



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)**

# **ENVIRONMENTAL ERGONOMICS AT HIGHWAY TOLL BOOTH**

Thesis submitted in accordance with the partial requirements of the  
Universiti Teknikal Malaysia Melaka (UTeM) for the  
Bachelor of Manufacturing Engineering (Process and System)

By

**OOI ZHUEN HONG**

Faculty of Manufacturing Engineering  
MAY 2007

**ENVIRONMENTAL ERGONOMICS AT HIGHWAY  
TOLL BOOTH**

**OOI ZHUEN HONG**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**BORANG PENGESAHAN STATUS TESIS\***

JUDUL: ENVIRONMENTAL ERGONOMICS AT HIGHWAY TOLL BOOTH

SESI PENGAJIAN : 2006/ 2007

Saya \_\_\_\_\_ OOI ZHUEN HONG

**(HURUF BESAR)**

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka(UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. \*\*Sila tandakan ( )

SULIT

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

TERHAD

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

TIDAK TERHAD

Disahkan oleh:

\_\_\_\_\_  
(TANDATANGAN PENULIS)

\_\_\_\_\_  
(TANDATANGAN PENYELIA)

Alamat Tetap:  
76, LORONG NANGKA 3,  
TAMAN DESA DAMAI,  
14000 BKT MERTAJAM, P. PINANG

Cop Rasmi:

Tarikh: 09/05/2007

Tarikh: \_\_\_\_\_

\* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).  
\*\* Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

## **APPROVAL**

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

.....

Supervisor

(Official Stamp & Date)

## DECLARATION

I hereby, declare this thesis entitled “Environmental Ergonomics  
At Highway Toll Booth” is the results of  
my own research except as cited in the reference.

Signature : .....  
Author's Name : .....  
Date : .....

## **ABSTRACT**

The main purpose of carrying out this project is to investigate how the ergonomic system is used in the different area including the factory, the workshop or others. So from the project, it will increase students' knowledge on the environmental ergonomic or formerly known as human factors. The topic that has been chosen by this final year project for the discussion is the ergonomic system in the toll booth in the highway. The highway toll booth that has been chose is Juru highway toll booth, situated at Penang. In order to identify the problem occurred among the workers during carrying out their work, questionnaire will be conducted and the problems that may be faced by the worker are highlighted among the workers. Lastly, discussion will be made and some of the recommendations will be highlighted in the end of this report.

# **DEDICATION**

*For my beloved mother and father.*

## **ACKNOWLEDGMENTS**

I would like to offer thanks and deepest gratitude from the bottom of my heart for all the support, encouragement and inspirations I obtained through out the duration of this project. The help rendered to me priceless, be it from the smallest of its kind to the largest. They include;

My supervising lecturer, Mr. Mohd Amri Bin Sulaiman of which we had a good working relationship, and who offered tremendous help and encouragement,

My family, who inspired me weather through the storm and carry on,

My beloved, who kept me through it all,

All the staff PLUS Expressways Berhad (PEB), specialties is Miss Khadijah Jamal and Miss Tan Mee Tian (Sr. Operation Executive N3) and Mr. Mohd Zainuddin Yaacob (Operation Assistant N3).

My friends and peers who are good companions in times of need.



# TABLE OF CONTENTS

a.	Approval	i
b.	Declaration	ii
c.	Abstract	iii
d.	Dedication	iv
e.	Acknowledgement	v
f.	Table of Contents	vi
g.	List of Figures	x
h.	List of Tables	xii
i.	List of Appendixes	xiv
<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Background	1
1.1.1	Applying ergonomics to the workplace	2
1.1.2	Objectives	2
1.1.3	Scopes	2
1.2	Definition	4
1.2.1	Ergonomics	4
1.2.2	Work Posture	5
1.3	Problem Statement	7
1.3.1	The working area	7
1.3.2	The layout of the Highway Toll Booth	7
1.3.3	Pain at work	8
1.3.4	Uncomfortable Toll Booth Environment	8
1.3.5	Design of the Toll Booth	9
1.4	Outline of Study	9

<b>2</b>	<b>LITERATURES REVIEW</b>	<b>11</b>
2.1	Overview	11
2.2	Definitions and General Background	11
2.3	Workplace Design	13
2.4.2	How does it affect people?	14
2.4.3	How about if there is layout and design problems in your workplace?	14
2.4.3.1	Physical layout:	14
2.4.3.2	Air and temperature:	15
2.4.3.3	Noise:	16
2.4.3.4	Chemicals:	16
2.4.3.5	Lighting:	16
2.4.3.6	Psychological factors:	16
2.4.4	What needs to be done?	17
2.4.5	Practical solutions	17
2.4.6	Layout and design considerations in the office	18
2.5	Five elements for a changing workplace	19
2.5.1	Office culture	20
2.5.2	Corporate identity	21
2.5.3	Organizational structure	21
2.5.4	Technology	22
2.5.4	Flexibility	22
2.6	Typical Ergonomic Injuries	24
2.7	Toll Booth Design	25
2.8	Repetitive Work	25
2.9	Pain at work.	26
2.10	About PLUS	28
2.11	Background History of PLUS	28
2.12	About the NSE	29
2.13	NSE Construction	30

2.14	NSE Toll Fare Systems	32
2.14.1	Closed toll systems	32
2.14.2	Open toll systems	32
2.15	Sitting Work – Guidelines	33
<b>3</b>	<b>METHODOLOGY</b>	<b>36</b>
3.1	Overview	36
3.2	Design of the Methodology	37
3.3	Type of the methodology	40
3.3.1	Observation	40
3.3.2	Interview	40
3.3.3	Analysis	41
3.3.4	Gain Information from the company	41
3.3.5	Research	41
3.3.6	Questionnaires	42
<b>4</b>	<b>RESULTS</b>	<b>43</b>
4.1	Overview	43
4.2	Dimension and layout of toll booth	43
4.3	Data measurement for environmental toll booth	44
4.3.1	Data of Sound Level of the Toll Booth	45
4.3.2	Data of Illumination of the Toll Booth	46
4.3.3	Data of Temperature of the Toll Booth	47
4.3.4	Data of Air Quality of the Toll Booth	48
4.4	Interview and questionnaire assessment	49
4.4.1	Health Problem for worker faced	49
4.4.2	Negative Psychology Effects for worker	50
4.4.3	Comfortable of workplace environment	51
4.4.4	Noisy	52
4.4.5	Dusty	53

4.4.6	Uncomfortable temperature of working environment	54
4.4.7	Work at Pain	55
<b>5</b>	<b>DISCUSSIONS</b>	<b>56</b>
5.1	Overview	56
5.2	Data Explanation	56
5.2.1	Discuss about dimension and layout of toll booth	56
5.2.2	Discuss about interview and questionnaire assessment	57
5.2.3	Discuss about environmental data	59
5.3	Comparison with Standard Guideline	60
5.3.1	Illumination Comparison	60
5.3.2	Air Quality Comparison	61
5.3.3	Sound Level / Noise Level Comparison	62
5.3.4	Temperature Comparison	63
5.4	<b>Recommendation</b>	64
<b>6</b>	<b>CONCLUSION</b>	<b>68</b>
	<b>REFERENCES</b>	<b>69</b>

## List of Figures

1.1	The Juru Highway Toll	3
1.2	Well and poorly adjusted seats	6
1.3	Pain at seating work	8
1.4	Outline of the study	10
2.1	The relationship of ergonomic between human, environment and machine	12
2.2	seating and posture for typical office tasks	35
3.1	Flow Chart above show the methodology of the project	39
4.1	The Dimension And Layout Of Toll Booth	43
4.2	Number of workers reported experiencing pain or discomfort related to work	49
4.3	Number of workers experiencing work pressure or mental stress	50
4.4	Number of workers agrees the comfortable of workplace environment	51
4.5	Number of workers agrees the noisy at workplace environment	52

4.6	Number of workers agrees the Dusty of workplace environment	53
4.7	Number of workers agrees the temperature of workplace environment is uncomfortable	54
4.8	Number of workers experiencing pains or discomfort for each body part	55
5.1	Area make worker uncomfortable	57
5.2	Comparison between the current design and the recommended design	64
5.3	Tesco install air curtain on top of the door to reduce dusty	65
5.4	Tesco install plastic curtain on top of the door to reduce temperature loss	66
5.5	Layer of the Sound Enclosure	67
5.6	Soundproof Cushions	67

## List of Tables

4.1	The Dimension Of Toll Booth	44
4.2	The data of Sound Level of the Toll Booth	45
4.3	The data of Illumination of the Toll Booth	46
4.4	The data of Temperature of the Toll Booth	47
4.5	The data of Air Quality of the Toll Booth	48
4.6	Number of workers reported experiencing pain or discomfort related to work	49
4.7	Number of workers experiencing work pressure or mental stress	50
4.8	Number of workers agrees the comfortable of workplace environment	51
4.9	Number of workers agrees the noisy at workplace environment	52
4.10	Number of workers agrees the Dusty of workplace environment	53
4.11	Number of workers agrees the temperature of workplace environment is uncomfortable	54
4.12	Number of workers experiencing pains or discomfort for each body part	55
5.1	Standard Guideline for Illumination. (Source: Guideline Heavy Duty Light Meter (Extech Instruments, Model 407026), this final year project used)	60
5.2	List of Air Contaminants and the Maximum Limits (Source: code of practice on air quality from department of occupational safety and health ministry of human resources Malaysia 2005)	61

5.3	Safe noise level recommended by OSHA (Source: The Occupational Safety and Health Administration)	62
5.4	Heat Stress Index. Courtesy United States Fire Administration	63



## **List of Appendixes**

- A. Gant Chart
- B. Basic Workstation Checklist
- C. Drawing of Toll booth Dimension
- D. Questionnaires
- E. Photo
- F. Permission of Headquarters PLUS Expressways Berhad
- G. Working Permission of Juru Highway Toll
- H. Anthropometry Data of workers
- I. Data Collected

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Background**

Ergonomics is the study of work in relation to the environment in which it is performed (the workplace) and those who perform it (workers). It is used to determine how the workplace can be designed or adapted to the worker in order to prevent a variety of health problems and to increase efficiency; in other words, to make the job fit the worker, instead of forcing the worker to conform to the job. One simple example is raising the height of a work table so that the worker does not have to bend down unnecessarily to reach his or her work. A specialist in ergonomics, called an ergonomist, studies the relation between the worker, the workplace and the job design.

There are many obvious benefits of applying ergonomics in the workplace. For the worker, the benefits are healthier and safer working conditions. For the employer, the most obvious benefit is increased productivity.

### **1.1.1 Applying ergonomics to the workplace :**

- Reduces the potential for accidents and incidents;
- Reduces the potential for injury and ill health; and improves performance and quality.

### **1.1.2 Objectives**

- To observe and identify the environmental ergonomics factors that may have led to the occurrence of the problems at highway toll booth.
- To find out the data and analyse them to verify the comments from the toll booth workers.
- To bring out some solutions or recommendations that will be able to minimize the problems.
- To expose students to the ergonomic factors that will be always applied in the working area.

### **1.1.3 Scopes**

In this final year project the scope will be cover the below criterion. To collect the data by make a questionnaire and interview section among the toll workers. Besides that, do the observation through video recording or camera photo to verify the questionnaire results. In addition, apply ergonomics equipments to measure air quality, sound level, temperature and illumination at the toll booth. Finally, come out

with some recommendations to make the current toll booth more comfortable for the workers. This final year project stresses on the research on the manual operations that are carried out at the toll booth. These manual operations do not include operations that use Smart Tag system and Touch n Go system. For this final year project, the places will be researching is Juru Highway toll booth. In Juru highway, these are five toll booths on both sides of the highway. Three of the toll booths on each side are manually operated while the other two is automated.



Figure 1.1 shows the Juru Highway Toll

## **1.2 Definition**

### **1.2.1 Ergonomics**

Ergonomics or human factor is a multidisciplinary activity striving information on people's capacities and capabilities for use in designing job, products workplaces, and equipment. As concerns about productivity, employees job satisfaction, and health and safety in the workplace have increased, interest in ergonomic has also increased. Many schools with an industrial engineering or a psychology department now include a course in human factors, and industrial hygienists are expected to know some ergonomics principles for certification.

Medical professional are recognizing the value of ergonomic analyses of jobs to assist them in the rehabilitation of people returning to work after illness. In addition, with increasing industrialization of developing countries, there is more demand for design guidelines that recognize the capabilities of people in manufacturing systems.

The probable benefits of well-designed jobs, equipment, and workplaces are improved productivity, safety, health and increased satisfaction of employees. Removing unnecessary effort from jobs or reducing demands by improving the way in which information is transferred between people or between product and people (inspection) allows for greater productivity and, ultimately, higher profitability.

The term's ergonomics and human factors are often used synonymously. Both describe the interaction between the operator and the job demand, and both are

concerned with trying to reduce unnecessary stress in the workplace. Ergonomics, however, has traditionally focused on how works affect people. This focus includes studies of their physiological responses to physically demanding work; environment's stress such as heat, noise, and illumination; complex psychomotor assembly tasks; and visual-monitoring task. The emphasis has been on ways to reduce fatigue by designing task within people's work capacities. In contrast, human factors, as practiced in the United States, have traditionally been more interested in the man-machine interface, or human engineering. It has focused on people's behaviour as they interact with equipment, workplaces, and their environment, as well as on human size and strength capabilities relative to workplace and equipment design. The emphasis of human factor is often on design that reduces the potential for human error.

### **1.2.2 Work Posture**

Work posture in the workplace is determined by the interaction of many factors, including workstation layout (heights of table and chair, reached of the worker to vehicles), equipment design (position of keyboard, location of visual displays), and work methods (sequence of work tasks, work technique). In addition, body-size characteristics of a worker interact with the entire workplace factor to determine specific posture used to perform a job.

To the greatest extent possible, jobs should be designed to accommodate a neutral posture. For a standing worker, this means that the trunk and neck should be nearly

vertical, with minimal twisting or bending (forward, backward, and sideways). Furthermore, both arms should hang comfortably down from the shoulders, roughly parallel to the trunk.

Awkward postures occur when there is mismatch between a worker's body size and the job requirements. If awkward postures are assumed repetitively or for long prolonged periods, increased rates of fatigue, discomfort, and injury may occur, resulting in reduced productivity and higher costs.

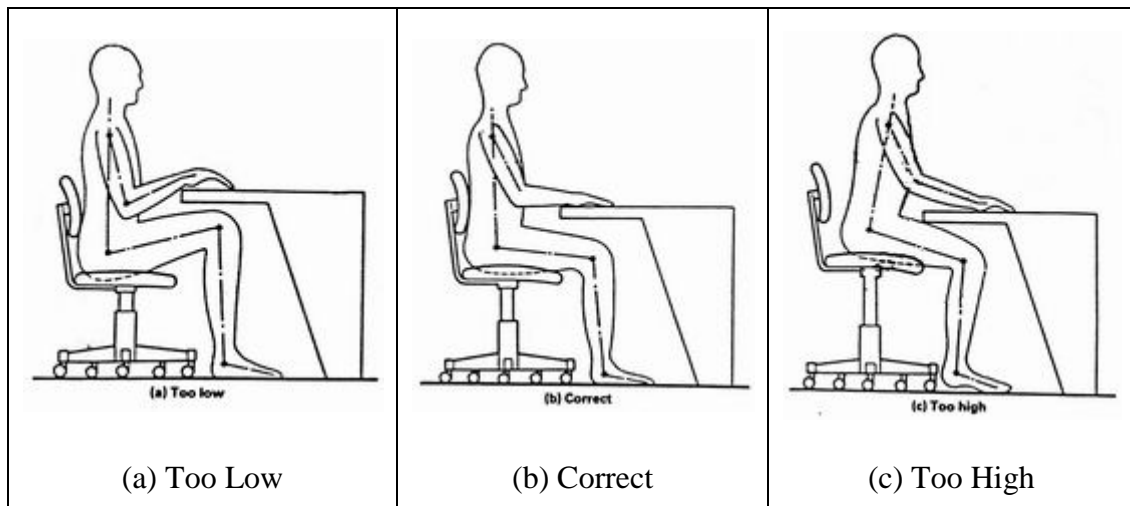


Figure 1.2 shows well and poorly adjusted seats

## **1.3 Problem Statement**

### **1.3.1 The working area**

It is often useful to divide up the area, which surrounds the working person into vertical height ranges. It is the easiest to describe these by referring to the levels of various parts of the person's body in a relaxed sitting and standing position, knee height, elbow height, shoulder height and etc.

### **1.3.2 The layout of the Highway Toll Booth**

Problems arise because of the layout of the highway toll booth. Comfortable layouts will easy the works. So, this workshop has a layout that needs to be change in order to increase the quality of service.