UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANTHROPOMETRIC CHARACTERISTICS OF TECHNOLOGY CAMPUS STUDENTS AND THEIR RELATIONSHIP WITH EXISTING BUS STOP BENCH

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

by

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DECLARATION

I hereby, declared this report entitled "Anthropometric Characteristics of Technology Campus Students and Their Relationship with Existing Bus Stop Bench" is the results of my own research except as cited in references.

Signature : ………………………………………….

Author‟s Name : …………………………………………

Date : …………………………………………

APPROVAL

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

……………………………….

(Project Supervisor)

ABSTRACT

The aim of this research is to study and comparing the current bus stop bench design in Technology Campus, UTeM according to anthropometric data collected. Also to re-design the improvement of the bus stop bench in Technology Campus that satisfies the ergonomics characteristics, if necessary, in order to improve productivity, health safety and comfort of the students in the bus stop. The three method need to be used to achieve the objective which of them are gather all the anthropometric data from 30 male and 30 female of students and measure the current bus stop, seconds is to compare the result with current bus stop and analyze the data collected by using RULA analysis and the last but not least is to design new improvements on bus stop using CATIA software. Optimizing the anthropometric data for bus stop design can be complex tasks because it will give affect the student discomfort, such as limited spaces, more than one seat in the same time in the bus stop bench and the number of design parameters which is 20 variables that must be put into consideration. This problem has recently been made much easier to solve as a result of the development of some design principles like design for clearance, design for reach and design for adjustable range. Because of the nature of the selected workstations, the three design principles need use. The significance of the findings is anthropometric data have been collect will be use as the database in Technology Campus for the futher study in ergonomics science.

ABSTRAK

Tujuan kajian ini adalah untuk mengkaji dan membandingkan reka bentuk tempat duduk perhentian bas yang sedia ada berdasarkan data antropometri yang dikumpulkan. Selain itu, untuk reka bentuk semula penambahbaikan tempat duduk perhentian bas Kampus Teknologi yang memenuhi ciri-ciri ergonomik, jika perlu, bagi meningkatkan produktiviti, keselamatan kesihatan dan keselesaan pelajar di perhentian bas. Tiga kaedah perlu digunakan untuk mencapai objektif dimana pengumpulan semua data antropometri daripada 30 orang pelajar lelaki dan 30 orang pelajar perempuan serta mengukur perhentian bas semasa, kedua ialah untuk membandingkan hasil yang diperolehi dengan perhentian bas semasa dan menganalisis data yang dikumpul dengan menggunakan analisis RULA dan akhir sekali adalah untuk reka bentuk peningkatan baru di perhentian bas menggunakan perisian CATIA. Mengoptimumkan data antropometri bagi reka bentuk perhentian bas boleh menjadi tugas yang kompleks kerana ia akan menjejaskan ketidakselesaan pelajar, seperti tempat terhad, lebih daripada satu orang duduk dalam masa yang sama di bangku perhentian bas dan bilangan parameter reka bentuk ialah sebanyak 20 pembolehubah yang perlu dimasukkan sebagai pertimbangan. Masalah ini telah dibuat serta lebih mudah untuk menyelesaikan akibat daripada pembangunan beberapa prinsip reka bentuk seperti reka bentuk untuk pelepasan, reka bentuk untuk jangkauan dan reka bentuk untuk pelbagai laras. Oleh kerana sifat normal kerja dipilih, tiga prinsip reka bentuk perlu digunakan. Kepentingan penemuan adalah data antropometri telah mengumpul akan digunakan sebagai pangkalan data Kampus Teknologi untuk kajian lanjut dalam bidang sains ergonomik.

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Firstly, Alhamdulillah thanks to Almighty Allah S.W.T for giving me the opportunity and spirit to accomplish this project successfully. From the beginning of this project, I have an opportunity to learn and get extra knowledge about this project especially knowledge that related to design for ergonomics workstation.

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DEDICATION

To my beloved father and mother:

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Joriah Binti Hashim

To all my siblings:

Norfarizah Binti Abdul Hamid

Nornadiah Binti Abdul Hamid

Abdul Muqsit Bin Abdul Hamid

To my supervisor and advisor:

Mr. Khairum Bin Hamzah

Mr. Mohd Fa'iz Bin Wahid

Mr. Mohd Qadafie bin Ibrahim

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CATIA	-	Computer Aided Three-dimensional Interactive Application
CAD	-	Computer Aided Design
FTK	-	Fakulti Teknologi Kejuruteraan
MSI	-	Musculoskeletal Injury
MSDs	-	Musculoskeletal Disorders
UTeM	-	Universiti Teknikal Malaysia Melaka
RULA	-	Rapid Upper Limb Assessment
SD	-	Standard Deviation
CV	-	Coefficient of Variance
p	-	Percentile
μ	-	Mean or Average

CHAPTER 1

INTRODUCTION

1.1 Background of Study

This project concerns the ergonomics or human factors of a workplace environment to increase productivity and decrease injury. To study the current bus stop in Technology Campus UTeM (Universiti Teknikal Malaysia Melaka) on whether they comply with the principles of ergonomics, the most important characteristic is anthropometric measurements. Ergonomics is the science of fitting the workplace conditions and job demands to the capabilities of the working population (OSHA).

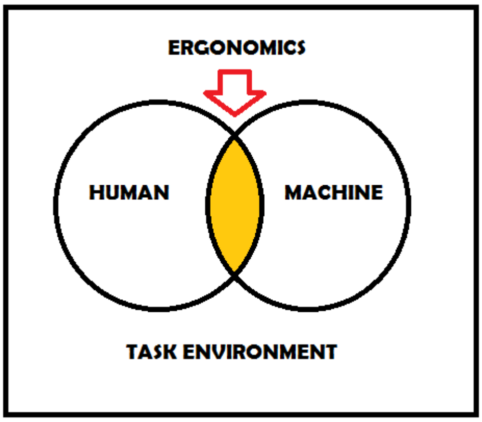

Figure 1.1: The ergonomics interface for human and machine at a work/task environment.

Commonly, ergonomics is applied to humans and the tools, equipment, and work methods needed to complete a task. In this case, it refers to an individual using the bus stop for prolonged periods of time. Anthropometry is the study of the physical dimensional measurements of humans (Nico *et al*., 2004). Anthropometric data consist of the measurements of a Technology Campus student"s body. Appropriate use of anthropometry in design can improve well-being, health, comfort, and safety. This information can also be used to help design an ergonomic bus stop and can be used for further study about ergonomics science.

1.2 Problem Statement

Anthropometric data can improve the design of things and spaces such as a bus stop designed for use by Technology Campus UTeM students. An improved design can increase satisfaction when it comes to comfort, efficiency, usage, and safety. Application of anthropometry in design can help prevent musculoskeletal disorders such as lower back and neck pain. However, there is a lack of ergonomics awareness in Malaysia, especially in facilities at UTeM where the ergonomics principle is not obeyed. In Technology Campus UTeM, no anthropometric data of the students have been collected. Moreover, the design structure of the bus stop in Technology Campus does not follow the anthropometric dimensions among students. Using a poorly designed bus stop bench, especially one that fails to account for the anthropometric characteristics of its users, can have a negative influence on human health.

1.3 Objective

This project focuses on the following objectives:

(a) To collect anthropometric data appropriate with ergonomics study from a sample of Technology Campus students.
(b) To study and compare the current bus stop bench design according to anthropometric data collected.
(c) To suggest an improvement on the design of the bus stop bench for Technology Campus student that satisfies the ergonomics characteristics.

1.4 Scope of Work

This project will focus on identifying the appropriate anthropometric measurements among Technology Campus UTeM students. The anthropometric data collected from the sample will be enough to represent all students in Technology Campus UTeM. In order to ensure the success of this project, a total sample size of 60 students will be taken. This project will also look into risk factors based on students‟ experiences when using the bus stop facilities at Technology Campus UTeM. An improved workplace design will be compared to the current design of the bus stop in Technology Campus UTeM by using RULA analysis to make sure that it satisfies the ergonomics principle.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter covers a fully-referenced review of the relevant literature. This chapter provides a review of the concept based on previous data from journals and books. A thorough review of all fields in the case study is distributed in this chapter. The case study conducted comprises of general definitions, historical data, previous case studies, and white papers done by experts. This chapter will introduce the planning and implementation of the whole project from its methodology to the end of final year project II. It also acts as a citation point to maintain the result and discussion in final year project II. The literature review of this case study can be used as a reference point to support the result based on previous data.

2.1 Ergonomics

2.1.1 Overview of Ergonomics

Ergonomics is an applied science concerned with the characteristics of people when it comes to designing and arranging the things that they use in order to use those things easily, effectively, and safely. It is also called human engineering or human factors engineering. It is a combination of two Greek words: ergo meaning work and nomos meaning law. It involves the study of the human response to exposure in the work environment; the interaction between humans and the tools, equipment, and work methods needed to complete a task; and fitting the task to the employee (Cynthia L Roth, 2012). According to Bridger (2003), human factors is the study of the interaction between people and machines and the elements that affect the interaction. Its main focus is to improve the performance of systems by:

(a) Designing the user-interface to make it more compatible with the task and the user. This makes it easier to use and more resistant to errors that people are known to make.
(b) Changing the work environment to make it safer and more appropriate for the task.
(c) Changing the task to make it more compatible with user characteristics.
(d) Changing the way work is organised to fulfil people‟s psychological and social needs.

Figure 2.1: An example of ergonomics designed bus stop in Dubai (2009).

2.1.2 Application of Ergonomics

The purpose of ergonomics is to enable a work system to function better by improving the interactions between users and machines (Bridger, 2003). Better functioning can be defined more closely as more output from fewer inputs to the system (greater productivity) or increased reliability and efficiency (a lower probability of inappropriate interactions between the system components). The precise definition of better functioning depends on the context. Whatever definition is used should, however, be made at the level of the total work system and not just on one of the components. Improved machine performance that increases the psychological or physical stress on workers or damages the local environment would not constitute improved performance of the total work system or better attainment of its goals. Workstation redesign to make workers more comfortable is an incorrect reason for the application of ergonomics if it is done superficially, for its own sake, and not to improve some aspect of the functioning of the total work system (such as reduced absenteeism and fewer accidents due to better working conditions).

According to Bridger (2003), there are two ways in which ergonomics impacts upon systems design in practice. Firstly, many ergonomists work in research organisations or universities and carry out basic research to discover the characteristics of people that need to be allowed for in design. This research often leads, directly or indirectly, to the drafting of standards, legislation, and design guidelines. Secondly, many ergonomists work in a consultancy capacity either privately or in an organisation. They work as part of a design team and contribute their knowledge to the design of the human–machine interactions in work systems. This often involves the application of standards guidelines and knowledge to specify particular characteristics of the system.

Real work systems are arrangement in sequent. This means that the main task is made up of sub-tasks (the next level down) and is governed by higher-level constraints that manifest as style of supervision, type of work organisation, working hours and shift work, etc. (Bridger 2003). If we want to optimise a task in practice, we rarely redesign the task itself. We either change or reorganise the elements of the task (at the next level down) or we change the higher-level variables. For example, to optimise a data entry task, we might look at the style of human–computer dialogue that has been chosen. We might find that there are aspects of the dialogue that cause errors to be transmitted to the system (e.g. when the operator mistakenly reverses two numbers in a code, the system recognises it as a different code rather than rejecting it). Alternatively, we might find there are insufficient rest periods or that most errors occur during the night shift.

To optimise a task, we first have to identify the level of the task itself (e.g. a repetitive manual handling task), the next level down (the weight and characteristics of the load and the container), and the next level up (the workload and work organisation). To optimise the task we can either redesign it from the bottom up (e.g. use lighter containers and stabilise the load) or from the top down (e.g. introduce job rotation or more rest periods) or both. At the same time, we can look at extraneous or environmental factors at the level of the task but external to it; factors that also degrade performance (e.g. slippery floors in the lifting example or bad lighting and stuffy air in the data entry example).

Once we make the redesigned task and evaluate the improvements to task performance, we then check it over time to find the improvements in system performance.

2.1.3 Musculoskeletal Disorder (MSD)

MSDs or musculoskeletal disorders are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and the nervous system. They can influence all tissues, intercept the nerves and tendon sheaths, and most commonly implicate the arms and back (US Department of Labor, 2000).

The physical stresses that can contribute to or cause MSDs are called risk factors. Product-related MSDs occur when the risk factors, which relate to musculoskeletal system pathology such as force, repetition, awkward postures, static postures, vibration, contact stress, and extreme temperatures, are not minimized or eliminated. Examples of MSDs include carpal tunnel syndrome, epicondylitis, herniated spinal discs, tarsal tunnel syndrome, tendinitis, rotator cuff tendonitis, DeQuervain"s disease, trigger finger, and low back pain. According to America & Mcculloch (2009), musculoskeletal disorders are also known as cumulative trauma disorders, repetitive strain injury, and occupational overuse syndrome. They describe a set of pathological conditions that reduce the ordinary function of the soft tissue of the musculoskeletal system, such as tendons, muscles, cartilage, ligaments, and nerves. The initial symptoms of MSDs may include fatigue, discomfort, and pain. As tissue damage worsens, other symptoms, such as weakness, numbness, or restricted motion, may also appear. Usually, in a single incident trauma, traumatic effects occur instantaneously (for example, cuts, bruises, lacerations, falls, etc) while in cumulative trauma, the effects develop over time (for example, back pain, carpal tunnel syndrome, eye strain, etc).

2.1.4 Risk Factors

Bridger (2003) mentions that there are five main risk factors for musculoskeletal disorders, namely force, awkward postures, repetition, duration of task, and contact stress. The risk factors involved while using the bus stop is contact stress and awkward postures.

2.1.4.1 Contact Stress

According to Work Safe BC (2004), regions in the body where the tendons, nerves, blood vessels, and bones are located close to the surface are the most sensitive to injury. Exposure to contact stress can influence the risk of injury to blood vessels, nerves, and soft tissue in the region of exposure. Contact stress concentrate with increasing force and decreasing contact surface area. These regions include the sides and back of fingers as well as the sides and centre of the palm, wrist, elbow, shoulder, hip, and knee.

Bus stop users may be exposed to contact stress while sitting or standing. If there are any jobs at the bus stop that have contact stress risk factors, these jobs must be assessed for risk of MSI (musculoskeletal injury). Based on Eastman Kodak Company (2004), contact stress risk factors include the following:

(a) Kneeling on a hard floor or against sharp edges
(b) Leaning against a hard work surface or edge
(c) Holding tools that end within the hand
(d) Handling objects with grooved, sharp, or uneven edges, or objects made of hard material that presses on the hand
(e) Holding down palm-type control buttons or pressing buttons frequently
(f) Using power tool triggers with sharp edges
(g) Sitting in chairs that are too high (i.e. the worker‟s legs are angled downward) without adequate foot support.

2.1.4.1 Awkward Postures

Awkward postures refer to positions of the body (limbs, joints, back) that reverse from the neutral position while performing job tasks (IOWA State University, 2013). Repeatedly performing tasks in such positions poses increased stress on the joints and/or spinal discs. As mentioned before, muscles do not work as efficiently in awkward postures and the muscles must exert more physical effort to accomplish the task. This increased force contributes to muscle-tendon fatigue and strain. When a person is performing tasks that involve long reaches, they are exposed to extreme awkward postures, meaning the positions of their shoulders, elbows and/or back deviate significantly from more neutral positions. Based on The University of CHICAGO (2011), awkward postures increase the total exertion required to complete a job:

(a) The body must apply force to joints and muscles to deviate body parts from the neutral position
(b) The further the deviation, the more force that is applied
(c) The further the deviation, the less force you are able to apply to your tool

(d) Working in awkward postures will cause you to fatigue faster

Figure 2.2: The postures that deviate significantly from neutral positions (Janet Horvath, 2012).