UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EVALUATION OF PSYCHOPHYSICAL EXPERIENCE AND HEART RATE OF MALAYSIAN FEMALE WHILE MANUAL LIFTING ACTIVITIES

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

by

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2013

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Evaluation of Psychophysical Experience and Heart Rate of Malaysian Female While Manual Lifting Activities

SESI PENGAJIAN: **2012/13 Semester 2**

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I hereby, declared this report entitled "Evaluation of Psychophysical Experience and Heart Rate of Malaysian Female While Manual Lifting Activities" is the results of my own research except as cited in references.

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APPROVAL

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

……

(Project Supervisor)

ABSTRAK

Di dalam industri pembuatan, mengangkat beban secara manual dilakukan dengan meluas oleh para pekerja. Bagaimanapun, teknik mengangkat beban secara manual yang tidak betul boleh menyumbang kepada kecederaan-kecederaan berkaitan kerja seperti sakit belakang dan sakit bahu kepada pekerja. Tujuan kajian ini ialah untuk merangka model matematik untuk meramal kesan paras ketinggian angkatan, berat beban dan sudut pusingan terhadap pengalaman psikofizikal dan kadar denyutan jantung wanita Malaysia semasa mereka mengangkat beban secara manual. Kajian ini melaksanakan pemerhatian tempat kerja dan kajian soal selidik bagi menentukan teknik angkatan dan masalah kesihatan yang dialami oleh pekerja wanita. Kemudiannya, satu eksperimen makmal telah dijalankan untuk menyiasat kesan paras ketinggian angkatan, berat beban dan sudut pusingan terhadap pengalaman psikofizikal dan kadar denyutan jantung subjek wanita semasa mengangkat beban secara manual. Berdasarkan analisis statistik, kajian ini mendapati berat beban telah dikenalpasti sebagai penyumbang utama kepada pengalaman psikofizikal, tahap kesakitan dan kadar denyutan jantung subjek wanita. Sembilan model matematik telah dirangka untuk meramal kesan ketinggian angkatan, berat beban dan sudut pusingan terhadap pengalaman psikofizikal dan kadar denyutan jantung wanita Malaysia. Semua model tersebut telah disahkan melalui data sejarah dan data eksperimen. Berdasarkan analisis statistik, satu kesepadanan yang baik di antara keputusan model matematik, data sejarah dan data eksperimen. Oleh itu, kajian ini menyimpulkan bahawa model yang telah dibangunkan di dalam kajian ini boleh dipercayai untuk meramal kesan ketinggian angkatan, berat beban dan sudut pusingan terhadap pengalaman psikofizikal, tahap kesakitan dan kadar denyutan jantung semasa mengangkat beban secara manual. Kajian ini mencadangkan kesan saiz beban dan cara angkatan seharusnya dipertimbangkan untuk kajian masa depan.

ABSTRACT

In manufacturing industry, manual lifting is widely practiced by the workers. However improper manual lifting technique can contribute to occupational injuries such as lower back pain and shoulder pain to the workers. The aim of this study is to develop mathematical models which are specifically used to predict the effects of lifting height, load mass, and twist angle on psychophysical experience and heart rate of Malaysian female while they are manual lifting. This study has performed workplace observation and questionnaire survey to determine lifting techniques and health problems experienced by the female workers. Subsequently a laboratory based experiment was conducted to investigate the effects of lifting height, load mass, and twist angle on psychophysical experience and heart rate of female subjects in manual lifting. Based on statistical analysis, this study found that the load mass has identified as main contributor to the psychophysical experience, pain level and heart rate of female subjects. Additionally nine mathematical models have been developed to predict the effects of lifting height, load mass, and twist angle on psychophysical experience and heart rate of Malaysian female. All models have been validated through historical data and experimental work. Based on statistical analysis, there is a good agreement between the results of the mathematical model, the historical data and the experimental work. Therefore, this study concluded that the models developed by this study are reliable for predicting the effect to the psychophysical experience, pain level and heart rate with respect to lifting height, load mass and twist angle in manual lifting. This study suggests that the effects of load sizes and lifting style should be considered in future study.

DEDICATION

I would like to convey my appreciation to my beloved parents, siblings, and friends who have giving me their moral supports continuously throughout my entire life.
Thank you for undivided loves and supports.
May God bless them for their positive supports which give me motivation to excellence in my future.

ACKNOWLEDGEMENT

First and foremost, great deals appreciated go to the contribution of my faculty and university, Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka.

I am also would like to thank to my supervisor, Dr. Isa bin Halim, whose invaluable guidance, advice, assistance from initial to the final level enabled me to develop understanding of this project. He inspired me greatly to work in this project. His willingness to motivate me contributed tremendously to my project. I appreciate the knowledge and advices that has gained from my supervisor. He has given me valuable cooperation, assistance, support and suggestion during this completion of project.

Special thank goes to Jati Beringin Sdn. Bhd. and Infineon Technologies (M) Sdn. Bhd. for providing fruitful case study during data collection.

Moreover, I would like to thank to my family who have giving me the supports and motivation to carry on from beginning until the completion of this project submission.

Finally, I would like to thank to my course mate for their cooperation, comprehensive and explanation as well as is providing some useful information in my final year project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

°	-	Degree
<	-	Less than
>	-	More than
ANOVA	-	Analysis of Variance
BPDR	-	Body part discomfort diagram rating
bpm	-	Beat per minute
CI	-	Confidence Interval
cm	-	Centimeter
DF	-	Degree of freedom
DOE	-	Design of experiment
Eq.	-	Equation
F	-	F Test (ANOVA)
H_0	-	Null hypothesis
H_1	-	Alternate hypothesis
HRM	-	Heart rate monitor
kg	-	Kilogram
LB	-	Lower Back
LBE	-	Laboratory based experiments
LBP	-	Lower back pain
p	-	p-value (ANOVA)
R	-	R-squared (regression analysis)
RPE	-	Borg Rating of Perceived Exertion Scale
SD	-	Standard deviation
SOP	-	Standard operation procedure
SS_E	-	Sum of squares error
T	-	T-ratio (ANOVA)

UA	-	Upper Arm
UTeM	-	Universiti Teknikal Malaysia Melaka
VAS	-	Visual analogue scale
VS	-	Versus
α	-	Alpha

CHAPTER 1
INTRODUCTION

This chapter presents the background of study, problem statements, objectives, and scope and limitation of study. In addition, the significance of study and the report outlines are also provided in this chapter.

1.1 Background of Study

Manual lifting requires a person to use force to carry an object by using both of his or her hands. There are few techniques of lifting such as stoop lifting and squat techniques, but those techniques only can use for a load that not so heavy.

Many of the industry in Malaysia still use the manual lifting techniques without assistance of equipment. The ergonomics risk factor associated with manual lifting can lead to occupational injuries. According to Lin *et al.* (2002), the incidence, severity, and potential disability of low back pain are related to the demands on the individual in the workplace.

This study is about evaluation of psychophysical experience and heart rate of Malaysian female while manual lifting. The heart rate is interaction of human body when do some lifting, while psychophysical experience is the feeling or experience after the lifting like tired, pain or others feeling.

This study aims to develop mathematical models of psychophysical experience and heart rate with respect to twist angle, load mass and lifting height in manual lifting

activities. The method to collect the data is direct surveys and questionnaire surveys of workers at an industry that applied the manual lifting technique and the laboratory based experiments.

1.2 Problem Statement

Based on observation, workers in industry require manual lifting in their daily job activities. However manual lifting practices lead several problems as summarized as follow:

a) Ergonomics risk factor associated with manual lifting can lead to occupational injuries such as low back pain and shoulder pain to industrial workers. Manual lifting contributes to occupational injuries associated with low back pain that can affect the life quality of industrial workers (Zurada, 2012).

b) Due to occupational injuries, the motivation, productivity and efficiency of the workers may be affected. Poor workers' health can reduce productivity and work quality (Shikdar and Sawaqed, 2003).

c) The company has to spend money for medical, treatment and rehabilitation to the injured workers. Workers' health issues have the potential to both increase costs and decrease revenues for any organization (Miller and Haslam, 2009).

d) Lead to absenteeism and high rate of turnover in the company. The absenteeism and turnover of workers can be reduced by increasing workers' spirit at work (Kinjerski and Skrypnek, 2008). Poor working practices lead to low motivation of workers to come to workplace. In the worst case, they might be resigning from the position. Hence ergonomic working environment including safe lifting techniques is necessity for the workers.

1.3 Objectives

The aim of this study is to develop mathematical models of psychophysical experience and heart rate with respect to postures, loads mass and lifting height in manual lifting activities. Specifically this study embarks the following objectives:

a) To investigate the technique applied by the workers while performing manual lifting and the health problems experienced by female workers due to manual lifting task.

b) To assess the psychophysical experience and heart rate of female workers while performing manual lifting tasks.

c) To formulate mathematical models of psychophysical experience and heart rate of female subjects with respect to twist angle, load mass and lifting height in manual lifting activities.

1.4 Scope and Limitation of Study

This study focuses on the how manual lifting affected the psychophysical experience and heart rate of the subjects. In order to get all the data and information for the study, laboratory based experiments (LBE) have been carried out. The subjects are female and all of them are selected at Universiti Teknikal Malaysia Melaka (UTeM). The subjects must in good health and not having physical disabilities. The following section describes the variables used in the LBE.

As the subjects, 10 female (Maiti and Bagchi, 2006) students from UTeM will do the laboratory based experiments (LBE). The loads that used for this experiment is 5 kg (Maiti and Bagchi, 2006), 10 kg (Rabinowitz *et al.*, 1998; Maiti and Bagchi, 2006*)* and 15 kg (Lee, 2003). The subjects need to lift the loads from floor to the shelf with lifting height 55 cm, 75 cm (Rabinowitz *et al.*, 1998) and 120 cm with three twist

angles which are 0°, 45° and 90° (Plamondon *et al.*, 2006). The limitation of this study is only limited to develop the mathematical model based on experimental works.

1.5 Significance of Study

There is a significance that has potential to help the workers in industry. Therefore, the occupational health of the workers can be improved especially in manual lifting task. The workers can practice the proper way to perform manual lifting task to avoid the occupational injuries such as low back pain.

Moreover, this study can be as future reference and research for the academicians. The results from the study can be delivered to society to enhance awareness on manual lifting activities.

1.6 Report Outlines

Chapter one provides background of study, problem statements, objectives, scope of the study, significance of study, and report outlines. In chapter two, the literature review of lifting technique and health problem in manual lifting are presented. The literature review is provided to support the methodology and discussion. The literature reviews have been found by using the journals and direct survey to the industry. Chapter three is all about methodology. It provides the method to identify the lifting techniques and health problems due to manual lifting, the psychophysical experience and heart rate in manual lifting and the method to formulate mathematical model for the psychophysical experience and heart rate with respect to postures, loads mass and lifting height in manual lifting activities. Chapter four presents the results obtain from the questionnaire survey and laboratory based experiments (LBE). Chapter five provides the conclusion and recommendation about the manual lifting tasks. Figure 1.1 shows the report outline of the study.

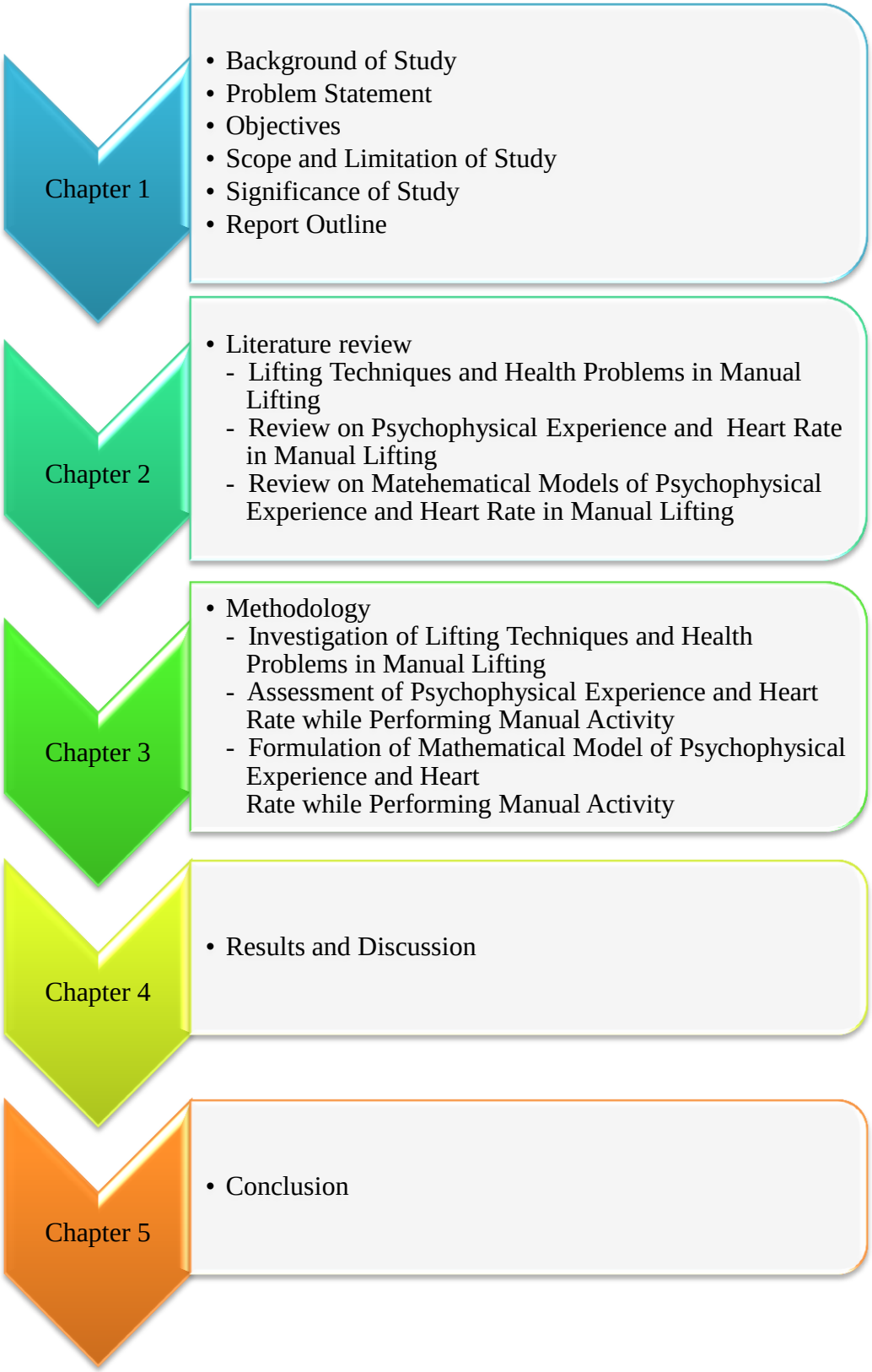


Figure 1.1: Report Outline

CHAPTER 2
LITERATURE REVIEW

This chapter provides literature review on lifting techniques that applied by the industry worker while doing manual lifting. In addition, this chapter also provide the health problems in manual lifting.

2.1 Lifting Techniques and Health Problems in Manual Lifting

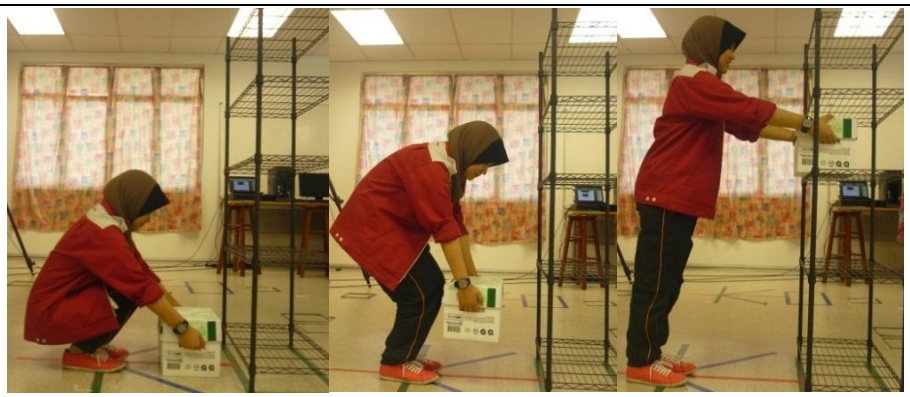
There are lot of manual lifting activities in the industry, so that there is also a lot of lifting techniques applied by workers while performing the manual lifting. The workers also can expose the health problems due to manual lifting. The details of lifting techniques and health problems in manual lifting are describes in the following sections.

2.1.1 Lifting Techniques in Manual Lifting

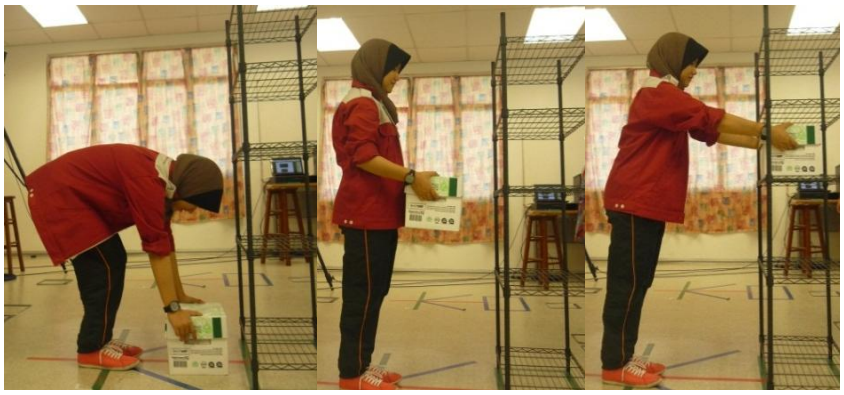
Manual lifting is defined as jobs that performed manually by humans including lifting, holding, carrying and moving heavy objects in the workplace (Zurada, 2012). Lifting happen when an object is move from a starting point to an ending point with a consequent increase in its vertical position (Hsiang *et al.*, 1997). While lifting, both trunk muscles and hip muscles provide the extension torques to lift the torso upward. The following section describes the lifting techniques.

There are lot of lifting techniques. The common lifting techniques are stooping and squatting lifting techniques. According Straker (2003), squat technique starts with

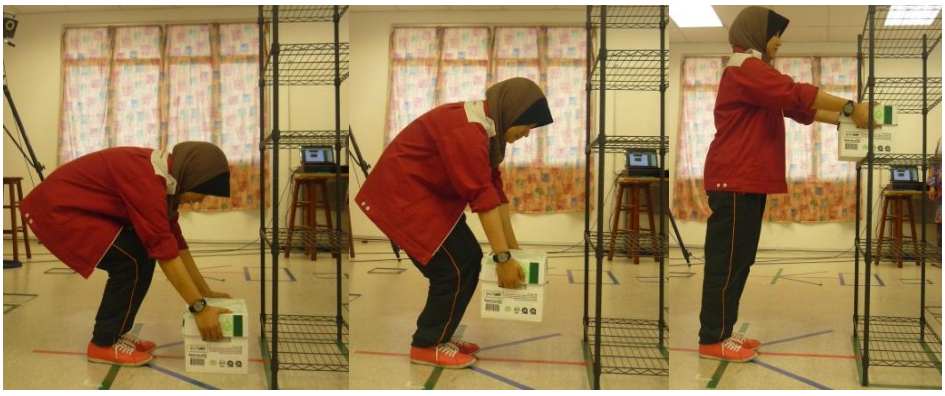
position of deep knee flexion with the trunk close to erect. In addition, Straker stated stoop technique starts with position of stretched knees and the inclined trunk. Furthermore, there is semi-squat technique, the posture between the squat and stoop lifts. The above mentioned techniques are shown in Figure 2.1.



Squat Lifting Technique Posture



Stoop Lifting Technique Posture



Semi-squat Lifting Technique Posture

Figure 2.1: Squat, Stoop and Semi-squat Lifting Techniques