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**JUDUL:** DEVELOPMENT OF STRUCTURING ANTHROPOMETRIC DATABASE
**SESI PENGAJIAN :** 2006/2007
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I hereby, declared this thesis entitled “Development of Structuring Anthropometric Database” is the results of my own research except as cited is references.

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## **ABSTRACT**

This research discuss the initial efforts to build an anthropometric database for Malaysian population as a guide and reference on designing better workplaces and products. Anthropometric surveys have been conducted and published on various populations, including Malaysian. The results of the research carried out on twenty-four static anthropometric dimensions on two-hundred and seventy-five subjects generally shows that the male body parts are longer than female, and the result shows that The UK, The US, and Japan anthropometric data are averagely longer than Malaysian. Statistical variables such as percentiles, mean and standard deviation are used to present and describe the data, where each of these variables has its own functions and particular purposes regarding the applications of the data.

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## LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURES

3-D	-	Three Dimensional
ANOVA	-	Analysis of Variance
ASCII	-	American Standard Code for Information Interchange
ATIS	-	Alliance for Telecommunications Industry Solutions
ISO	-	International Organization for Standardization
KUTKM	-	Kolej Universiti Teknikal Kebangsaan Malaysia
MP	-	Mega Pixel
N	-	Sample size
ODBC	-	Open Database Connectivity
S	-	Standard Deviation of the data
SPSS	-	Statistical Package for the Social Sciences
SQL	-	Structured Query Language
UTM	-	Universiti Teknologi Malaysia
$\bar{X}$	-	Mean value
$X_i$	-	Average of the three readings

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Nowadays, customers satisfaction on products produced is very important. So, every design created must meet and satisfy customers' requirements. But on the other side, this condition is not easy to be achieved. One of the factors is the variability in human population of one country, such as Malaysia. These variabilities are broad, including age variability, sex variability, racial and ethnic group and also occupational variability. Industry need to make policy on how much of they are going to accommodate the population.

In order to design a higher quality product that meet the customer size particularly, the anthropometry data must be considered and play important roles in the industry itself. Anthropometry is a development from the anatomy based origin, and is applied widely in industrial engineering. Generally, anthropometry is a study of measurement of human dimension, which refers to the measurement of living human individuals for the purposes of understanding human physical variation (Wikipedia). Anthropometry is very useful for design product guidelines for heights, clearance, grips, and reaches of workplace and equipment.

United States, European countries and few of Asian countries like Japan had already developed their own anthropometry database for industrial use. Malaysia also

had developed its own, but this research project is an attempt to compare the data obtained with the Malaysian Anthropometry Data.

This chapter will provide an overview of the research project titled Development of Structuring Anthropometry Database. It will include the problem statement, the project's objectives, the scope of study, the importance of study, the outline of study, and the summary of methodology.

## **1.2 Problem Statement**

The application of ergonomic principles in the workplace is very important to the industries. This application can result increased productivity, improved health and safety of workers, lower workers' compensation claims, job satisfaction, increased work quality, lower worker turnover, lower lost time at work, improved morale of workers, and decrease absenteeism rate.

In designing a better workplace and products, anthropometric data should be applied. Anthropometric surveys have been conducted and published on various populations, including Malaysian. Malaysian Anthropometry Data is quite new and there are still rooms for improvements.

This research will gathers anthropometry data on specific type of industry and will compare the data with the existing Malaysia Anthropometry Data if possible. From this data, a database will be built for the specific industry for the use to improve their current workplace conditions and products design.

### **1.3 Objectives**

The main objective of this research is an attempt to create a prototype of an anthropometry database and compare it with the Malaysian Anthropometry Data. Beside that, other specific objectives include:

- i. To develop a prototype of anthropometry database.
- ii. Better understanding of diverse Malaysian population in the human body measurement.
- iii. Contribute to knowledge of Malaysian human statistics; for better design of their products.

### **1.4 Scope of Study**

This research will conduct data collection for specific measurement of human body parts. The body parts chosen will be related to a specific type of industry that involve in improving the quality and productivity of the products, and also reducing the musculoskeletal problems of the workers. There will be a total of twenty-four static anthropometric dimensions involved in this research, both standing and seating dimensions.

### **1.5 Importance of Study**

The importance of the study is to come out with an anthropometry database for a specific type of industry. Base on these database, an ideal workplace for Malaysian workers for that specific type of industry may be build, thus reducing work-related

injuries, improve quality and productivity and improve the quality of life of the workers themselves.

## **1.6 Hypothesis**

For this research, a few hypotheses have been made regarding to the future results of the research. The hypotheses are:

- i. The male body parts are longer than female.
- ii. Japan, UK and US anthropometric data are different than Malaysian.
- iii. Japan, UK and US anthropometric data are averagely longer than Malaysian.

## **1.7 Outline of Study**

This research will be divided into six chapters. The first chapter is mainly about the introduction of the research, problem statement, objectives, scope of study, importance of the study and lastly the study outlines.

The next chapter is the literature review. Based on the reference gathered (journals, books, websites etc.), this chapter will discuss the definition and introduction to ergonomics and anthropometry. It will also discuss the method on how the research will be done based on the past researches.

Chapter three will be discussing about the review of the research methodology. This will include the design and framework of the study. This chapter will also discussing about the advantage and disadvantage of the methods chosen, and the selection of the best method.

In the next chapter, the data collection will be discussed briefly. This will include the setup for the data collection, the data collection table and the example of the data which had been taken. In chapter five, the data and the findings during the research will be discussed in details and in the last chapter, the conclusion and the recommendation will be reviewed.

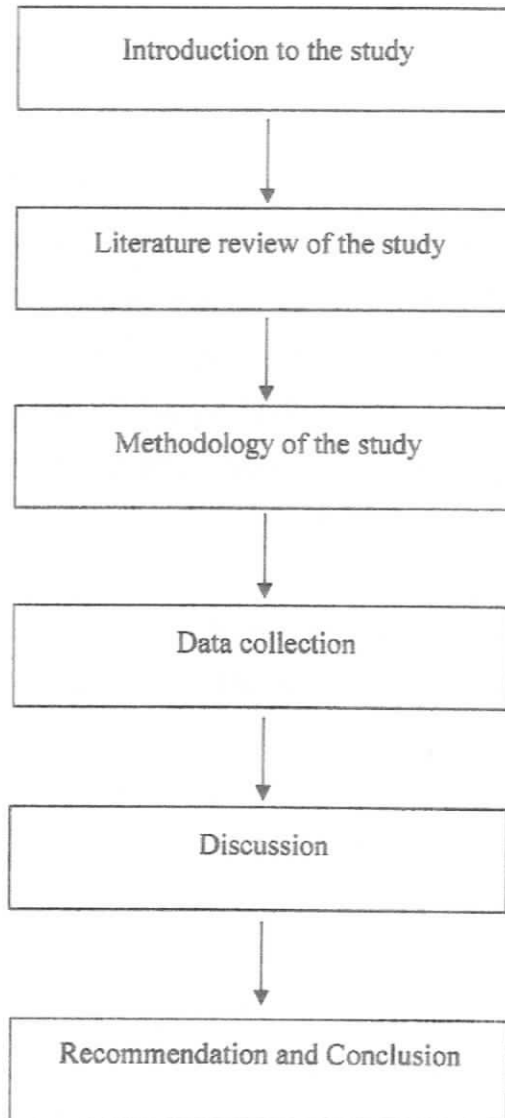


Figure 1.1: Outline of the study

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter provides a review of the concepts of Anthropometry in Ergonomics which leading to research of Anthropometry characteristics of Malaysian population. Ergonomics in the broadest sense is the study of human characteristics while Anthropometry brings the means of human body measurements. In the other hand, Anthropometry in Ergonomics can be defined as measurement of human body as one of the human characteristics.

In addition, since this research involves pilot studies on KUTKM students' population and structuring Anthropometry Database for Malaysian population which related to scope of studies, structuring the Anthropometry Database would also be reviewed. Discussions include measurement and device method, anthropometric measures and modeling of anthropometric database. Finally, a review of performance measures used by previous researches is conducted before concluding the chapter.



## **2.2 Ergonomics and Anthropometry**

### **2.2.1 Brief History of Ergonomics and Anthropometry**

Ergonomics has been in existence since the late 19th century when a man named Frederick W. Taylor completed a series of studies which bestowed upon the world of business a strong foundation of understanding which defines our contemporary outlook on work. Fredrick's efforts had such an impact on the business world of today that he has been named the father of scientific management.

Originally, Taylor's interest in scientific management arose from the campaign of a progressive activist group that was looking to improve the work situations of the middle classes as well as their employers by staging large scale changes in manufacturing processes. The efforts in this group in conjunction with his own observations as a foreman in a metals shop caused Taylor to experiment with these studies.

First, Taylor recorded the amount of time it took for his workers to complete a specific task. Than, by rearranging the equipment to a more comfortable layout he noticed a substantial increase in productivity. Secondly, Taylor began using psychological methods such as encouragement and appreciation to optimize production.

After exercising several studies, Taylor developed a series of theories which became widely known as "Taylorism." These theories were popularized during World War I as businesses began to pay more attention to personnel selection, work methods, work standards, and motivation. Taylor consolidated his expertise on defining the capabilities and limitations of human labor. From this information contemporary managers are more easily able to amplify productivity by correctly marching employees to tasks, improving work methods, and defining work standards.

One of the branches from ergonomics is anthropometry. The French savant, Alphonse Bertillon (b. 1853), gave this name in 1883 to a system of identification depending on the unchanging character of certain measurements of parts of the human frame. He found by patient inquiry that several physical features and the dimensions of certain bones or bony structures in the body remain practically constant during adult life. Anthropometrics was first used in the 19th and early 20th century in criminalistics, to identifying criminals by facial characteristics. Francis Galton was a key contributor as well, and it was in showing the redundancy of Bertillon's measurements that he developed the statistical concept of correlation. Bertillon's system originally measured variables he thought were independent, such as forearm length and leg length, but Galton had realized were both the result of a single causal variable.

During the early 20th century, anthropometry was used extensively by anthropologists in the United States and Europe. One of its primary uses became the attempted differentiation between supposed differences in the races of man, and it was often employed to show ways in which races were supposedly inferior to others. The wide application of intelligence testing also became incorporated into a general anthropometric approach, and many forms of anthropometry were used for the advocacy of eugenics policies. During the 1920s and 1930s, though, members of the school of cultural anthropology of Franz Boas also began to use anthropometric approaches to discredit the concept of fixed biological race. Anthropometric approaches to these types of problems became abandoned in the years after the Holocaust in Nazi Germany, who also famously relied on anthropometric measurements to distinguish "Aryans" from Jews. This school of physical anthropology generally went into decline during the 1940s.

During the 1940s antropometry was used by William Sheldon when evaluating his somatotypes, according to which characteristics of the body can be translated into characteristics of the mind. He also believed that criminality could be predicted according to the body type. This use of antropometry is today also outdated. Because of

his extensive reliance on photographs of nude Ivy League students for his work, Sheldon ran into considerable controversy when his work became public.

### **2.2.2 Definitions of Ergonomics, Anthropometry and Anthropometry Database**

There are various definitions that can be found throughout the literature. The word "Ergonomics" comes from two Greek words "ergon", meaning work, and "nomos" meaning "laws". Jeffrey E. Fernandez (1995) defined ergonomics as the design of the workplace, equipment, machine, tool, product, environment, and system, taking into consideration the human's physical, physiological, biomechanical, and psychological capabilities, and optimizing the effectiveness and productivity of work systems while assuring the safety, health, and wellbeing of the workers. In general, the aim in ergonomics is to fit the task to the individual, not the individual to the task.

Karl Kroemer, Henrike Kroemer, Katrin Kroemer-Elbert (2001) in their book *Ergonomics: How to Design for Ease and Efficiency* stated that ergonomics is the application of scientific principles, methods and data drawn from a variety of disciplines to the developments of engineering systems in which people play a significant role. R.S. Bridger (2003) in his book *Introduction to Ergonomics* defined it as the study of the interaction between people and machines and the factors that affect the interaction.

Among the basic disciplines of ergonomics are psychology, cognitive science, physiology, biomechanics, applied physical anthropometry, and industrial system engineering. Throughout the literature, there is only one definition of Anthropometry found, which is the measurement of human body.

Database can be defined as an organized collection of data, basically a collection of records stored in a computer in a systematic way (Wikipedia). ATIS Committee defined database as a set of data that is required for a specific purpose or is fundamental to a system, project, enterprise, or business.

From the definitions above, a comprehensive definition of anthropometry database that can be used throughout this research is *a set of data of human body measurement that is required for a specific purpose, which is properly organized and stored in a computer in systematic way.*

### **2.2.3 Terminology and Measuring Conventions in Anthropometry**

Body measurements are usually defined by the two endpoints of the distance measured. The discipline of anthropometry has a specialized vocabulary of terms with specific meanings for designating points and distances of measurement, range, direction of motion, and mass. Below are the terminology and measuring conventions used in anthropometrical research:

- i. Height: a straight-line, point-to-point vertical measurement.
- ii. Breadth: a straight-line, point-to-point horizontal measurement running across the entire body or a body segment.
- iii. Depth: is a straight-line point-to-point horizontal measurement running fore and aft the body.
- iv. Distance: is a straight-line, point-to-point measurement between landmarks on the body.
- v. Curvature: a point-to-point measurement following a contour; this measurement is usually neither closed nor circular.

- vi. Circumference: a closed measurement that follows a body contour; hence, this measurement is not circular.
- vii. Reach: a point-to-point measurement following the long axis of the arm or leg.

The standard reference planes are the medial (mid-sagittal), the frontal (or coronal), and the transverse planes, usually thought to meet in the center of mass of the whole body.

Figure 2.1 shows reference planes and descriptive terms. Figures 2.1 to 2.5 illustrate anatomical landmarks on the human body.

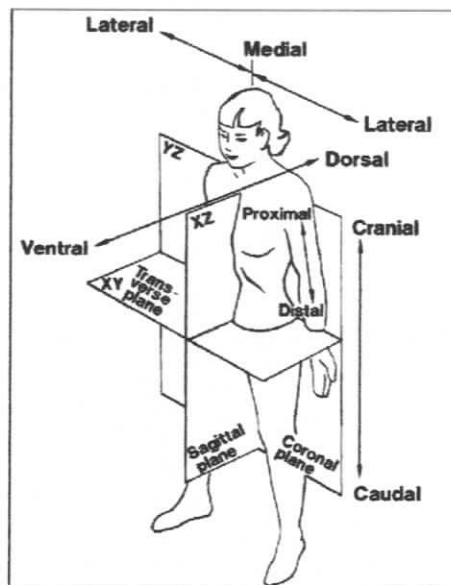


Figure 2.1. Body Planes and Orientations

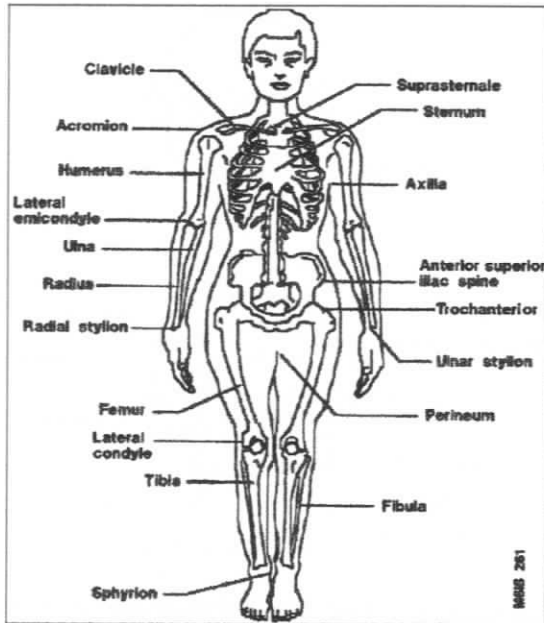


Figure 2.2. Anatomical and Anthropometric Landmarks in the frontal view

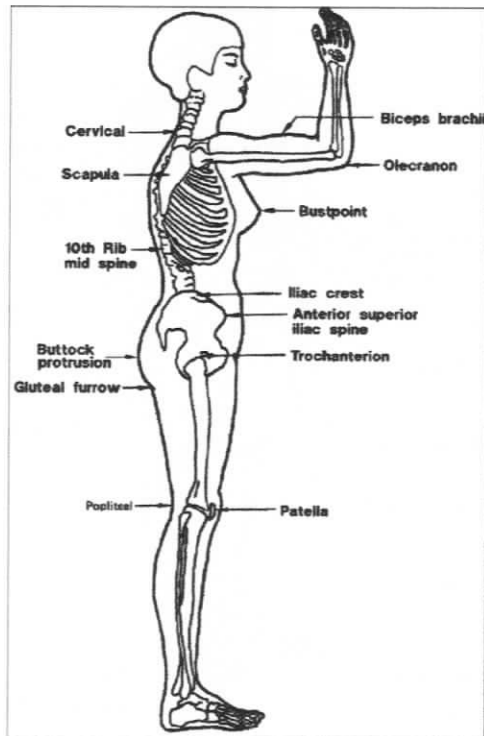


Figure 2.3. Anatomical and Anthropometric Landmarks in the sagittal view

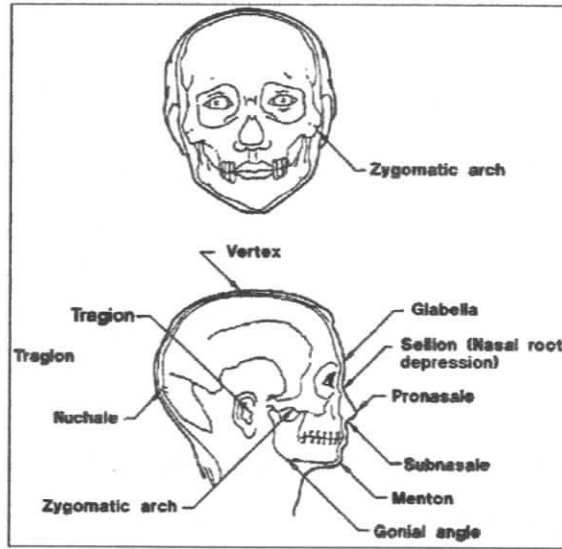


Figure 2.4. Anthropometric Landmarks of the Head and Face

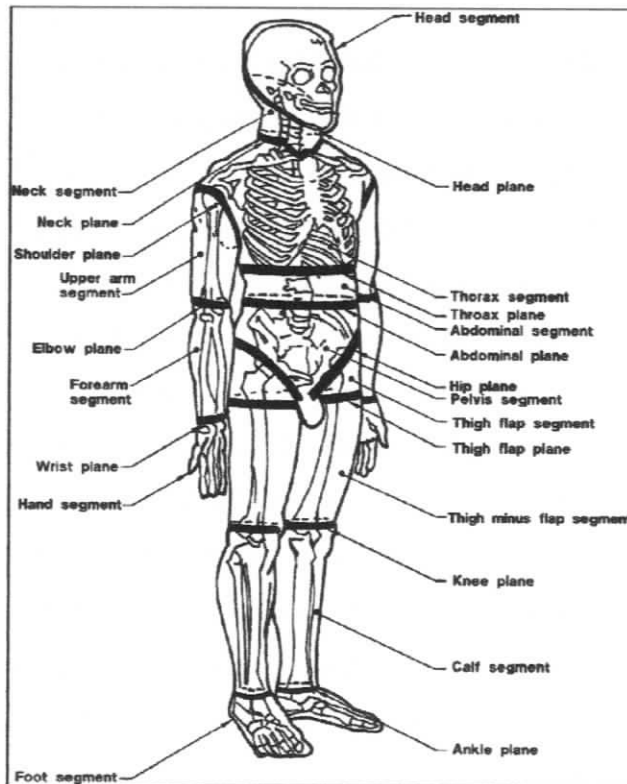


Figure 2.5. Illustrative view of Body Segments and Planes of Segmentation

#### 2.2.4 Measurement Techniques

Karl Kroemer, Henrike Kroemer, Katrin Kroemer-Elbert (2001) in their book *Ergonomics: How to Design for Ease and Efficiency* stated that there are two types of measurement in Anthropometry:

- i. Classical measuring techniques
- ii. New measurement techniques

One of the famous **classical techniques** is *Morant techniques*. This techniques uses a set of grids, usually attached to the inside corner of two vertical walls meeting at right angles. The subject is placed in front of the grids, and projections of the body onto the grids are used to measure anthropometric variables. Boxlike jigs with grids provide references for the measurement of head and foot dimensions.

Many bony landmarks cannot be projected easily onto grids. In this case, special instruments are used. The most important is the *anthropometer*, a graduated rod with a sliding edge at a right angle. The rod can be taken apart for transport and storage, but, put together, it is 2 meters long. (Anthropometric data are traditionally recorded in metric units.) The *spreading caliper* consists of two curved branches joined in a hinge. The distance between the tips of the branches is read from a scale. A small *sliding caliper* can be used for short measurements, such as finger thickness or finger length. A special caliper is used to measure the thickness of skinfolds. A *cone* is employed to measure the diameter around which fingers can close. Circular holes of increasing size drilled in a thin plate serve to measure the external diameter of the finger. Circumferences and curvatures are measured with *tapes*. A scale is used to measure the weight of the body. Many other measuring methods can be applied in special cases, such as the shadow technique, the use of templates, or casting.

Most traditional measuring instruments are applied by the hand of the measurer to the body of the subject. This approach is simple, but time consuming; also, it requires