UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ERGONOMIC RISK FACTOR THAT CONTRIBUTE TO DISCOMFORT AND VIBRATION ANALYSIS WHILE RIDING TRAIN

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 and Technology) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

……

(Profesor Madya Dr. Wan Hasrulnizzam bin Wan Mahmood)

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ABSTRAK

Ergonomik adalah kajian mengenai hubungan antara individu dan pekerjaan atau persekitaran semasa yang terdedah kepada mereka. Bahaya ergonomik merujuk kepada keadaan tempat kerja yang menimbulkan risiko kecederaan kepada sistem muskuloskeletal pekerja. Selain tempat kerja, sistem pengangkutan seperti kereta api bergerak tidak terkecuali dari menghasilkan gangguan persekitaran ergonomik bagi penumpang yang menaiki kereta api. Keselesaan penumpang harus diutamakan ketika menaiki pengangkutan awam. Tujuan kajian ini adalah untuk menilai pendedahan getaran seluruh badan kepada penumpang menggunakan pengukuran langsung di dalam kabin kereta api dan kaedah subjektif melalui penumpang kereta api. Di samping itu, untuk mendapatkan maklumat mengenai faktor risiko yang menyumbang secara ketara pada perasaan tidak selesa di kalangan penumpang kereta api semasa menaiki kereta api bergerak di seluruh destinasi yang dikehendaki. Kajian ini dilaksanakan di dalam komuter kereta api KTMB yang mana destinasinya bermula dari stesen Tampin ke stesen KL Sentral. Skop projek difokuskan pada pelbagai peringkat usia di kalangan golongan penumpang wanita yang biasanya duduk di koc wanita di dalam komuter. 130 kajian soal selidik diedarkan semasa penyelidikan namun disebabkan oleh beberapa batasan yang dihadapi hanya 97 kaji soal selidik yang sah untuk dianalisis data. Alat pengukuran yang digunakan merupakan *tri-axial seat pad accelerometer* disambungkan ke *4-channel VI-400PRO Human Vibration Meter (HVM)* diletakkan dalam kereta api berhampiran kerusi, penyambungan antara kabin dan berhampiran pintu di dalam kabin wanita di KTM Komuter Berhad. Hasil yang diperolehi dari kajian penyelidikan, tahap pendedahan getaran seluruh badan dapat ditentukan dan faktor-faktor yang telah disenaraikan menyumbang kepada wujudnya perasaan ketidakselesaan akibat persekitaran dan pendedahan getaran kepada penumpang keretapi. Bacaan nilai kadar getaran berkaitan dengan *Standard Antarabangsa 2631-1* yang digunakan oleh semua untuk memastikan keselesaan penumpang. Keputusan kajian ini dapat memberi kesedaran kepada para penumpang untuk mengurangkan pendedahan kesan gegaran kepada diri semasa menggunakan kemudahan kereta api.

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ABSTRACT

Ergonomics is the study of the relationship between people and their work or current environment exposed to them. Ergonomic hazards refer to workplace conditions that pose the risk of injury to the musculoskeletal system of the worker. Besides workplace, a transportation system such a moving train not excluded to produce ergonomically environment disturbance for the passengers who were riding the train. When in public transport, the passengers' convenience should be prioritized. The purpose of this study is to assess exposure of whole body vibration (WBV) to the passenger using direct measurement inside the train cabin and subjective method through the train's passengers. Besides that, to determine information on risk factors that contribute significantly to discomfort feelings among the train passenger during riding the moving train throughout desired destination. This research study were site base in KTMB commuter train which where the destination is from Tampin to KL Sentral train station. Project scope is focused on variety of ages of woman passengers that commonly sit in the woman coach inside the commuter. 130 questionnaire were distributed during the research. However due to some limitations only 97 questionnaire survey is valid for data interpretation. The tri-axial seat pad accelerometer was connected to a 4-channel VI-400PRO Human Vibration Meter (HVM was placed at the train floor near the seats, gangway, and near door inside the women cabin in KTM Komuter. The results obtain from the research study, WBV exposure level can be determined and the factors that were listed did contribute to existence of discomfort feeling due to environment and vibration exposure to train's passenger. The reading of vibration data values is related to the International Standard 2631-1 that is used by all to ensure a comfortable ride for passengers. Results of this study can provide awareness to the passengers in order to have less effect of WBV when travelling using komuter train.

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DEDICATION

To my beloved parents, sibling and family, thank you for your support all this time. I am much appreciated that. To my supervisor, Associate Professor Dr Wan Hasrulnizzam bin Wan Mahmood and Puan Fatimah Abdullah thank you for always guiding me throughout the project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

AS	-	Australian Standard
BMI	-	Body Mass Index
PhD	-	Doctor of Philosophy
ERL	-	Express Rail Line
HVM	-	Human Vibration Meter
KTMB	-	Keretapi Tanah Melayu Berhad
LBP	-	Low Back Pain
LRT	-	Light Rail Transit
MRT	-	Mass Rapid Transit
MSD	-	Musculoskeletal Disorders
OSHA	-	Occupational Safety and Health
RMS	-	Root Mean Square
SPM	-	Sijil Pelajaran Malaysia
VDV	-	Vibration Dose Value
WBV	-	Whole Body Vibration
WRMSD	-	Work-Related Musculoskeletal Disorders

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CHAPTER 1
INTRODUCTION

1.1 Project Background

Ergonomic principles are commonly known to create a safe, healthy, efficient and effective activity most importantly in the workplace area. However the principles were applied through all of people without actually noticing it. It is usually informed that human factors and ergonomics knowledge is less important to the community as they not receive the attention and consideration that it should deserves (Grote, 2014).

Ergonomic risk factors come in variety of factors and causes as shown in the Figure 1.1 below. Risk factor is any attribute and exposure of an individual that making awkward postures repetitively or for prolonged period's time may lead to developing risk of ergonomic injuries that related to work categories which include vibrations (Joshi, Leu and Murray, 2012). Excessive force and contact stress may result risk of muscle cramp, ache and also numb because of the static posture in long period of time.

Besides that, the surrounding environment such as temperature of the current conditions its either in low or high temperature may affect human's moods and discomfort that lead to the occurrence of ergonomic risk factors. The posture of stand, sit, drive, walking and other more position posture of human body is actually classified into the ergonomic principles. Posture describe the orientation of any body part segment that relative to the gravitational vector that were angular measure from the vertical.

But for this project research will be focusing on the standing posture of human body. Based on these ergonomic principles, human physical abilities and limitations can be determined. However the limitation of a person is different due to several of reasons

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such as age, weight, gender, scope of daily job, and others (Sorensen *et al.*, 2016). Ergonomic risk factors are a result of failed ergonomic principles applied.

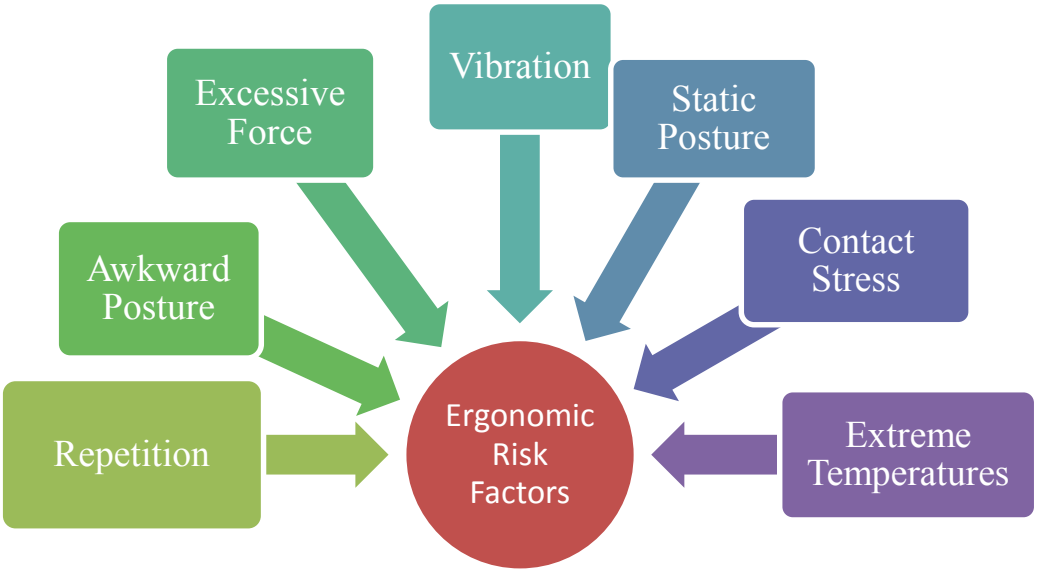

Figure 1.1: Factors of Ergonomic Risks (BMFP 3553 Industrial Ergonomics)

The public transportation such as moving train is commonly used by the community in modern country. It usually have been used by people that either have to travel to the workplace or only for weekend outing or both. Each of the train car, the space comes in a seat and also standing spot (Berkovich *et al.*, 2013). An unexpected crowd is the common phenomena when involving public transportation. For the public transport users and rail passengers, the impact of crowding on travelling journey is a major issue no matter how far or shorts the duration.

The "crowding" term has been proven to be challenging because it has multiple meanings and has been inconsistently defined (Mohd Mahudin, Cox and Griffiths, 2012). The duration of travelling is depending on the destination of the moving train users. For this project research will be focus on Keretapi Tanah Melayu Berhad (KTMB) commuter users. This project research is proposed to investigate the risk factor that contribute to discomfort feeling that were develop when in prolonged stand position and vibration rates experienced by the train's passenger while in the moving train.

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1.2 Problem Statement

The users of public transportation will be rising day by day as there are a lot of workers usually travelling to their workplace by using public transportation in order to maximize the application of green technology in big city by minimize the production of carbon from the vehicle, to save car park, money and also few other factors that reliable and related. Besides the workers, there is other individual that mostly uses public transportation as their second options when travelling in order to minimize cost of living and saves time due to traffic jam as stated by (Khalid *et al.*, 2014) traffic congestion is one of the significant problems that confront many urban areas in Malaysia.

Mostly of these public transportation operations have been combined under one single authority that will do arrangements, creates, builds, manages and oversees the operations in order to make the system more efficient and effective in moving people to their desired destinations with ease and smoothness of journey makings (Bachok *et al.*, 2015). Workers that usually left from work will be experiencing fatigue body after a long day of working hours. During peak hours the moving train cabin will be experiencing massive crowdedness with all the other train passengers that use train as their daily transportation to work.

Crowdedness creates discomfort because users have to be in prolonged standing posture while riding train for the whole journey to their destination. Besides workaholic workers that use these public transportations, frequent train users will experience discomfort due to the crowd that unpredictable when or where. It was determined that, standing posture will lead to discomfort even faster to be compared in sitting posture in long duration of time.

(Berkovich *et al.*, 2013) past research stated that, most recent research measured passengers per square meter, providing more accurate measurements of discomforts of standing since, unlike load factor, it allows for carriage layouts and ease with which crowding is accommodated. There is a time limitation in total per day for an application of continuous standing mostly for workers as shown in Figure 1.2. In the long term time,

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