation in the Carton-Attach Process of Greenshine Enterprise

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Abstract: This research focuses on evaluating the current condition of the workers in the Carton-Attach Process of Greenshine Enterprise with regards to musculoskeletal discomfort in performing related tasks. Investigating how the current workstation adds to the occurrence of musculoskeletal injuries, and providing ergonomic solution to this problem. By conducting observations, interviews, surveys, the researchers gathered information about the occurrence of musculoskeletal disorders in the Carton- Attach Process. Risk factors associated in the current workstation used in the process are therefore identified through a self-constructed checklist and Nordic Survey Questionnaire. As to the assessment of the risk factors present, the researchers utilized the Rapid Entire Body Assessment (REBA), the Rapid Upper Limb Assessment (RULA), and the Ovako Working posture Assessment System (OWAS). The same tools were also used in order to verify whether the solution provided have been effective. Imposing this solution will result to the elimination of awkward postures and unnecessary movements, reduction of physical demands and improvement of the health of the workers in the carton- attach process. Hence, the significance of this study is to help the workers of the carton- attach process by improving the workstation used in their workplace, consequently improving their work quality and reducing any risk factors faced by the workers in doing the job.

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

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Introduction

Nowadays, industries are concerned in workers' welfare other than competing and introducing new products in the market. Increasing the quality of products has been the target of every company jeopardizing their worker's well-being. As advancement and technologies continue to evolve in every production area of a manufacturing company, so does the need to guarantee that the tools or equipment used in the production are designed for the workers' body requirement; thus, improving their work quality and reducing any risk factors faced in doing the job. Recent studies in the field of ergonomics identify both occupational and non-occupational risk factors which lead to MSDs. Risk factors related to work activity and ergonomics can make it more difficult to maintain the balance, and increase the probability

that some individuals may develop an MSD (Middlesworth, 2013) Performing jobs in prolonged standing condition has contributed numerous health effects such as work-related musculoskeletal disorders. However, those injuries can be minimized through application of engineering and administrative controls (Samad and Shelke, 2016).

The main endeavor of this study is to reduce the level of exposure of the workers to risk factors contributing to WMSD's. As to the assessment of the reduction to risk factors present, the researchers utilized the Rapid Entire Body Assessment (REBA), the Rapid Upper Limb Assessment (RULA), and the Ovako Working posture Assessment System (OWAS). REBA is a postural analysis tool sensitive to musculoskeletal risks in a variety of tasks and assessment of working postures found in health care and other service industries (Hignett and McAtamney, 2004). On the other hand, RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremely MSD. This tool considers the biomechanical and postural requirements of job tasks on the neck, trunk and upper extremities. Lastly, OWAS identifies the most common work postures for the back (4 postures), arms (3 postures) and legs (7 postures), and the weight of the load handled (3 categories). Whole body posture is described by these body parts with a four digit-code. These 252 postures have been classified to four action categories indicating needs for ergonomic changes (Vivelab, 2017).

These three tools are the best fit in the analysis of musculoskeletal risks of the workers of the carton-attach process. All the necessary parts of the body used in the execution of the process can be assessed using these three tools. Without the need for an advanced degree in ergonomics or expensive equipment, the researchers chose these tools in order to aid them in their study. MSDs can affect any major area of the musculoskeletal system, including neck, shoulders, wrists, back, hips, legs, knees, and feet. The severity of MSDs can vary. In some cases, it causes pain and discomfort that interferes with everyday activities. Early diagnosis and treatment may help ease the symptoms and improve long-term outlook.

Using the data and information gathered in the study, the researchers arose with the idea of providing an ergonomic workstation that could help in minimizing the risk factor of the workers in the carton - attach process of Greenshine Enterprise. Ease of handling, reduction of risk factors, and safety were also considered in the design of the said workstation. Successful implementation of the improved workstation will provide a greater impact on the productivity and improvement of the health of the workers.

Materials and Methods

The research design of the study, "Design and Development of Ergonomic Workstation in Carton-Attach Process of Greenshine Enterprise" is a developmental type of research. The main objective of the research is to analyze the existing posture of how the workers work. To get a basis for improvement, the researchers observed and analyzed the working environment of the process and how the existing workstation affects the workers. The improvement and desired result has done by the use of proposed ergonomic workstation in the company. Data gathering is one of the most vital part of the study as it will give the necessary data and information needed by the researchers for the assessment of the problem and the solution. The researchers gathered the data needed, in the production of Greenshine Enterprise. This includes the existing design of the equipment used in the carton-attach process. The researchers used these data to measure the risks of having injury and discomfort in using the existing design. The proponents were able to gather the information needed by the means of the following procedures:

1. Actual observation in the carton - attach process using the ergonomics tools, Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA) and Ovako Working Posture Analysis (OWAS).
2. Conducting interviews and survey using self-constructed checklist and Nordic – based Questionnaire to the operators in the carton-attach process to know more about the working posture.
3. Determination on the appropriate approach to be used in the production.

Results of the investigation with the corresponding interpretations are as follows:

Current status of the workstation in the carton-attach process

The current status of the inappropriate workstation used by the workers can lead into musculoskeletal disorder. The existing workstation size and height that is used by the workers is L= 291 cm x W=77 x H=69.5. The workers are uncomfortable when performing their task. While using the existing workstation, the workers bend so much. Exerting force from pressing down overlapping carton strips before applying glue can cause wrist pain. The workers are also exposed from awkward posture in prolonged time since the height of the table is inappropriate. Also, they tend to reach down to get glue from its container because there is no proper compartment for the glue container. These practices cause MSDs that greatly affect the health of the workers. When the workers feel uncomfortable they just do stretching to be relieved from fatigue. The workers are exposed 7 hours in the operation.

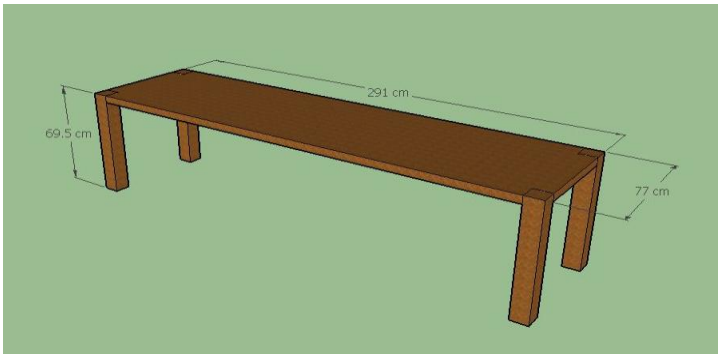

Figure 1. Schematic Illustration of Current Workstation

The MSD's experienced by the workers using the existing workstation

The result of the current workstation is shown in Table 1. There are risk factors present in the current practice such as body pain and back pain. Similarly, the workers experienced discomfort due to awkward posture while the work is performed.

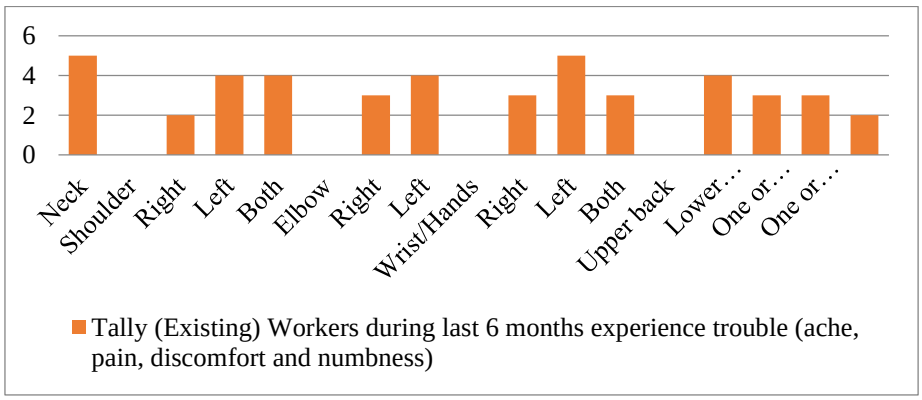

Figure 2. Nordic Survey Result (Ache, Pain, Discomfort and Numbness Experienced by the Workers during the Last Six Months)

As shown in the Figure 2, five workers have been surveyed by using Nordic Questionnaire. The graph presented the ache, pain, discomfort, and numbness that the workers experienced for the last six months. Based on the survey result there is a high risk factors encountered by the workers in neck, upper back, lower back and hips/thighs.

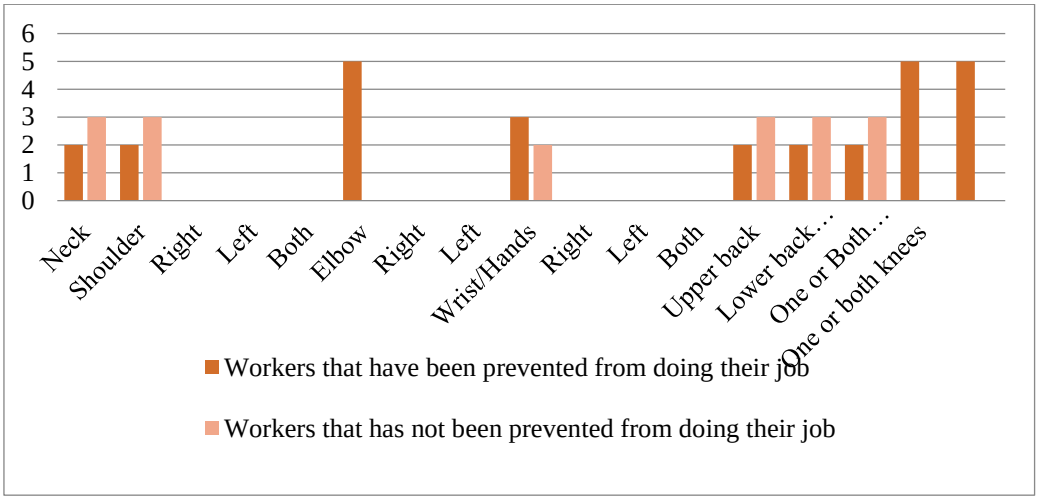

Figure 3. Nordic Survey Result (Workers that have been prevented from doing their normal work due to troubles experienced from doing their job during the last six months)

As shown in Figure 3, five workers have been surveyed by using Nordic Questionnaire. The graph presented the workers that were prevented from doing their normal work for the last six months. Based on the survey result there is a high risk factor encountered by the workers in neck, shoulder, upper back, lower back and hips/thighs.

Assessment of the workers in the carton-attach process using RULA, REBA and OWAS

Based on the assessments made on the carton-attach process, it revealed that risk factor is present. The task/job is done by the worker for at least 6-7 hours a day. An awkward posture is evident as the worker bends while getting the glue, applying the glue and attachment of glued cartons. The trunk is only supported by the arm which can cause body pain. Moreover, it is possible that the worker might suffer from back pain, neck pain, or numbness of the leg since the process is done repeatedly. Considerably, an awkward posture is evident during the performance of the task specifically the legs which are bent, with arm and foot supporting the body weight. The worker put stuff on the existing table to reach the desired elevation but unfortunately it does not achieve the wanted height of the workstation. This reveals that there is a need to make the necessary ergonomic intervention that will address the problem related to risk factor specifically awkward posture, as well as providing solution to reduce the level of risk that is present in the process.

Results and Discussion

The researchers came up to develop an Ergonomic workstation to address the risk factors in the carton-attach process at Greenshine Enterprise. Using an Ergonomic intervention, the researchers are able to identify the risk factors the workers are experiencing while performing their task. The present study is about “Design and Development of Ergonomic Workstation in Carton-Attach Process of Greenshine Enterprise”. The concepts and researches found below have a relevance to this study. Through the related research and literature, the researchers determined the facts that serve as the foundation of the project and were able to propose a

better concept. The studies guide the researchers to have a better understanding and to figure out the result of the study.

The study of Rahman and Nasrull (2014) entitled "Development of an Ergonomic Risk Assessment Tool for Work Postures" developed a new ergonomic risk assessment technique which assesses the exposure of physical risk factors associated with WMSDs. Tools such as REBA, RULA, OWAS, PATH, QEC, LUBA and BackEst were used by the researchers to evaluate the interrelations between the tools and how significant these tools are in every assessment. Contrasting to this study, the present study used tools such as REBA, RULA, and OWAS in assessing work posture of the workers to develop and design an ergonomic workstation to help the workers; thus, not to develop other risk assessment tool.

A thesis presented by De Guzman *et al.*, (2015) entitled, "Body Discomfort Among Workers of Armor Milling Corp: A Basis for the Ergonomic Design of a Lift Table", aims to know the body discomfort the workers encountered. The researchers used survey questionnaires that lead the researchers to develop an ergonomic design table. This is similar to the present study since questionnaire and anthropometric measurements were also taken and used as bases in designing the ergonomic workstation. However, the present study also utilized the REBA, RULA and OWAS.

In every study that the researchers gathered about workstations, tools used and risk factors, the ideas significant and similar with this improvement research were analyzed and noted. Though the related studies and the present study have different explanations and methods, still the goals come up with the same ideas for which the previous study serves as a reference of the present study. The researchers used Ergonomics to be able to design and develop an Ergonomic workstation that will best fit the needs of workers at Greenshine Enterprise. The researchers analyzed and interpreted the anthropometric measurements obtained from the sample population which is used as basis for the dimension of the output specifically the height.

The Social Security Administration (SSA) classifies work into five different levels: sedentary, light, medium, heavy and very heavy. These classification levels came from the Dictionary of Occupational Titles (DOT) and are based on the amount of physical exertion the work requires. Light work requires the ability to stand up to six hours in an eight-hour workday and be able to lift up to 10 pounds frequently and up to 20 pounds occasionally. (SSA, 2016).

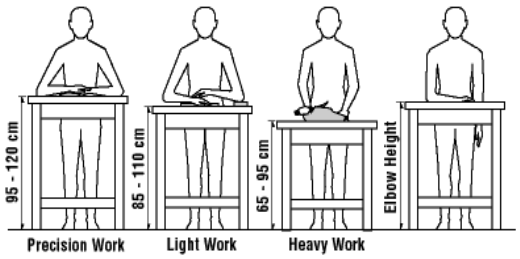

Figure 4. Standard Elbow Height

The anthropometric data point which served as basis to come up with the proposed prototype is the elbow height. Researchers made use of z-score distribution instead of percentile due to the following reasons: Z -scores are calculated based on the distribution of the reference population (both the mean and the standard deviation); thus, they reflect the reference

distribution. Second, as standardized measures, Z- scores are comparable across age, sex and measure (as a measure of "dimensionless quantity"). Third, a group of Z -scores can be subjected to summary statistics such as mean and SD and can be studied as a continuous variable. Z -score values can quantify the growth status of children outside of the percentile ranges.

Listed **in Table 1** is the summary of anthropometric measurements of 5 samples which represent different age groups who are potential users of the output.

Table 1. Anthropometric Measurements

Anthropometric Data	Maximum Value using Z-score (1.09) at 95% Confidence Level (cm)	Minimum Value using Z-score (-1.09) at 5% Confidence Level (cm)	Mean
Elbow Height Standing	103.16	95.91	99.53

Table 1 shows the extreme and the average anthropometric measurements obtained from male samples. Based from the result, elbow height must have values ranging from 95.91 cm – 103.16. This is used in determining the height of the table and its range of adjustability.

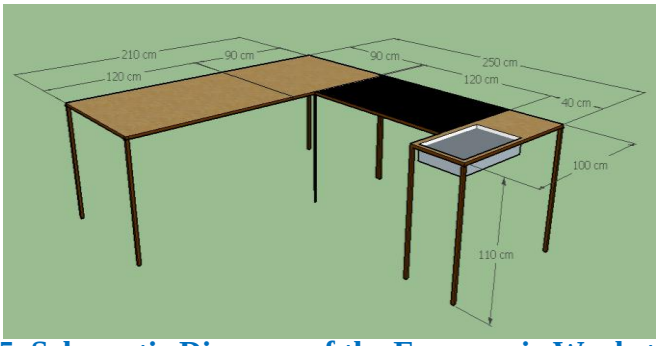

Figure 5. Schematic Diagram of the Ergonomic Workstation

Figure 5 shows the schematic diagram of the Ergonomic Workstation. It shows a platform where the processes will take place. The design of the workstation is based on the preferred height of the workers that uses the workstation on the carton-attach process in the production. Based from the collected anthropometric measurement of the worker, the maximum height of the table is 110 cm and 85 cm in the minimum height.

Evaluation of Ergonomic Workstation

Testing Stage

To evaluate the performance of the Ergonomic workstation, final testing was conducted. Same ergonomic assessment tools were used to assess the significant impact of the design. It is further performed to verify whether the objective of reducing the risks (if not totally eliminate) is achieved. Pertinent data were collected and analyzed using the ergonomic checklist. Ergonomic assessments such as REBA, RULA and OWAS were conducted through the use of the ErgoFellow Software.

The workers were asked to use the Ergonomic workstation in the carton-attach process. The researchers were confident that the fabricated Ergonomic workstation provided some advantages like adjustable height to provide ease, appropriate glue container and brush, and

suitable glue container compartment. The researchers believed that the output reduced the risks factors specifically the awkward postures, and inappropriate force exertions associated with the task being performed.

The final prototype testing intended to determine if the design of Ergonomic Workstation will carry the desired results thereby meeting the endeavor and objectives of the study. The workers were asked to use the prototype in the carton-attach process. Images taken were subjected to ergonomic assessments such as REBA, RULA, and OWAS checklist. They were also used to evaluate the status of the workers with the equipment during the carton-attach process.

To determine the significant impact of the design in terms of its ability to provide a much safer and convenient workplace to the workers is the purpose of these assessments. Thus, it reduces the ergonomic risk factors particularly the awkward posture of the workers.

Assessment in the Carton-Attach Process using the Proposed Workstation

Table 2. Comparison of Ergonomic Assessment of the Current and Improved Process

Process	Current Practice			Improved Design		
	REB A	RUL A	OWA S	REB A	RUL A	OWA S
Carton-Attach Process	10	6	2	2	3	1

Table 2 displays the comparison of ergonomic assessment of the current and improved process in carton-attach process with the integration of the proposed Ergonomic workstation. It is noticeable that in the carton-attach process, there is a significant improvement as evidenced by the REBA, RULA, and OWAS indices with scores of 2.0, 3.0, 1.0. Based on the assessments made, the current measurement process posed high risk to the worker which necessitates improvement to reduce or eliminate the risk factors based on the score sheets for REBA with a score of 10.0, RULA with a score of 6.0, and OWAS with a score of 2.0. After the improvements made, the process posed low risk which requires no action in terms of the OWAS assessment.

Conclusion

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

1. The existing table used by the workers when performing their task can cause the risk factors. The workers are uncomfortable doing their task. When the workers are on the standing process, they take unnecessary break for stretching to be relieved from fatigue.
2. Through the result of self-constructed checklist and 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.
3. The assessments made on the carton-attach process revealed that existing workstation causes musculoskeletal disorder to the workers of carton-attach process based on the ergonomic assessments such as REBA, RULA, and OWAS with indices of 10.0, 6.0, 2.0.
4. An Ergonomic Workstation was designed and developed, which has an adjustable platform ranging from 85 cm to 110 cm in height and a space for the raw materials and glue container.
5. The integration of the Ergonomic workstation in the carton-attach process eliminated the awkward posture since the workers are comfortably working while standing neutral position.

REBA with a score of 2.0; RULA with a score of 3.0; OWAS with a score of 1.0 were determined.

Recommendation

With the findings obtained in the course of the study, the researchers had the following recommendations:

1. The prototype can be improved by using high quality materials and can be further improved by making it an automated adjustable workstation. The company should also consider that the height of the improved workstation must correspond to the height of their workers.
2. The researchers recommend further study regarding the whole structure of the ergonomically designed Ergonomic workstation for future improvements and innovation.
3. It is also recommended that the work environment be improved to support the other processes required in the making of carton boxes and give considerations in the welfare of the workers because manpower is one of the important assets of the company.

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