UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EVALUATION OF PSYCHOPHYSICAL EXPERIENCE AND HEART RATE OF MALAYSIAN MALE 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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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:

……

(Project Supervisor)

ABSTRAK

Pengangkatan secara manual adalah salah satu teknik yang dipraktiskan oleh para pekerja dalam industri pembuatan. Teknik mengangkat secara manual yang tidak betul boleh menyebabkan pekerja tersebut mengalami sakit bawah belakang dan sakit bahu. Tujuan kajian ini ialah untuk merangka model matematik yang mana spesifik digunakan untuk meramal kesan kepada berat beban, paras ketinggian angkatan, dan sudut pusingan terhadap pengalaman psikofizikal dan kadar denyutan jantung lelaki Malaysia semasa mereka melakukan pengangkatan secara manual. Selain daripada itu, pengangkatan secara manual yang berterusan boleh memberi kesan terhadap fizikal dan mental. Hal ini akan menyebabkan produktiviti dan kecekapan pekerja terjejas. Kajian soal selidik terhadap industri pembuatan telah dijalankan untuk mengenalpasti teknik-teknik mengangkat dan masalah kesihatan yang dialami oleh pekerja lelaki. Selain itu, satu eksperimen makmal telah dilaksanakan untuk mengkaji kesan kepada berat beban, paras ketinggian dan sudut pusingan terhadap pengalaman psikofizikal dan kadar denyutan jantung subjek lelaki dalam pengangkatan manual. Berdasarkan analisa statistik, kajian ini mendapati bahawa berat beban telah dikenalpasti sebagai penyumbang utama kepada pengalaman psikofizikal, tahap kesakitan dan kadar denyutan jantung subjek lelaki. Tambahan pula sembilan model matematik telah dirangka dan disahkan melalui data sejarah dan data eksperimen. Berdasarkan analisis statistik, satu persetujuan yang baik antara keputusan model matematik, data sejarah dan data eksperimen. Oleh itu, kajian ini menyimpulkan bahawa model yang dirangka boleh digunapakai untuk meramal kesan pengalaman psikofizikal, tahap kesakitan dan kadar denyutan jantung terhadap berat beban, paras ketinggian dan sudut pusingan dalam pengangkatan manual. Kajian ini menunjukkan bahawa faktor-faktor persekitaran seperti suhu tempat kerja dan pencahayaan perlu dipertimbangkan dalam kajian masa depan.

ABSTRACT

Manual lifting is one of the common activities in industries. Due to the manual lifting activities, the worker may be exposed to low back pain and shoulder pain. The aim of this study is to develop mathematical model for psychophysical experience, pain level and heart rate with respect to load mass, lifting height and twist angle for Malaysian male while performing manual lifting activities. Manual lifting activities may leads to mental and physical fatigue. Thus, the motivation, productivity and efficiency of workers may be affected. The questionnaire survey to a Metal Stamping Industry was conducted to identify lifting techniques and health problems experienced by the male workers. Then, a Laboratory Based Experiment was applied to investigate the effect of load mass, lifting height and twist angle on psychophysical experience, pain level and heart rate of male subjects in manual lifting. Statistical analysis tools associated with descriptive statistics, comparative statistics and regression statistics were used to analyze the data. Based on results, this study found that load mass has identified as vital contributor to psychophysical experience, pain level and heart rate. Additionally, nine mathematical models have been developed and validated through historical data and experimental data. Based on statistical analysis, there is a good agreement between the results of mathematical model, historical data and experimental data. Therefore, this study concluded that the models are reliable to be used for predicting the effect of psychophysical experience, pain level and heart rate with respect to lifting height, load mass and twist angle in manual lifting. This study suggests that environmental factors such as the workplace temperature and lighting should be considered in the 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.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

°	-	Degree
<	-	Less than
>	-	More than
ANOVA	-	Analysis of Variance
bpm	-	beat per minute
D_OE	-	Design of Experiment
Eq.	-	Equation
F	-	F Test (ANOVA)
H_0	-	Null hypothesis
H_1	-	Alternate hypothesis
HR	-	Heart Rate
HRM	-	Heart Rate Monitor
LBE	-	Lab Based Experiment
LBP	-	Low Back Pain
NIOSH	-	National Institute for Occupational Safety and Health
p	-	p-value (ANOVA)
R	-	R-squared (regression analysis)
RPE	-	Borg Rating of Perceived Exertion Scale
SD	-	Standard Deviation
SOP	-	Standard Operating Procedure
SS_E	-	Sum of Squares Error
T	-	T-value (ANOVA)
UTeM	-	Universiti Teknikal Malaysia Melaka
VAS	-	Visual Analog Scale
VAS	-	Visual analogue scale
VS	-	Versus
α	-	Alpha

CHAPTER 1
INTRODUCTION

This chapter provides the information on background of study, problem statements, objectives, scope and limitation of study, significance of study and report outlines.

1.1 Background of Study

Manual lifting is one of the common activities in industries. Manual lifting can be defined in terms of the body postures adopted at the start of the lift and move any objects using manually (Burgess L.R. & Abernethy B. 1997). Due to the manual lifting activities, the worker may be exposed to occupational injuries such as low back pain, shoulder pain and other work related injuries. The occupational injuries will cause loss of work production and disturb routine daily activities of workers.

Previous study recognized that manual lifting is one of the major causes to occupational injuries such as low back pain (Waters et al., 1993b). A recent review by the National Institute for Occupational Safety and Health (NIOSH), there is evidence for awkward postures, heavy physical, lifting and forceful movements as risk factors for low back pain (Bernard, 1997). Therefore, to avoid from these problems, control measures should be taken proactively. Otherwise, the injuries will become more serious.

Measurement of the psychophysical experience and heart rate are the effective ways to assess physical strain on the human body (Sheila K., 1974). The relationship between work factors and the perception of physical stress, fatigue, and discomfort on the body of workers can be determined through psychophysical experience (Sheila K., 1974). Continued and repeated exposure to manual lifting can increase the psychophysical demands of the workers (Mital et al., 1994). It is because, when the workers perform the repeated manual lifting tasks, their heart rate will increase. Therefore, increase in heart rate will increase the physiological stress on the workers.

This study is aimed at development of mathematical models which considering psychophysical experience and heart rate with physical factors (twist angle, load mass and lifting height) while performing manual lifting activities. This study performs direct survey to industry, interview with workers, video recording and laboratory experimental work to investigate the effects of manual lifting tasks.

1.2 Problem Statements

Manual lifting involved any activities that require the use of force exerted by a person. Previous studies shown that manual lifting has contributed to following difficulties:

(a) Ergonomics risk factor associated with manual lifting can cause occupational injuries such as low back pain and shoulder pain to industrial workers. Manual lifting are the major causes of work-related low back pains (Waters et al., 1993b).

(b) Due to the occupational injuries, the motivation, productivity and efficiency of the workers may be affected. Exposure of long period in manual lifting will cause fatigue and resulted in decrease of performance. However, these effects can be avoided if the motivation of the workers is great (Harrington, 1978).

(c) Occupational injuries and illnesses not only impact on safety and health but also economics, because of high costs related with work injuries (Abel P. et al., 2011). Therefore, due to work injuries, the company needs to spend money for medical, treatment and rehabilitation to the workers.

(d) Manual lifting activities leads to mental and physical fatigue. Therefore, it may lead to poor quality output, industrial disputes, accidents, injuries, lead to absenteeism, a high rate of turnover and demands for early retirement (Roy J S. 2000).

1.3 Objectives of Study

This study was conducted in order to achieve the following objectives:

(a) To investigate the technique applied by the workers in manual lifting and the health problems experienced due to manual lifting task.

The technique applied among the industrial workers to lift the objects will be observed. Direct survey to the industry will be carried out to identify the health problems experience faced by the workers.

(b) To assess the psychophysical experience and heart rate of male subjects while performing manual lifting tasks.

The psychophysical experience and heart rate will assess to the 10 male subjects and find out the cause of body parts that are affected due to manual lifting.

(c) To formulate a mathematical model of psychophysical experience and heart rate with respect to twist angles, load mass and lifting heights in manual lifting activities.

The effects of these three variables will be formulated in mathematical models.

1.4 Scope and Limitation of the Study

This study investigates the manual lifting techniques that are applied by the industrial workers in their workplaces. In order to evaluate the psychophysical experience and heart rate of male Malaysian while manual lifting activities, the subject are randomly selected from 10 male students at the Faculty of Manufacturing Engineering (FKP) in Universiti Teknikal Malaysia Melaka (UTeM). The loads used in order to perform manual lifting are 5 kg, 10 kg and 15 kg. The lifting height is 55 cm, 75 cm and 120 cm while the angle is 0˚, 45˚ and 90˚. Besides, this study performed direct survey using questionnaire, interview and video recordings while the industrial workers are performing manual lifting activities. There was a limitation of the study where by the subjects has to perform the manual lifting using both hands, stoop lifting technique and at laboratory setting experiment.

1.5 Significance of the Study

By conducting this study, it will give some benefits to the workers, academics and society. There is some health problem experienced by the industrial workers due to manual lifting. Therefore, important information that is related to the industry provided in this study can apply by the industrial practitioners. It is because to improve occupational health especially in manual lifting task. The Occupational Safety and Health organizations in Malaysia such as Social Security Organization, National Institute Occupational Safety & Health, and Department of Occupational Safety & Health can utilize the data and models provided from this study to improve the safety and health of industrial workers. Moreover, it is to improve the existing guidelines and regulations on manual lifting tasks. Lastly, it will give the benefits to academicians for future reference and research on manual lifting tasks.

1.6 Report Outlines

This study started from identification the problem while performing manual lifting activities especially for industrial workers. Chapter one provides an introduction, problem statements, objectives, and scopes of the study, significance of study and report outlines. The main and essential objective is to investigate the technique applied by the workers in manual lifting and the health problems experienced due to manual lifting task. The scope explains the range and limitation of the study. In chapter two, literature review is provided to support data, methodology and discussion of the study. Literature review was performed through online databases such as journal, books, and other writing sources related to ergonomics approach. Chapter three discusses the method used in order to perform the manual lifting tasks. Chapter four presents the results obtained from the questionnaire survey, and interview. Besides, this chapter discusses the findings with supporting of journals. Chapter five concludes this study and provides recommendation for future works. Figure 1.1 below shows the report outline of the study.

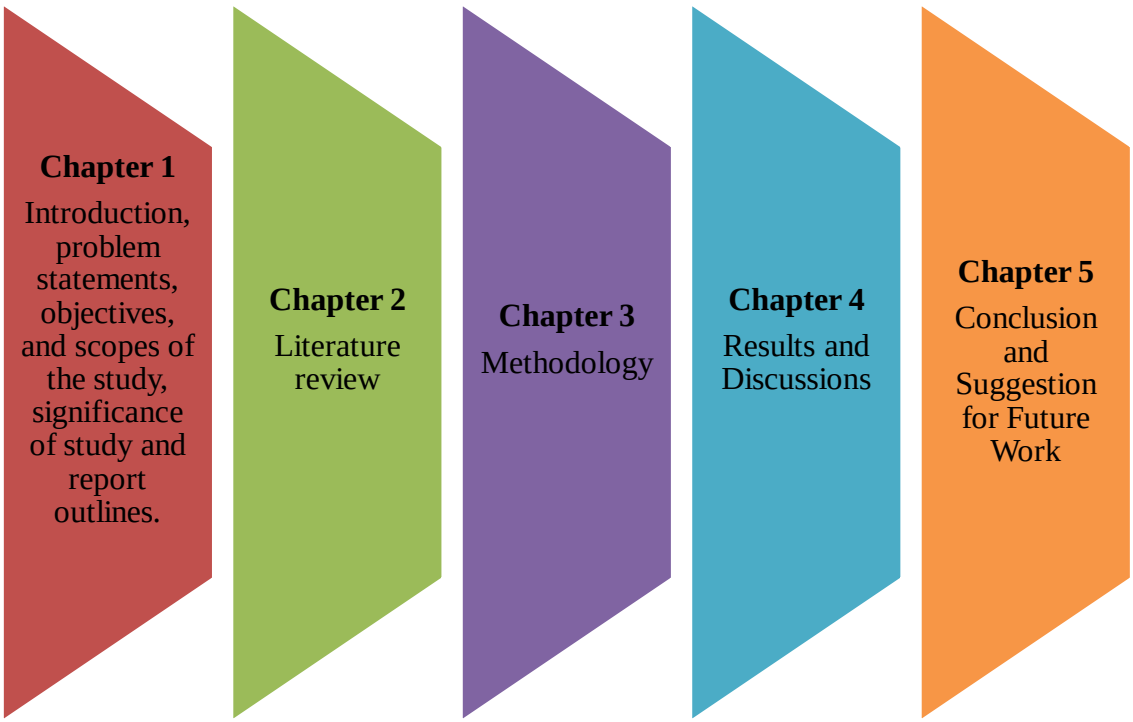

Figure 1.1: Report Outline of the Study

CHAPTER 2
LITERATURE REVIEW

This chapter provides literature review on lifting techniques applied by the workers in manual lifting and the health problems experienced due to manual lifting task. In addition, related information on the psychophysical experience and heart rate while performing manual lifting tasks are described as well. Lastly, formulation of mathematical models related to manual lifting activities is reviewed in this chapter.

2.1 Lifting Techniques and Health Problems in Manual Lifting

There are lot of lifting techniques that are applied by the industrial workers. Due to the manual lifting, the workers can exposed to occupational injuries such as low back pain and shoulder pain. The details explanation about lifting techniques and health problem in manual lifting are describe in the following sections.

2.1.1 Lifting Techniques in Manual Lifting

Lifting is a very complex process involving a number of different body mechanisms. Manual lifting techniques refers to the method of individual to perform a lift under a given task and environmental conditions (Simon et.al, 1997). The following section describes the type of lifting techniques.