



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**ERGONOMIC ENVIRONMENT USING SUBJECTIVE METHOD
REGARDING DISCOMFORT AND RISK ANALYSIS FOR
PROLONGED STANDING AT KTM KOMUTER**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Manufacturing Engineering Technology (Process & Technology) with Honours.

by

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Date :

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor's Degree in Manufacturing Engineering Technology (Process & Technology) with Honours. The member of the supervisory is as follow:

.....

(ASSOC. PROFESSOR DR WAN HASRULNIZZAM)

ABSTRAK

Tujuan projek ini dijalankan adalah untuk menentukan faktor yang menyebabkan ketidakselesaan badan dan kepenatan yang dirasakan oleh pengguna keretapi KTM Komuter lebih-lebih lagi dalam perjalanan jarak jauh. Pemerhatian telah dilakukan ke atas 19 responden dengan Indeks Jisim Badan lebih dari berat badan normal. Skop projek ini khusus kepada pengguna KTM Komuter wanita. KTM Komuter dipilih untuk projek ini kerana mempunyai perjalanan jarak jauh berbanding keretapi awam yang lain. Ini kerana jarak perjalanan KTM Komuter boleh mencapai sehingga dua jam. Berdasarkan pemerhatian yang dijalankan, postur badan responden telah dikategorikan dan dianalisis menggunakan perisian komputer CATIA V5. Patung *manikin* telah dimasukkan ke dalam CATIA V5 dan data antropometri yang diambil dari responden telah digunakan untuk ukuran *manikin* tersebut. Empat postur badan responden telah dipilih dan digunakan untuk dianalisis menggunakan *Rapid Upper Limb Assessment* (RULA) di dalam perisian CATIA V5. Kemudian, analisis postur responden telah dilakukan untuk mendapatkan skor analisis RULA. Analisis yang dijalankan menunjukkan tiga postur badan adalah sederhana bahaya manakala satu lagi postur badan adalah bahaya dan memerlukan perubahan secepat mungkin. Berdasarkan analisis RULA yang dijalankan, postur badan yang terbaik telah dicadangkan bagi mengurangkan kadar risiko mengalami *Musculoskeletal Disorder* (MSD). MSD adalah satu penyakit yang disebabkan oleh faktor risiko ergonomik. Secara keseluruhannya, kesakitan dan ketidakselesaan yang dialami oleh responden boleh dielakkan dengan menukar postur badan semasa menggunakan keretapi.

ABSTRACT

The purpose of this project is to determine the risk factors that contribute to discomfort and muscle fatigue during prolonged standing for train passengers. Observations have been conducted on 19 female respondents with the Body Mass Index (BMI) either overweight or obese which higher than normal. This research limited for women who are using KTM Komuter because the route and time taken for KTM can be up to two hours and above compare to other train facilities. Variations of body postures observed from respondents frequent train user were characterized and analyzed by using CATIA V5 software. A lifelike manikin was inserted and edited based on the anthropometric data collected from the respondents. Then, the human activity analysis was simulated by using CATIA V5 software. In this project, there are four finalized body postures of the respondents were taken and analyzed by using Rapid Upper Limb Assessment (RULA) method in CATIA V5. The result of the study shows that three postures need further investigation and another one is harmful and need to change immediately to reduce ergonomic risk factor. Based on the RULA scores, the ideal body postures while riding train in a long period of time was proposed to minimize the risk from suffer Musculoskeletal Disorders (MSD). The pain experienced by the respondents can be preventing by changing body posture while in the train.

DEDICATION

This thesis is dedicated to my mother, who had taught me the best kind of knowledge. It is also dedicated to my family who always support me during my studies. Special thanks to my supervisor, Associate Professor Dr Wan Hasrulnizam for supervision. And also to my beloved friends who keep giving me encouragements of completion of this project.

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LIST OF ABBREVIATIONS

CATIA	-	Computer Aided Three-dimensional Interactive Application
EMG	-	Surface Electromyography
ERA	-	Ergonomic Risk Assessment
FIOH	-	Finnish Institute of Occupational Health
KTMB	-	Keretapi Tanah Melayu Berhad
LBP	-	Low Back Pain
MSD	-	Musculoskeletal Disorders
OCRA	-	Occupational Repetitive Action
RULA	-	Rapid Upper Limb Assessment
REBA	-	Rapid Entire Body Assessment
sEMG	-	Electromyography
WRMSD	-	Work-Related Musculoskeletal Disorders

CHAPTER 1

INTRODUCTION

1.1 Project Background

The most common problems are Musculoskeletal Disorders (MSD) which experienced by majority of workers in India (Ansari and Sheikh, 2014). MSD such as leg and lower back pain, cardiovascular problems, fatigue, discomfort, and pregnancy-related health outcomes may be experienced by the worker nowadays. Ergonomic is one of the factors that have been suggested associated to MSD besides highly repetitive work and prolonged standing. Importance keys in design of work place, series of production, well working environment, working method, security at work, personal security and so on affected by ergonomics that eventually resulting of workers in falling fatigue (Ansari et al., 2013). Figure 1.1 portrays ergonomic risk factors that contribute to MSD. Besides prolonged standing which lies under awkward posture, the other several risk factors are static posture, repetitive motion, force, whole body vibration and contact stress.

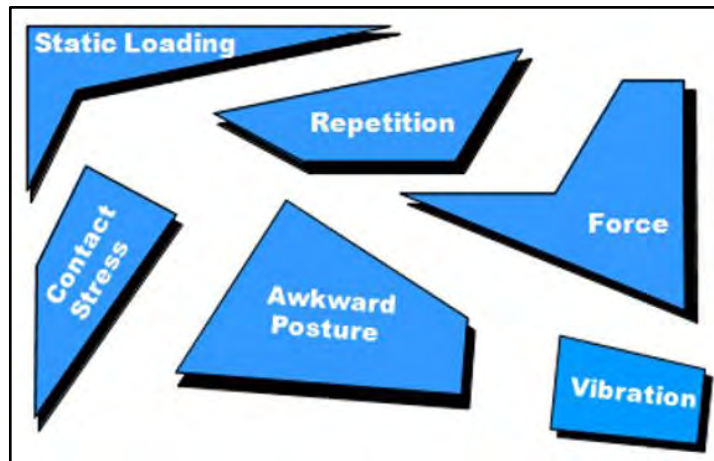


Figure 1.1: Factors that contribute to MSD (Anon, 2014)

Repetitive movement which is can be describe as awkward posture are the one of the most common dangerous issues in the workplace (Parent-Thirion et al., 2012). Ergonomic risk factors also including repetitive motion, excessive force, working in areas with constants vibrations, prolonged positions causing awkward or uncomfortable postures, static postures, constant stress on any body part of working in extreme temperature. Ergonomics commonly interpreted as working in office with computers all day long. Ergonomics is a method for designing workstations, work practices, and work flow to oblige the capacities of workers.

Ergonomic outline diminishes chance components known to add to word related ergonomic wounds and ailments, for example, sprains and strains and aggregate injury issue. Fatigue and discomfort may result from excessive force and awkward postures which can damage the muscles, tendons, ligaments, nerves and blood vessels. This type of injuries is known as MSD (Bridger, 2003). There are workers in various fields in industry need to stand all along the working shift in a long period of time. Recent studies have been conducted examining the relationship between these health outcomes and the amount of time spent standing.

Ringhiem et al. (2015) stated that to change postural position and shift body weight during the period of prolonged standing from one leg to another. In this project, postural assessment method that used was Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA). These analyses were run to determine either the workers are working off their own boundaries. By using RULA

method, it was proven the level of risks for the majority of the workers are high. Meanwhile some of the workers were under lower levels and majority at high risk by using REBA.

An investigation found that workers that required for prolonged standing easily get fatigued and chances of getting musculoskeletal problems which also justified by REBA. In addition, another factor that would contribute to musculoskeletal disorder is awkward postures (Ansari and Sheikh, 2014). Visualizing the performance of postural activity in several designs are possible nowadays with the existence of computerized human models developed over the years for design of human workspace. Simulated work posture of operators made by using Computer Aided Three-dimensional Interactive Application (CATIA) Version 5 by using recorded videos and observations.

1.2 Problem Statement

Keretapi Melayu Berhad (KTM) Komuter is one of the most famous commuter rail service public transportation that has been used by people especially people who using this medium of transport back and forth daily to go their workplace. This is due to tremendously increasing of private vehicle in this country for the past years that causes by numerous factors by the year of 2010, 17.4 million private vehicle automobiles meanwhile there are 11.7 million newly registered drivers causing traffic jammed (Shariff, 2012). Due to this rising number of riders in KTM Komuter, there is not enough coach seats provided in the train. Many people need to stand all along the journey especially during the peak hour. A research carried out found that two per cent (2%) of the respondents proposed for the management to add more seats to rise up the comfort level for the passenger (Bachok et al., 2014).

There is enormous number of passenger of KTM Komuter forced to stand as there are not enough seats in the train. Spending lot of time standing may cause the individuals to feels discomfort and muscle fatigue at a certain period of time (Halim et al., 2014). It also identified that standing position are affected by few factors that

resulting in discomfort which are postural activity while standing, duration of standing, holding time, vibration, including air quality.

1.3 Project Question

This research has been develops based on several objectives:

- i. To determine the risk factors that contribute to discomfort and muscle fatigue by passengers in train due to prolonged standing.
- ii. To do assessment using subjective method (RULA and REBA Scorecard) and direct measurement method (Anthropometry measurement) for passenger while riding train.
- iii. To validate the proposed idea on the best standing posture while riding train in standing position using CATIA software.

1.4 Project Scope

This study is the real practice of respondents who ride train and need to stand all along the journey for two hours of standing without sitting. This research limited for working women who are using KTM Komuter because the route and time taken for KTM can be up to two hours and above compare to other train facilities. In additional, this research project focuses on women age 19 to 35 years old and overweight women. The respondents also encounter obesity problem as this group of women will be fatigue faster than young and energetic women. However, respondents also need to carry weight or loads while travelling.

A survey also conducted before the research involving 19 people who ride KTM Komuter frequently to achieve more information about the discomfort of prolonged standing in the train. A data collection of recorded postural position of respondents will be examined as result at the end of the research project. Figure 1.2 below indicates the following ergonomic risk factors that contribute to MSD while spending a lot of time standing in the train. But this project only focuses on the awkward posture for human factor.

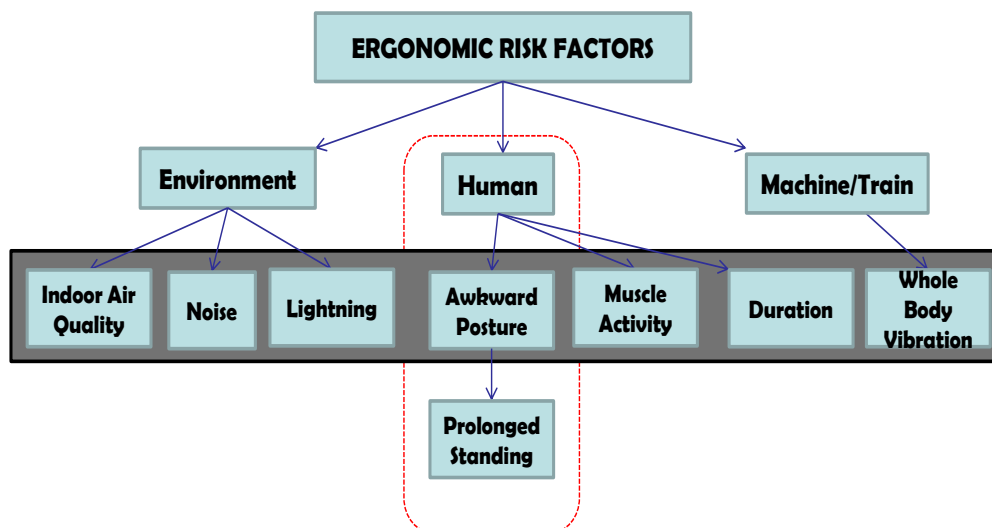


Figure 1.2: Ergonomic risk factors that contributes to MSD in the train

1.5 Significance of Project

The expecting research outcomes on bringing a benefit towards:

1. New findings/ New Knowledge

- a. The industrial area and KTM Komuter passengers can refer or use the outputs of this research to prevent MSD due to prolonged standing.
- b. Malaysia Ministry of Human Resource can use the data and models to improve existing guidelines to reduce occupational health among KTM passenger.
- c. This research can offers new references and methods for future research.

2. Specific or Potential Applications / Contribution to Nation:

The outcomes of this research which will come out with scoring of RULA and REBA can be used to determine guidelines for the KTM prolonged standing passengers. This study provides information on risk factors that developing injuries such as awkward postures during prolonged standing in a train. By using RULA and REBA, a survey method developed to investigate if the posture of the passengers can lead to MSD. The potential user can obtain information from recommendation that will be produced at the end of this project how to stand on a train to prevent fatigue and MSD.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides more information and acquaints us about the exploration of the research topics by doing evaluations on previous research related to this research project. Knowledge of the topics is necessary before starting a research project to collect information that can be used. There are few main topics should be investigate which are discomfort and muscle fatigue risk factors, assessment methods for discomfort and muscle fatigue, subjective methods, direct technical measurement method and manikin ergonomics based on CATIA V5. The main objectives of this study are to analyse the ergonomics risk factors for prolonged standing in the moving train for a certain period of time and to observe the common postures of the passengers in the train.

This includes the loads that the passengers carry around while on the train. Passengers often take it for granted about their postural activities in daily routine. They are actually popping up hazard and sometimes may cause injury without them noticed to its risks. By identifying the hazardous risk of the awkward posture in the train, passenger will aware of it and it they can reduce the risk of prolonged standing in the train. The review of this literature will support the idea of risk factors of prolonged standing in the train an issue that should be taken seriously.

2.2 Ergonomic

Ergonomics is a method of designing workstations work practices and flow to accommodate the abilities of employees (Fernandez, 2007; Bridger, 2003). Ergonomics injuries and illnesses such as carpal tunnel syndrome, tendinitis and MSD rate are increasing which cut across all industries and occupations. Webster's New World Dictionary (College Edition) defines ergonomics as "The Study of the problems of people in adjusting to their environment; especially the science that seeks to adapt work or working conditions to suit the worker" (Doggette, 1995). It is also state that ergonomics deals more than just physical aspects of work besides may consider be thought as a science of fitting the job to the individual workers.

According to Pheasant (1987), ergonomics is the science of work where the people are doing it, the way it is done, equipment they are using, their workplaces and their psychological in a workplace. He also stated that the word 'ergonomics' comes from the Greek which was created by late Professor Hywell Murrell during a meeting at Queen Anne's mansions on 8 July 1949. In other words ergonomics is also can be define as science of fitting the job to the worker and the product to the user. Ergonomics is design of workplace, equipment machine tool, product, environment and system and take it into consideration of the human's physiological and psychological capabilities and optimizing the efficiency of the productivity of work system. Ergonomics related to the design of methods and processes can help eliminate or decrease work related risks as well as improve the quality and productivity (Ansari et al., 2013).

Ergonomics which also known as Human Factor, is the understanding of interactions of humans and other elements in system and other elements of a system to optimize human being and overall system performance (Kamala et al., 2016). It is also considers both a social goal and economic goal. The main goal of ergonomics is to develop and implemented the man adaptation techniques, efficiency and safest ways in order to optimize the well-being and thus that would increase the productivity (Santos et al., 2015). Young et al., (2015) summarize that he study of workload in ergonomics has increased in popularity since the 1980s. Applied problems, particularly in transportation have taken seriously in recent years.