



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**REDESIGN OF POLAR CUTTING WORKSTATION IN PAPER
CUPS MANUFACTURING INDUSTRY USING ERGONOMICS
APPROACH**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Department of Manufacturing Management)(Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Industri pembuatan memainkan peranan yang penting dalam pembangunan negara Malaysia. Industri pembuatan cawan kertas merupakan salah satu daripada industri pembungkusan makanan yang memerlukan produktiviti dan kualiti yang tinggi. Kajian ini memberi fokus kepada stesen kerja pemotongan kertas di dalam sebuah syarikat pembuatan cawan kertas. Di stesen kerja yang sedia ada, pekerja perlu menjalankan proses tersebut dengan postur yang tidak selamat. Akibatnya, pengendalian bahan secara manual semasa proses tersebut akan menyebabkan masalah berkaitan ergonomik di kalangan pekerja. Tujuan kajian ini adalah untuk membentuk semula stesen kerja pemotongan kertas supaya postur bekerja and teknik mengangkat secara manual dapat dipertingkatkan Kajian ini menggunakan pendekatan pemerhatian dan aplikasi *Quality Function Deployment (QFD)* untuk mereka bentuk semula stesen kerja pemotongan kertas yang sedia ada. Analisis *RULA (Rapid Upper Limb Assessment)* dan *NIOSH Lifting Equation* telah digunakan untuk menilai postur bekerja dan risiko mengangkat secara manual. Kajian ini menunjukkan stesen kerja yang baru dapat menurunkan nilai *RULA* daripada 6 ke 3 bagi tugas mengangkat secara manual. Di samping itu, nilai *Lifting Index* menurun daripada 1.44 ke 0.70 dan 2.02 ke 0.67 bagi posisi asal dan destinasi masing-masing. Kesimpulannya, kajian ini menunjukkan bahawa tempat kerja yang telah direka bentuk semula memberi kesan positif kepada postur kerja dan tugas mengangkat secara manual. Cadangan untuk masa depan, kawalan pentadbiran haruslah dilaksanakan dalam syarikat ini untuk meningkat kualiti produk tersebut.

ABSTRACT

Manufacturing industry plays a significant role in the development of Malaysia. Paper cups manufacturing industry is one of the food packaging industry that deal with high demands on productivity and quality. This study focuses on the polar cutting workstation in a paper cups manufacturing company. In the existing workstation, the operator has to perform the polar cutting process in unsafe working postures. As a consequence, those manual material handling involved in the polar cutting process can contribute to the ergonomics health problem to the operator. The aim of this study is to redesign the polar cutting workstation in order to improve the manual lifting task by using an ergonomics approach. This study applied the observation-based methods and Quality Function Deployment (QFD) to redesign the existing polar cutting workstation. This study conducted the Rapid Upper Limb Assessment (RULA) analysis and NIOSH Lifting Equation analysis were used to measure the effectiveness of the redesigned polar cutting workstation. This study has shown the redesigned workstation able to improve the RULA score from 6 to 3 for the manual lifting tasks. Besides, the Lifting Index value is reduced from 1.44 to 0.70 and 2.02 to 0.67 for the origin and destination respectively. This study concluded that the redesigned workstation proposed has significant improvement in working posture and manual lifting task. For future work, this study suggests that the administrative control should be implemented in the company to further improve the product quality.

DEDICATION

I dedicate this project to my family and friends. A special feeling of gratitude to my beloved parents, Mr. Kee Ah Bah and Mdm. Ng Ai Khim whose encouraged me throughout the process. Thank you for the endless supports for helping me to finish which I have started. To my project supervisor, Dr. Isa Bin Halim, deeply appreciate and thank you for guiding and advising me to accomplish the project reports.

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LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURES

CAD	-	Computer Aided Design
CATIA	-	Computer Aided Three Dimensional Interactive Application
CBA	-	Cost-benefit Analysis
EMG	-	Electromyography
HoQ	-	House of Quality
LI	-	Lifting Index
MMH	-	Manual Material Handling
MSD	-	Musculoskeletal Disorders
NLE	-	NIOSH Lifting Equation
OSHA	-	Occupational Safety and Health Administration
OWAS	-	Ovako Working Posture Analysing System
QFD	-	Quality Function Deployment
REBA	-	Rapid Entire Body Assessment
RULA	-	Rapid Upper Limb Assessment
RWL	-	Recommended Weight Limit
NIOSH	-	National Institute of Occupational Safety and Health
SOCISO	-	Social Security Organization

CHAPTER 1

INTRODUCTION

This chapter introduces the background of study which focuses to a manufacturing industry in Malaysia. In addition, this chapter describes the problem statements, objective of study, scope and limitations of study and significance of the study. At last, this chapter includes the outline of the report as a comprehensive guideline for the project.

1.1 Background of Study

Industry sectors in Malaysia have grown rapidly during the late 20th century. Prior to the rapid industrialization, Malaysia is a newly industrialized country that expected to achieve the vision of a developed country by the year 2020. The manufacturing industry is one of the main contributors to the achievement of the vision 2020. Consequently, employees in the manufacturing industry have to deal with the high demands on productivity and quality. In addition, industries in Malaysia require higher production rates to compete with other industries and establish the business. As a consequence of these demands, the operators in the manufacturing industry may experience occupational health issues if their workplaces are exposed to ergonomic risk factors.

Ergonomics risk factors are characteristics of a work activity that contribute to ergonomic hazards. In this study, there are three types of ergonomics risk factors presented in the manufacturing industry, which are awkward posture, repetitive motion and forceful exertions. Awkward posture refers to unnatural positions of the body

while performing work activities which is very common in the industry. Awkward postures are the important factors that can cause physical stress to the body, such as low back pain. In the industry, many work tasks are repetitive in a series of motions over and over again with little variation. When these repetitive motions continue for prolonged periods, operators may feel fatigue and strain of muscle. If the cycle time of the task is 30 seconds or less, the task is considered highly repetitive. Besides that, work tasks like lifting heavy loads can contribute to forceful exertions risk factors. In critical conditions, combination of task repetition and forceful exertions can lead to the formation of musculoskeletal disorders. These factors could be contributed by the poor machine design, tool, and workplace design (OSHA US, 2000). If the work tasks and equipment do not involve ergonomic principles in the design, operators may have exposure to unsafe working conditions.

These ergonomics risk factors exist in the selected manufacturing industry, which manufacture the paper cups. One of the processes called polar cutting process which used to cut the paper stack into half size before die cutting process. Polar cutting process is a must process in the process of manufacturing paper cups. After the cutting process, the operator is required to perform manual lifting process during arranging the paper stack on the pallet. In this process, the operator is required to carry the paper stack, which in heavy load and place on the pallet. This process has to be repeated continuously per working shift according to the production rates. Therefore, operator may expose to ergonomics risk factors through the process. Consequently, these factors may cause fatigue and musculoskeletal injuries to the operators. Figure 1.1 below shows the paper stack that used to make paper cups before polar cutting process. Figure 1.2 shows the polar cutting process performed by the operator using a polar cutter machine.



Figure 1.1: Paper stacks that used to make paper cups before polar cutting process.



Figure 1.2: Polar cutting process performed by the operator using a polar cutter machine.

Manufacturing industry nowadays gives priority to the operator's health issues as ergonomic would give impacts to the production. The current task caused the health problems of the operators such as low back pain and musculoskeletal injuries. Basically, lack of training, skills and experience of the operators is the main factor of

the health problems. With the absence of the injury operator, the productivity of the company will be affected. Productivity of the company is important to determine the efficiency of the production output. Besides that, operator's health problems will directly affect the quality of the products.

In order to improve the manual material handling task in the company, there are a few possible solutions can be conducted through the study. For instance, a good designed workstation can reduce the ergonomic risks of the operators. Therefore, redesign a proper workstation could be the best solution for this study. The shape, location and orientation of the workstation should be adjusted to fit the operators and the task. Workstation design is one of the major concerns in which ergonomist can help improve the fit between humans, environments and machines. Hence, workstation design plays a very important role in industries especially for those operators who performing the manual material handling tasks.

The aim of this study is to redesign a polar cutting workstation to help operators in performing the polar cutting process which potentially to lead ergonomic risks to the operators.

1.2 Problem Statement

In the existing polar cutting workstation, the operator has to perform the polar cutting process in unsafe working postures. Polar cutting is the process which used to cut the stack of papers in high speed and precisely. Polar cutting process is an ordinary process for the printing and food packaging industries. As every cutting process for a stack of papers, operator has to manually lift the papers being cut and place onto the pallet which the pallet height only 14 cm. Meanwhile, the operator is exposed to the awkward working posture during the task. Figure 1.3 shows that the operator performs the manual lifting process in awkward posture in the polar cutting workstation.



Figure 1.3: Awkward posture experienced by the operator in polar cutting workstation.

In addition, the operator has to repeat the same manual handling task for one working shift which is 8 working hours. The paper weights about 21 kg. Poorly designed material handling process leads the operators to expose to ergonomics risk factors. In the cutting workstation, the combination of awkward posture, forceful exertions and repetition of manual material handling definitely give impact to the ergonomics health problem of the operator. Those factors are highly potential musculoskeletal injuries to the operators. An ergonomically deficient workplace can cause physical and emotional stress, low productivity and poor quality of work (Azadeh et al., 2008). In addition, the manual handling process increases the processing time that may affect the productivity of the production. Those problems are not only affects the operator's health, but also influencing the whole process flows in the company. Figure 1.4 shows the possible causations of musculoskeletal disorders in the polar cutting workstation.

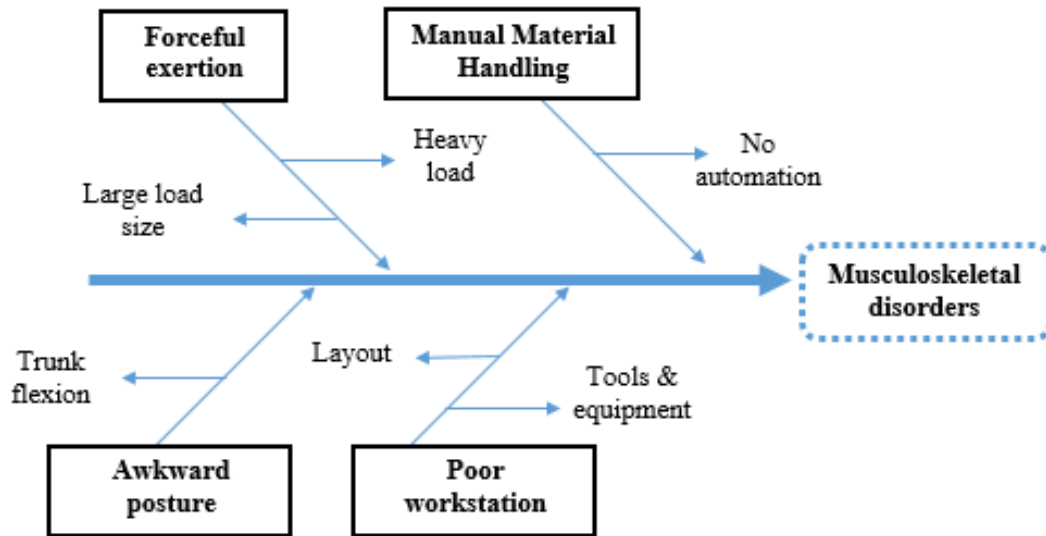


Figure 1.4: Cause and effect of musculoskeletal disorders in polar cutting process.

Generally, there are four main causes of musculoskeletal disorders in the polar cutting process as shown in Figure 1.4. The specific causes for each main cause will be explained as follows:

a) Manual Material Handling (MMH)

In the polar cutting workstation, there is no powered handling device used to perform the manual lifting process. The operator has to lift the load using own bare hand. MMH is strongly related to the risk of musculoskeletal disorders

b) Forceful Exertion

During the polar cutting process, the operator is required to move the paper stack from the pallet to the workstation and move to another pallet after the process. The lifting load in the job task is too heavy and the paper stack in large size. The measurement of paper is about 29.5 x 47.5 inches (before cutting) and 29.5 x 23 inches (after cutting).

c) Awkward posture

The operator experienced the awkward posture during the manual lifting process. The operator is required to perform back flexion in order to place the

paper stack on the pallet which is in lower height. In this case, the operator is highly potential exposed to musculoskeletal disorders.

d) Poor workstation design

The layout of the workstation affects the working movement of the operators. In existing workstation, the operator is required to turn to the backward position when lifting the paper stack on the pallet. Besides, the tools and equipment used at the workstation maybe not appropriate. Hence, the poor workstation design can cause the musculoskeletal disorders to the operators.

1.3 Objectives of Study

This study is conducted to solve the above mentioned problems by using an ergonomics approach to achieve the following objectives:

- a) To determine the musculoskeletal disorders (MSDs) experienced by the operator of polar cutting workstation in performing manual lifting task.
- b) To redesign the polar cutting workstation to facilitate the operator in performing manual lifting task of the polar cutting process.
- c) To evaluate the effectiveness of the designed workstation in the manual lifting task of the polar cutting process.

1.4 Scope and Limitation of Study

The scope of this study focuses on how the redesigned workstation affects the manual lifting process at the polar cutting workstation in a paper cups manufacturing industry. Manual material handling variables such as duration of manual activity, lifting frequency, and workstation dimensions is assessed. The subjects of the study involved only one male operators at the polar cutting workstation, therefore gender factor is not considered as parameter in this study. Ergonomics risk factors in term of repetitive

working posture will be analysed during the manual material handling of the operator for one working shift only.

The limitation of the study is only involved of redesign the polar cutting workstation as a proposal in the paper cups manufacturing industry. The findings of the study are based on the simulation, but not the real implementation. The implementation of the study depends on a company's decision.

1.5 Significance of Study

This study is significantly providing several potential benefits to the following parties, even though the proposed improvement may not be implemented in the company. The specific benefits of participatory ergonomics are:

1) Manufacturing industry

The solution provides better ergonomics knowledge to the operators which able to reduce the occupational risks, reduce the turnover, improve the organisational health and improve the productivity with better work system design.

2) University

The study acts as a reference for students to appreciate the importance of the ergonomics issues in manufacturing industry. Through the study, students can get a better understanding of the ergonomics risks which could help them to enhance the working performance when involved in related fields of study.