

WORK POSTURE IMPROVEMENT AT PLASTIC PRINTING
PROCESS IN PLASTIC MANUFACTURING INDUSTRY

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WORK POSTURE IMPROVEMENT AT PLASTIC PRINTING PROCESS IN PLASTIC MANUFACTURING INDUSTRY

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

by

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IN PLASTIC MANUFACTURING INDUSTRY**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The members of the supervisory committee are as follow:

.....

(Dr. Isa bin Halim)

ABSTRAK

Sejak beberapa dekad yang lalu, industri pembuatan telah diiktiraf sebagai pemacu utama prestasi eksport dan juga untuk pertumbuhan ekonomi yang memberangsangkan di Malaysia. Antara semua industri pembuatan, industri pembuatan plastik adalah salah satu sektor pertumbuhan paling dinamik disebabkan oleh permintaan yang tinggi daripada pengguna. Dalam industri pembuatan plastik, terdapat 5 proses utama pengeluaran iaitu percetakan, laminasi, penyemperitan, pencelahan dan pemotongan. Dalam proses percetakan plastik, stesen kerja percetakan adalah separa automatik. Di stesen kerja ini, operator terdedah kepada pelbagai faktor risiko ergonomik seperti mengangkat dan mengendalikan beban berat, postur kerja yang tidak neutral, berdiri yang berpanjangan, dan tekanan haba. Untuk meningkatkan produktiviti, kualiti produk, dan keselamatan dan kesihatan pekerjaan operator, matlamat kajian ini adalah untuk mereka bentuk semula stesen kerja percetakan plastik yang sedia ada untuk bertambah baik postur kerja supaya mengelakkan berlakunya kecederaan pekerjaan. Kajian ini menggunakan pemerhatian di tempat kerja dan kajian soal selidik untuk menyiasat masalah ergonomik yang dihadapi oleh operator yang menjalankan proses percetakan plastik. Faktor risiko yang berkaitan dengan postur kerja yang tidak neutral dianalisis dengan *Rapid Upper Limb Assessment (RULA)*. Skor *RULA* yang diperolehi untuk setiap postur adalah 5, 6 atau 7, ini menunjukkan bahawa postur perlu diselidiki lebih lanjut dan berubah. Tambahan pula, keperluan operator mengenai stesen kerja percetakan plastik dikumpulkan dan dipindah ke *House of Quality (HOQ)*. Kemudian, tiga konsep reka bentuk stesen kerja telah dilakarkan dan disaring dengan menggunakan kaedah *Pugh* untuk memilih konsep reka bentuk yang optimum. *Cost and benefit analysis (CBA)* telah digunakan untuk menilai keberkesanan reka bentuk dari segi penjimatan kos dan *return on investment (ROI)*. Kajian ini menyimpulkan bahawa reka bentuk baru stesen kerja telah bertambah baik dari segi skor *RULA*. Sementara itu, kajian ini mencadangkan penyiasatan lanjut mengenai analisis produktiviti dan kualiti produk serta kajian aktiviti otot bagi operator dalam kajian masa depan.

ABSTRACT

Over the past decades, manufacturing industry has been recognized as the main driver for export performance as well as for the impressive economic growth in Malaysia. Among all the manufacturing industries, plastic manufacturing industry is one of the most dynamic growth sectors due to the high demand of consumers. In plastic manufacturing industry, there are 5 main production processes which are printing, lamination, extrusion, slitting and cutting processes. In plastic printing process, the printing workstations are semi-automated. At these workstations, the operators are exposed to various ergonomics risk factors such as lifting and handling heavy loads, non-neutral work posture, prolonged standing, and heat stress. In order to enhance the productivity, product quality, and occupational safety and health of operators, the aim of this study is to redesign the existing plastic printing workstation for improving work posture to prevent the occurrence of occupational injuries. This study applied workplace observation and questionnaire survey to investigate the ergonomics related problems faced by the operators who are carrying out plastic printing process in a plastic manufacturing industry. The risk factor which relates to non-neutral work posture was analyzed by Rapid Upper Limb Assessment (RULA). The RULA scores obtained for each posture were 5, 6 or 7, which indicated that the postures should be investigated further and changed. Furthermore, the operators requirements regarding plastic printing workstation were collected and transformed into House of Quality (HOQ). Then, three concepts of the improved design workstation were sketched. They were screened by using Pugh method to select the optimum design concept of workstation. Cost and benefit analysis (CBA) was used to evaluate effectiveness of the improved design workstation in terms of cost saving and return on investment (ROI). This study concluded that the new design of the workstation has improved the RULA score. Meanwhile, this study suggested further investigation of productivity and product quality analysis and the study on muscle activity for the operators in future study.

DEDICATION

For my beloved family, project supervisor, industrial supervisor, lecturers and friends that always believe in me to complete this project and report.

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LIST OF ABBREVIATIONS

GDP	-	Gross domestic product
CAGR	-	Compound annual growth rate
SOCSO	-	Social Security Organization
SOP	-	Standard operating procedure
AutoCAD	-	Automated Computer-Aided Design
CATIA	-	Computer-Aided Three-Dimensional Interactive Application
DELMIA	-	Digital Enterprise Lean Manufacturing Interactive Application
CMDQ	-	Cornell Musculoskeletal Discomfort Questionnaire
RULA	-	Rapid Upper Limb Assessment
3D	-	Three-dimensional
REBA	-	Rapid Entire Body Assessment
WMSDs	-	Work related musculoskeletal disorders
OWAS	-	Ovako Working Posture Analysing System
QEC	-	Quick Exposure Check
HOQ	-	House of Quality
CBA	-	Cost and benefit analysis
ROI	-	Return on investment
BCR	-	Benefit cost ratio
NPV	-	Net present value
WP	-	Working Postures
WSD	-	Work Shift Duration
WD	-	Workstation Design
SMA	-	Symptoms of Musculoskeletal Ailments
MSDs	-	Musculoskeletal disorders
TFT-LCD	-	Thin-film-transistor liquid-crystal display
OSHA	-	Occupational Safety and Health Administration
BRIEF	-	Behavior Rating Inventory of Executive Functioning

3D SSPP	-	Three-Dimensional Static Strength Prediction Program
NIOSH	-	National Institute for Occupational Safety and Health
ANOVA	-	Analysis of variance
NASA-TLX	-	National Aeronautics and Space Administration Task Load Index
MRFs	-	Musculoskeletal risk factors
MSSs	-	Musculoskeletal symptoms
SPSS	-	Statistical Package for the Social Sciences
VOEs	-	Voice of engineers

LIST OF SYMBOLS

RM	-	Ringgit Malaysia
α	-	alpha
kg	-	kilogram
cm	-	centimeter
®	-	Registered
™	-	Trademark

CHAPTER 1

INTRODUCTION

This chapter describes the background of study, problem statement, objectives of study, scope and limitation of study and significance of study. The background of study focuses on the existing working practices and ergonomics risk factors presence at plastic printing process workstation. The problem statement reveals the ergonomics related problems experienced by the operators at the printing process workstations. The intention of this study is to redesign the existing plastic printing process workstation for improving work posture to reduce the risk of occupational health. Additionally, the scope of study emphasizes the focus and limitations of the study. At the end of this chapter, the significance of study is presented.

1.1 Background of Study

Over the past decades, Malaysia received considerable amounts of foreign direct investment (FDI) which has played a vital role in the development of the manufacturing industry in Malaysia. Manufacturing industry is an essential engine of economic growth for the Malaysian economy. The significance of the manufacturing industry to the economy is proven in its contribution to the gross domestic product (GDP). It contributes positive estimated growth of 4.8 percent per annum in the overall performance of the manufacturing sector, contributing 23 percent or RM243.9 billion to GDP in 2015 (Saptari, 2016). Manufacturing sector contributed 76.2 percent of total exports in 2013, from 58.7 percent in 1990 (Wan, 2016). Additionally, manufactured goods continue to dominate exports with a share of 81.8 percent of total exports or RM636.7 billion in 2015. Therefore, the manufacturing sector has been recognized as the main driver for export performance as well as

for the impressive economic growth in Malaysia. In brief, manufacturing industry acts as a critical role in the transformation and development of the Malaysian economy.

Plastic manufacturing industry is one of the most dynamic growth sectors in Malaysia. This industry attained a standard growth rate of 15 percent during last 11 years due to the robust rate of Malaysian economy. According to Overview (2011), plastic manufacturing industry recorded total sales of RM16.1 billion in 2008, which increase of 4.1 percent when compared to RM15.46 billion in 2007. Meanwhile export of the plastic products for the year 2007 increased by 11.5 percent from RM8.38 billion to RM9.34 billion in 2008. Plastic manufacturing industry can be classified into four sub-sectors such as consumer and industrial products, plastic packaging, electrical & electronics and automotive components. The plastic packaging remains the largest market for the plastic industry with 40 percent of total industry output. This is due to pharmaceutical, and food and beverages industries have the highest demand for plastic packaging materials. In Malaysia, the food consumption level increased at a compound annual growth rate (CAGR) of 4.62 percent from 2002 to 2012 whereas the total pharmaceutical sales value had grown at a CAGR of 10.6 percent from 2002 to 2012, more than double of the food consumption value in the same period (UZABASE Materials Sector Team, 2014). Hence, the strong growth in these two industries showed strong demand on the plastic packaging materials.

In plastic manufacturing industry, there are 5 main production processes which are printing, lamination, extrusion, slitting and cutting processes. In this industry, most of the routine tasks are automated but some of the workstations are semi-automated therefore the operators have to operate both automated and semi-automated machines simultaneously. In plastic printing process, the printing workstations are semi-automated. At these workstations, the operators are exposed to various ergonomics risk factors such as lifting and handling heavy loads, non-neutral work posture, prolonged standing, and heat stress. These ergonomics risk factors can cause the operators to experience occupational health problems such as, back pain, neck pain and shoulder pain. As a consequence of these pains, the operators feel uncomfortable and unable to pay full concentration while operating the machines, hence

affects the product quality. Additionally, the operators may also be unable to achieve the production target.

In the past three years, the Social Security Organization (SOCSO) of Malaysia reported 15754 sprain and strain cases in workplaces (SOCSO Annual Reports 2012, 2013 and 2014). A strain is caused by twisting or pulling a muscle or tendon. Strain can occur after improperly lifting heavy loads or overstressing the muscles. In addition to improperly lifting heavy loads, improper design of workstation such as inappropriate table height is also one of the contributors to strain because the operators have to adopt non-neutral work posture during performing jobs.

Figure 1.1 shows the working environment at plastic printing workstation. Figure 1.2 shows the operators perform the plastic printing process in non-neutral work posture.



Figure 1.1: Working environment at plastic printing workstation



Figure 1.2: Operators perform the plastic printing process in non-neutral work posture

In order to enhance the productivity and occupational safety and health of operators in plastic manufacturing industry, the aim of this study is to redesign plastic printing workstation for improving work posture to prevent the occurrence of occupational injuries.

1.2 Problem Statement

This study performed workplace observation and questionnaire survey to investigate the ergonomics related problems faced by the operators who are carrying out plastic printing process in a plastic manufacturing industry located in Ayer Keroh Industrial Estate, Melaka. Based on the workplace observation and questionnaire survey, this study discovered that the ergonomics related problems experienced by the industry are:

a) Low productivity

The production rate of the plastic printing process is considered very low. The company has decided production target is 12 plastic rolls to be processed per day, but the operators only managed to obtain 8 plastic rolls per day. This is due to the