



**ERGONOMICS INTERVENTION TO IMPROVE PLASTIC ROLL
HANDLING PROCESS AT PRODUCTION AREA IN PLASTIC
MANUFACTURING INDUSTRY**

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

by

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FACULTY OF MANUFACTURING ENGINEERING

2017

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **ERGONOMICS INTERVENTION TO IMPROVE PLASTIC ROLL HANDLING PROCESS AT PRODUCTION AREA IN PLASTIC MANUFACTURING INDUSTRY**

Sesi Pengajian: **2016/2017 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Manufacturing Management) (Hons). The member of the supervisory committee are as follow:

.....
(Dr. Isa Bin Halim)

ABSTRAK

Industri pembuatan memainkan peranan yang penting dalam ekonomi Malaysia. Pembuatan plastik adalah salah satu daripada industri di sektor pembuatan. Kebiasaannya, bahan mentah untuk produk-produk industri pembuatan plastik adalah berbentuk gegelung yang mana saiznya besar dan berat. Melaksanakan aktiviti pengendalian bahan tanpa teknik yang betul dan alat bantuan yang kurang efisien boleh membawa kepada isu risiko ergonomik yang boleh menyebabkan kesihatan pekerjaan seperti sakit belakang. Tujuan kajian ini adalah untuk mereka bentuk semula alat pengendalian plastik gulung yang sedia ada untuk memudahkan proses pengendalian plastik gulung. Isu-isu ergonomik berkaitan dengan proses pengendalian plastik gulung secara manual telah dikenal pasti melalui pemerhatian di tempat kerja dan kajian soal selidik. Faktor-faktor risiko ergonomik dalam proses pengendalian plastik gulung sedia ada dianalisis dengan menggunakan *Rapid Upper Limb Assessment (RULA)* dan *Push-Pull Analysis*. Dalam usaha untuk mereka bentuk semula alat pengendalian plastik gulung sedia ada untuk mempertingkatkan produktiviti dan kesihatan pekerja, keperluan pelanggan telah diterjemahkan ke dalam keperluan teknikal dalam *House of Quality (HOQ)*. Tambahan pula, pelbagai konsep reka bentuk alat pengendalian plastik gulung telah dikumpul dan ditapis melalui kaedah pemilihan konsep untuk memilih reka bentuk konsep yang terbaik berdasarkan kesesuaian dan kos pengeluaran yang rendah. Analisa kos dan faedah telah digunakan untuk menganalisis keberkesanan reka bentuk yang dipilih dari segi penjimatan kos dan pulangan ke atas pelaburan untuk memenuhi keperluan keusahawanan. Kajian ini menyimpulkan bahawa reka bentuk baru alat pengendalian plastik gulung mampu memudahkan proses pengendalian plastik gulung dengan pengurangan skor RULA. Kajian ini mencadangkan bahawa fabrikasi sebenar perlu dilakukan supaya ianya dapat diguna pakai di industri untuk memperbaiki postur kerja dan mengurangkan penggunaan tenaga yang berlebihan.

ABSTRACT

Manufacturing industries play an important role in the economy of Malaysia. One of the manufacturing industries is plastic manufacturing industry. In this plastic manufacturing industry, the product which is in the form of plastic rolls are heavy and large. Basically, the transportation of plastic rolls from one location to another is carried out manually by the operators by using substandard assistive device. Performing tasks without proper technique and assistive device leads to ergonomics risk factors which may causes occupational health such as low back pain and musculoskeletal disorders (MSD). The aim of this study is to redesign the existing plastic roll handling device to ease the plastic roll handling process. The ergonomics issues related to manual plastic rolls handling tasks were determined via workplace observation and questionnaire survey. The ergonomics risk factors at the existing plastic rolls handling process were analysed by using Rapid Upper Limb Assessment (RULA) and Push-Pull Analysis. In order to redesign the existing plastic roll handling device to improve productivity and occupational health of workers, customer requirements were translated into technical requirements in House of Quality (HOQ). Furthermore, the concepts of the improved design of the plastic roll handling device were gathered and screened through concept selection method to select the best conceptual design based on the practicability and low manufacturing cost. Cost and benefit analysis (CBA) was used to analyse the effectiveness of the selected design in terms of cost saving and return on investment in order to meet the entrepreneurial requirement. This study concluded that the new design of the plastic roll handling device is able to improve plastic roll handling process with the RULA score improvement. This study suggests that the real fabrication and application should be implemented in the industry in order to improve the work posture and reduce the exertion of excessive force.

DEDICATION

Special dedication to my beloved parents, siblings and friends
for giving me moral support, money, cooperation, encouragement and also understandings
to complete this final year project.
Thank You So Much & Love You All Forever.

ACKNOWLEDGEMENT

First and foremost, special thanks to my project supervisor, Dr. Isa Bin Halim, for providing me guidance, advices, critics and encouragement which make me complete this report on time and also his scarification in time to coach and explain to me without a word of complaint. He had dedicated to provide me useful information and comments in completing the presentations and the reports successfully without difficulty.

I would like to thank my lovely family who always supporting and motivating me to complete this final year project. Their encouragement and support help me accomplish this report. Thank you so much for giving me uncountable supports.

Besides, I would like to thank Lum Mah Plastic & Printing Sdn. Bhd. including all workers for providing me facilities, supportive information and opportunity to conduct this project at the company.

Thank and deeply indebted to all my friends whose involve in this project directly and indirectly. Their advices and comments are help me to improve the quality of this report.

Finally, I would like to thank you for those who directly or indirectly involved during this project and completion of this report. All your kindnesses are very much appreciated.

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LIST OF ABBREVIATIONS

ASEAN	-	Association of Southeast Asian Nations
CATIA	-	Computer Aided Three-Dimensional Interactive Application
CBA	-	Cost and Benefit Analysis
GDP	-	Gross Domestic Product
HOQ	-	House of Quality
LBP	-	Low Back Pain
LI	-	Lifting Index
LMPP	-	Lum Mah Plastic & Printing
MMH	-	Manual Materials Handling
MSDs	-	Musculoskeletal Disorders
MVC	-	Maximum Voluntary Contraction
NLE	-	NIOSH Lifting Equation
OPP	-	Oriented Polypropylene
OSHA	-	Occupational Safety and Health Administration
OWAS	-	Ovako Working posture Analysing System
PE	-	Polyethylene
PP	-	Polypropylene
QFD	-	Quality Function Deployment
REBA	-	Rapid Entire Body Assessment
RULA	-	Rapid Upper Limb Assessment
RWL	-	Recommended Weight Limit
SOCSSO	-	Social Security Organization of Malaysia
SPSS	-	Statistical Package for the Social Sciences

LIST OF SYMBOLS

α	-	Alpha
cm	-	Centimetre
m	-	Metre
%	-	Percent
kg	-	Kilograms
N	-	Newton

CHAPTER 1

INTRODUCTION

This chapter introduces the background of study which focuses to manual materials handling at a plastic manufacturing industry in Malaysia. In addition, this chapter describes the problem statements, objective of study, scope and limitations of study as well as significance of study.

1.1 Background of Study

In this era of competitive world, manufacturing industry plays an important role to increase Malaysian economy. Malaysia was recognized as one of the most active countries in reforming their investment in manufacturing market among the Association of Southeast Asian Nations (ASEAN), especially during the 1980s and 1990s. According to the Department of Statistics Malaysia, manufacturing sector increased by 5 percent year-on-year in 2015, represent Malaysia's total economic growth of 5 percent (Lai Wan, 2016). Among several sectors that contributing to Malaysia economy, manufacturing sector is identified as the second largest sector that provides 24.7 percent to Gross Domestic Product (GDP) (Malaysia Productivity Corporation, 2015). Besides that, rubber and plastic products sector contributed 7.6% to the added value in GDP 2014, represent the important of plastic product manufacturing as a source of income to Malaysia and contribute to economic growth (Malaysia Productivity Corporation, 2015).

There are many types of industry under manufacturing sector in Malaysia such as food processing, pharmaceuticals, chemicals, woodworking, electrical and electronics, metalworking

and plastic product manufacturing. In the plastic manufacturing industry, there are several manufacturing processes. The plastic rolls manufacturing process is start with printing process which print the image or text of desired design on the plastic rolls. Second, the plastic rolls either will go to the extrusion process or dry lamination process depend on the specification of the materials needed. The function of both processes is to increase the thickness and strength of the plastic rolls by adding another plastic layer on them. Plastic rolls with Oriented Polypropylene (OPP) or Polypropylene (PP) materials will go through extrusion process while other materials such as nylon and Polyethylene (PE) will go through dry lamination process. The final process is slitting whereby the plastic rolls are formed into roll or bag types. Transportation of plastic rolls from one location to another is carried out manually by the operators. Manual materials handling (MMH) involved activities such as lifting, pulling, pushing, lowering, carrying, holding, and transferring.

MMH activities such as manual lifting of load is still a prevalent choice and commonly practiced in plastic manufacturing industries despite the fact that the automation technology has been well developed and advanced, and associated with mechanized and automated equipment. Manual lifting can be performed whether in a symmetric or asymmetric posture. There are two types of lifting techniques that are commonly applied by the industrial workers: stoop lifting and squat lifting. The stoop lifting technique is practiced when the workers bend the upper torso forward and downward from an erect position, meanwhile stoop lifting is crouching in low position with the legs drawn up closely to the body (Hsiang et al., 1997). The workers may be exposed to high chance for occupational injuries such as back pain if they perform the MMH activities in bending posture and heavy load, as illustrated in Figure 1.1. The Social Security Organization of Malaysia (SOCSO) reported 2,011 cases of back pain in 2013, the highest injury occurred in workplace (SOCSO, 2013).

In plastic manufacturing industry, transportation of plastic rolls is highly depending on the operator. Usually, the operators used a lift table trolley to transfer large and heavy plastic rolls to the production area. This study observed that the operators practiced improper loads handling in their work activities due to lack of MMH training. This can be seen at the start point of the handling process whereby an operator needs to take large and heavy plastic rolls from the

warehouse without support of a co-worker. After taking the plastic rolls, the operator needs to install the plastic rolls into the machine in awkward work posture. This an excessive manual handling can cause occupational injuries such as muscle fatigue and back pain.

Besides potential for occupational injuries, improper manual materials handling techniques may affect the productivity of the industry. Performing tasks with improper technique leads to ergonomics risk factors such as awkward work posture. Working in awkward postures results in reduced strength, less accuracy and increased fatigue. When the operators are fatigued, their movement might be slow and concentration becomes lesser, thus hinder productivity. Figure 1.1 below shows worker handling a heavy plastic roll using substandard assistive device in awkward bending posture.



Figure 1.1: Handling of a heavy plastic roll using substandard assistive device in awkward bending posture

Many efforts such as researches and guidelines have been made to improve productivity and occupational health of worker who involved in MMH. Among them are educating the workers with ergonomics knowledge and awareness to practice proper MMH technique (Deros et al., 2015); development of NIOSH Lifting Equation 1991 to estimate the recommended weight limit for a worker in performing manual lifting tasks (Dempsey, 2002); lifting guidelines

and training on safe manual lifting (Health and Safety Executive, 2013); experimental study to find an optimum lifting height, load mass, container size, and lifting frequency (Singh et al., 2012); and redesign the manual handling device (Mohammadi et al., 2013). However, the numbers of accidents related to MMH in Malaysia are still high which were 15754 cases from the year 2012 to 2014 (SOCSO Annual Report 2012-2014). This is because workers ergonomic awareness's level on safety and health at workplace were very low (Durishah *et al.*, 2004). Furthermore, incorrect in manual materials handling techniques will cause in spinal and muscle injuries due to the high strength and energy used (Muslimah et al., 2006).

The aim of this study is to redesign the existing materials handling device used for plastic roll transferring process in a plastic manufacturing industry. Ergonomics design principles are applied to the design of the materials handling device to improve productivity and occupational health of workers.

1.2 Problem Statement

This study performed workplace observation and questionnaire survey to investigate the problems faced by the workers who involved in plastic rolls handling task in a plastic manufacturing industry located in Ayer Keroh Industrial Estate, Melaka. Based on the workplace observation and questionnaire survey, this study revealed that the problems faced by the industry are:

a) **Poor occupational health**

Almost all workers which are 17 out of 19 complained occupational health problems such as back pain, shoulder pain, and muscle pain. They visited medical practitioners and obtained at least 3 medical certificates per year. They suffered from the pains because of performing the plastic rolls handling task in awkward posture (Figure 1.2), forceful exertion (Figure 1.3), and repetitive task in long work duration. Performing the forceful task in awkward posture and

repetitive loading require workers to exert high physical effort, thus lead to faster fatigue rate. Additionally, forceful exertion can cause irritation, inflammation, strains and tear of the muscles, tendons and ligaments. Workers who were exposed to continual or repeated risk factors in manual materials handling over a long time will lead to injuries to hands, back, shoulders or other parts of body. Injuries caused by the improper manual materials handling known as musculoskeletal disorders (MSDs), (OSHA, 2007).

b) Low productivity

The production rate of the plastic rolls in the company is considered very low. The company has decided production target is 15 plastic rolls per day in the extrusion department, however, the workers managed to obtain 11 plastic rolls per day. This is due to workers have to perform the plastic rolls handling in improper technique due to limited workplace clearance and accessibility (Figure 1.4). Lack of clearance and accessibility negatively affect movements of the workers when transferring and maneuvering the plastics rolls. Additionally, the workers used a substandard mechanical assistive device to transfer the plastic rolls from one area to another point (Figure 1.3). Lack of clearance and accessibility, and substandard mechanical assistive device can hinder the productivity.