

HUMAN ANALYSIS AND ERGONOMICS OF AN
ELECTRIC BICYCLE SEATING POSTURE

IFFAH NAFISAH BINTI IBRAHIM
B051210237

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2015



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**HUMAN ANALYSIS AND ERGONOMICS OF AN ELECTRIC
BICYCLE SEATING POSTURE**

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

by

IFFAH NAFISAH BINTI IBRAHIM

B051210237

910702146446

FACULTY OF MANUFACTURING ENGINEERING

2015

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Human Analysis and Ergonomics of An Electric Bicycle Seating Posture

SESI PENGAJIAN: 2014/2015 Semester 2

Saya Iffah Nafisah binti Ibrahim

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:

B-8-13 PPR Bukit Jalil, Jalan Bukit Jalil,

Taman Bukit Jalil Indah,

58000 Kuala Lumpur, WPKL

Cop Rasmi:

Tarikh: _____

Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “PSM Title” 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 Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory is as follow:

.....

(Prof Dr. Md Dan bin Palil)

ABSTRAK

Faktor manusia digunakan sebagai peranan yang penting dalam aplikasi reka bentuk ergonomic. Ergonomik ialah kajian tentang hubungan antara manusia dan persekitaran kerja mereka. Bahaya ergonomik merujuk kepada keadaan di tempat kerja yang menimbulkan risiko kecederaan kepada sistem muskuloskeletal pekerja. Aplikasi ergonomik kejayaan diukur dengan peningkatan produktiviti, kecekapan, keselamatan, penerimaan reka bentuk sistem paduan dan titik yang paling penting adalah lebih baik kualiti hidup manusia. Kajian ini mengambil tempat di G-Wheel Revolution Manufacturing Sdn. Bhd yang terletak di Dengkil, Selangor, Malaysia. Terdapat lapan model basikal elektrik yang dihasilkan oleh syarikat ini, iaitu Lasak, Iris, Musytari, Neutron, Nucleas, Revo-X dan Revo-Z. Kesemua model mempunyai pengkhususan masing-masing. Model Musytari dipilih sebagai skop kajian. Fokus utama kajian ini adalah untuk mengkaji dan menganalisis kerusi pelumba untuk basikal elektrik. Dalam kajian ini, diharapkan untuk menjelaskan dan memberi kefahaman yang lebih baik tentang reka bentuk ergonomic kerusi pelumba untuk basikal elektrik. Oleh itu kajian ini secara tidak langsung memberi manfaat untuk basikal elektrik yang dihasilkan oleh G-Wheel Manufacturing untuk analisis ergonomik reka bentuk mereka.

ABSTRACT

Human factor act as an important role in an ergonomic design application. Ergonomics is the study of the relationship between people and their work environments. Ergonomic hazards refer to workplace conditions that pose the risk of injury to the musculoskeletal system of the worker. A success ergonomics application is measured by improved productivity, efficiency, safety, acceptance of the resultant system design and the most significant point is improved quality of human life. This study takes place at G-Wheel Revolution Manufacturing Sdn. Bhd which located at Dengkil, Selangor, Malaysia. There are eight models of electric bicycle which produced by this company, where there were Lasak, Iris, Musytari, Neutron, Nucleas, Revo-X and Revo-Z. All the models have their own specialization. For this Musytari range is the scope of study. The main focus of this study is to study and analyze the rider seat for the Electric Bicycle. In this study, it is expected to explain and give better understanding about the ergonomic rider seat design for electric bicycle. Hence this study indirectly gives benefit for electric bicycle which produced by G-Wheel Manufacturing for their design ergonomics analysis.

DEDICATION

To my beloved parents, sibling and family, thank you for your support all this time. I am much appreciated that. To my supervisor, Prof Md Dan bin Md Palil, thank you for always guiding me throughout the project.

ACKNOWLEDGEMENT

I would like to thanks UTeM for accepting me as one of your student in Faculty of Manufacturing Engineering. Also to all my lecturers that had teach me since in the first year of degree until this final year here. Thank you everyone.

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CAD	-	Computer-Aided Design
ELSA	-	External LSA
H	-	Greater Trochanter
HE	-	Head Extension
IC	-	Caudal-most point on iliac crest
IGS	-	Interactive Geometry Software
L_1	-	First Lumbar Process
LSA	-	Latent Semantic Analysis
MSD	-	Musculoskeletal Disorder
PT	-	Pelvic Tilt
RULA	-	Rapid Upper Limb Assessment
S	-	Acromial Shelf
S_1	-	First Sacral Process
T	-	Tragus
TA	-	Trunk Angle

CHAPTER 1

INTRODUCTION

1.1 Background

Ergonomics is the application of scientific principles, methods, and data drawn from a variety of disciplines to the development of engineering system, in which, people play a significant role. Among the basic disciplines are psychology, applied physical anthropometry and industrial system. Nowadays ergonomic factor is treat as one of the main characteristic in designing any product. Human factor act as an important role in ergonomic application. A success ergonomics application is measured by improved productivity, efficiency, safety, acceptance of the resultant system design and the most significant point is improved quality of human life. The ergonomic factor is crucial for a consumer product, which it will be used by human being. Sports equipment also used ergonomic consideration in their designing stage. It is a useful way of how to examining human with sport equipment.

In this project, ergonomic factor will be discussed about its application with a bicycle seat. Type of bicycle used in this project is an elctronic bicycle. A bicycle is widely used by any age such as, it is used by a scholar to go to school, a worker to go to their workplace and old age people used bicycle for their physiotherapy activity. Hence bicycle keep their riders fit and healthy. It is important to keep in mind the diverse population using the bicycle because the design should match the anthropometric data to be ergonomic. Also it is notable to keep a check on the production costs of the bicycle because it is generally considered a economic product. (Jirapure, Andure, and Mohod, 2012)

- i. To study and investigate the standard design of the bicycle seat for electric bicycle.
- ii. To test and analyze the design of the existing electric bicycle.
- iii. To suggest new design and recommend the comfort of the seat for the electric bicycle which include the ergonomic cyclist posture.

1.4 Scope and Findings

This study focused on the human analysis and ergonomics for the cyclist seat of the electric bicycle. The limitation of this study is, it will only be focused on electric bicycle which manufactured by G-Wheel Manufacturing. There are few priority aspects that need to be considered. Since this study is about the ergonomics design hence requirement, principle and problem occur from the user need to be studied and come out any solution to provide an optimum ergonomics design. In addition, anthropometric measurement, working posture, time study, muscle fatigue, musculoskeletal disorder (MSD), RULA analysis and productivity aspects must be included together.

1.5 Thesis Structure

Chapter One briefly described the importance and urgent need for ergonomic design in any product which are consumed by human to gives comfort and safety which, this will improves productivity and quality of the output task.

Chapter Two studies the literature relevant to ergonomics design standards and ergonomics posture. Includes the anthropometry measurement, working posture and RULA analysis.

Chapter Three is about the methodology for this study. For RULA analysis there must be some data that need to be gathered first before proceed. The data

needed was the anthropometry measurement of possible user. Also the few design concept of bicycle seat need for comparison.

Chapter Four will be discussed about the result and analysis gain by using methods on Chapter Three. In this chapter we can determine whether the objective of this study is achievable or not. The redesigning procedure is depends on the result achieved.

Chapter Five is conclusion and future work, contribution to knowledge and suggestions for futher work. An overall discussion is provided and conclusion are drawn.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter introduces the background and definition of ergonomics and anthropometry. The application of anthropometry for bicycle seat design is discussed and the data sources are extracted from journal, research publication and proceeding papers. The ergonomics of bicycle seat design can be divided into a two sections, which, the seats and primary controls. This two section will be discussed in detail with relation to ergonomics design principle and standard.

2.2 Definition of Ergonomics

The word “Ergonomics” is derived from the Greek work “ergon” mean work and “nomos” mean law, which altogether mean “the law of work” (**Dul & Weerdmeester, 1954**). According to British Dictionary “Ergonomics” means the study of the relation between workers and their environment. The environment refers to the surrounding environments of human workplaces. For this study the surrounding environments are the seat design and the primary controls.

The objective of ergonomics design is that all human-made tools, devices, equipments, machine, and environments should advance, directly or indirectly, the safety, well-being, and the performance of human beings. The major task is to generate a tolerable working condition that do not pose known dangers to human life or health. Hence, an optimal ergonomics design is achievable, which the design

could be adapted to human characteristic, capabilities, desires, physical, mental, and human social well-being.

To achieve an optimum ergonomics design, the use of models gives the designer a very detailed view to understand human physiology while cooperating with working equipment. Models means the digital human modelling which, it can be considered a digital representative of human inserted into a simulation or virtual environment to facilitate prediction of safety or performanc (**Duffy, 2009**). The data that represent digital human modelling is called anthropometry. Anthropometric information describes the dimensions of the human body, usually through the use of bony landmarks to which height, breadths, depths, distances, circumferences and curvatures are measured.

2.3 The Application of Anthropometry for Bicycle Design

Anthropometry can be defined as the measurement of the human body. The anthropometry word comes from the Greek words „anthropos“ (man) and „metron“ (measure). Anthropometry can be considered as the basic ergonomics practices. Based on (Henri, Cristiaans, and Angus, 1997) the anthropometry data for bicycle is:

- i. Body length and weight
- ii. Trunk length (distance from sitting area to the supra sternal, the central hollow between the collar bones).
- iii. Shoulder and breadth.
- iv. Grip reach (vertical distance from the acromial, the uppermost point on the lateral edge of the right shoulder, to the centre of 25mm cylinder held in clenched right hand).
- v. Upper leg length (horizontal distance from foremost point on the kneecap to the rearmost point of the buttock (sacrum) while seating).
- vi. Crotch height (vertical distance from the floor to the distal part of the interior ramus of the pubis bone).
- vii. Distance between ischial tuberosities (pelvic bones).

2.4 Importance of Ergonomics Design

Each design engineer has their own creativity when designing any product in the design stage. Ergonomic factor must be include in any form of engineering design. The human anthropometry is an essential criteria in any activity productivity. As example, most of us work while walking or standing or while sitting on a chair or stool, but we often kneel and reach , bend, or twist our bodies. Some work is done with the body lying supine or prone for instance, in low-seam mining and repair work. In any type of workstation, it must be suitably designed to provide comfort for the user. According to (Jirapure, Andure, and Mohod, 2012) there are five level of equipement/machinery ergonomics design need to be considered, there are:

- i. It must be safe while in contact with human beings.
- ii. It must not produce harmful effects in human beings over longer periods.
- iii. It must be physically comfortable, which it should not require excessive efforts on both physical and mental or visual.
- iv. It should provide mental satisfaction – gives pleasure to human being.
- v. It must create an essential factor of social profitability and limitations.

2.5 Ergonomics of Bicycle Design

Bicycle is one type of vehicle that tranport human from one place to another place. It is a vehicle with a tubular metal frame mounted on two spoked wheels, one behind the other. The rider sits on a saddle propels the vehicle by means of pedals that drive the rear wheel through chain and steers with handlebars on the front wheel (American Psychological Association (APA), 2012). Moreover, bicycle not only being used as a vehicle it can also be a sports equipment, which provides health improvement to its rider. Each bicycle is design to gives comfort for its rider. According to (Henri, Cristiaans, and Angus, 1997) there are many factor that influence the comfortness when riding a bicycle, which:

- i. Environmental condition: temperature, wind and rolling resistance.