



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**REDESIGN THE TOILET SEAT BY USING ERGONOMIC
APPROACH**

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

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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:

.....
(Dr. Seri Rahayu binti Kamat)

ABSTRAK

Projek tahun akhir memberi tumpuan untuk menghasilkan rekabentuk ergonomik tandas duduk berdasarkan data antropometri pelajar FKPs. Tandas adalah produk yang telah berubah sedikit dalam beratus-ratus tahun. Dari segi ergonomik, kedudukan mencangkung adalah cara terbaik untuk membuang air besar berbanding duduk kerana lebih berkesan dan mudah membuang najis keluar dari badan. Walau bagaimanapun apabila tandas moden dicipta, semua pengguna mahukan kemodenan dan mula meninggalkan tandas cangkung. Dalam konteks ini, masalah-masalah berkaitan dengan tandas duduk yang sedia ada di pasaran tidak pertimbangkan ciri ergonomik telah menimbulkan banyak masalah kepada sesetengah pengguna akibat postur badan yang tidak sesuai. Data daripada masalah yang dihadapi dan ciri-ciri ergonomik diperolehi melalui kajian soal selidik di kalangan 60 responden dari Fakulti Kejuruteraan Pembuatan (FKP), Universiti Teknikal Malaysia Melaka (UTeM). Pemilihan rekabentuk konsep dimuktamadkan dengan menggunakan Kaedah Pemilihan Pugh; Pemeriksaan dan Pemarkahan. Rekabentuk akhir pemodelan 3D tandas duduk dibuat menggunakan perisian SolidWork 2011. Penilaian Rapid Upper Limb (RULA) telah digunakan untuk menganalisis postur badan untuk tandas sedia ada dan juga tandas duduk yang direkabentuk semula. Berdasarkan analisis RULA itu, tandas duduk yang direkabentuk semula telah meningkatkan postur pengguna. Sistem Pengukuran Tekanan Badan (BPMs) yang digunakan untuk menilai tekanan yang terlibat di sekitar kawasan punggung dalam posisi duduk dan dudukcangkung. Keputusan menunjukkan, tekanan bagi postur dudukcangkung lebih rendah berbanding posisi duduk. Oleh itu, kajian ini menyimpulkan bahawa mempertimbangkan ciri ergonomik dalam rekabentuk tandas duduk menyumbang kepada postur badan yang selamat dan boleh mempercepatkan proses membuang air besar.

ABSTRACT

This final year project is focusing to produce an ergonomic toilet seat design based on anthropometry data of FKPs students. The toilet presented a product that had changed little in hundreds of years. In terms of ergonomic requirements, squatting position is the best way to defecate compare to sitting due to more effective way to pooping and effortlessly make its way out of the body. However, when the modern toilet was invented, all of users are scampered towards modernization and then started leaving behind the humble squat toilet to use sophisticated toilet seat. In this context, the problems related to non-ergonomic consideration of the existing toilet seat in the market nowadays pose much trouble to some users due to inappropriate body posture. The data of the problems encountered and ergonomics features were obtained through a questionnaire survey among 60 respondents of Fakulti Kejuruteraan Pembuatan (FKP), Universiti Teknikal Malaysia Melaka (UTeM). The selection of concepts design is finalized by using Pugh Selection Method; Screening and Scoring method. The final 3D modelling design of the toilet seat was drawn using SolidWork 2011 software. The Rapid Upper Limb Assessment (RULA) was applied to analyse the postures for existing toilet and also to the redesigned toilet seat. Based on the RULA analysis, the redesigned toilet seat has improved the postures of the users. Body Pressure Measurement Systems (BPMs) used to evaluate the distribution pressure around buttocks area in sitting and sitsquat position. The results shows that sitsquat posture reduces the pressure around buttock area compare to the existing sitting posture. Hence, this study concluded that considering ergonomics features to the toilet seat design contribute to safe body posture and can improve the bowel movements process.

DEDICATION

Special dedication to my beloved parents; my beloved late father Mat Zin Bin Hassan and to my only mother Rokiah Bt Taib, all the work hard is only for you and thank you for loving, caring and encouraging me. To my lecturers, siblings and friends, thank you for giving me knowledge and moral support to complete this project and reports.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

BMI	-	Body Mass Index
BPMs	-	Body Pressure Measurements Systems
CATIA	-	Computer-Aided Three-Dimensional Interactive Application
FKP	-	Fakulti Kejuruteraan Pembuatan
MSD	-	Musculoskeletal Disorder
PSM	-	Project Sarjana Muda
RULA	-	Rapid Upper Limb Assessment
SPSS	-	Statistical Package for the Social Science
UTeM	-	Universiti Teknikal Malaysia Melaka
V5	-	Version 5
V15	-	Version 15
Eq.	-	Equation
2D	-	Two Dimensional
3D	-	Three Dimensional
r_{ij}	-	Raw rating of concept j for the i th criterion
w_i	-	Weighting for i th criterion
n	-	Number of criteria
S_j	-	Total score for concept j
Σ	-	Summation

CHAPTER 1

INTRODUCTION

Chapter 1 explains the project problem statements, objectives, scopes, methodology, and the structure research of reports. In general, it promoted the idea of the final project conducted and provides an initial overview of the entire contents of the project under title 'Redesign the Toilet Seat by Using Ergonomic Approach'.

1.1 Project Background

In today's business, most of organizations need to redesign and innovates their products offered to market. In general, the redesign activities will improves the standard and ability of the product design process (Li *et al.*, 2006). The modification made based on a single reference product which is almost corresponded to the customer demands and shorten the process duration. Thus, the new products will be introduced when the problems occurred between the existing products in the market after a period of time and the customer raise with new requirement. Normally, there are several reasons for redesigning products such as the existence of the design error, changes in customer demands, improve quality, reduce costs, extend product life, or reduce environmental impacts. According to Han and Lee (2006) the solution through redesign activities are generally more feasible and reliable since they have already been experienced with and successful in prior products.

In this context, the problems related to non-ergonomic consideration of the existing toilet seat in the market nowadays pose much trouble to some users due to inappropriate body posture. In everyday life, the toilet is place that must be access by

everyone for a particular purpose. The concern of the product is the toilets posture that can cause several diseases, such as constipation, pelvic floor issues, haemorrhoids, colon diseases, and difficulty peeing and urine infections. The defecation healthy posture by somebody may possibly affect certain medical ailments, like defecation syncope, and also urination (Rane & Corstiaans, 2008). In general, there are two types of toilets that are commonly used in Malaysia market, namely: both squatting-type and sitting-type toilet or known as toilet seat. Squatting defecation posture involves squatting by standing with knees and hips sharply bent and the buttocks suspended near the ground, while the sitting defecation posture involves sitting with hips and knees at approximately right angles on a seat like a chair (Sikirov, 1990).

In terms of ergonomic requirements, squatting position is the best way to defecate compare to sitting due to more effective for user to pooping and effortlessly make its way out of the body (Richman & Sheth, 2007). However, some users cannot squat due to physical or psychological barriers. While the modern toilet was invented, all of users are scampered towards the comfort one and then started leaving behind the humble squat toilet to use sophisticated toilet seat. Even though the toilet seat design offers a practical concept, quickly and loaded with modernization but when it is viewed in terms of ergonomics and health factors, it is questionable and not only to hygiene factor. In this case, the sitting posture inappropriate angle will leads the puborectalis muscle to choke the rectum. This condition would cause of obstruction in the flow waste out of the body that requiring more energy to strain during defecation in order to evacuate the bowels (Reid, 1989).

Based on the reason above, the user's body posture while using the toilet becomes an important factor in order to redesigning the existing toilet seat based on the appropriate body position during defecation to produce an ergonomic toilet seat. Therefore, it is important to review the current research study on the problems such as pain and disease that related to the body posture of the existing toilet seat. Moreover, it is also necessary to consider the ergonomic features that need to be implemented into this project through creating the stylish design that clearly stepped

beyond the dimensions of conventional toilet seat and to obtain the superb functions while not reduce the functionality of the product prior.

1.2 Problem Statement

The existing toilet seat design in the market seems not suitable and giving many problems for some users, especially for the users who have problems of low back pains, spine, feet, etc. Briefly, bad toilet posture can cause many side effects on consumer health. The main problem highlighted in this study is focused on an inappropriate body postures during defecation that can cause uncomfortable feeling when using the toilet seat. Scholars and product specialists have proposed that many issues arise are actually due to the sitting compared to squatting. According to Bockus (1964), *“the ideal posture for defecation is the squatting position, with the thighs fixed upon the abdomen.”* But not all of people can use squatting-type toilet in their daily life due to physical or psychological barriers and because squatting can be tiring, especially for older folks. So, some users had to use the toilet seat even they know the benefits of squatting toilet. In addition, even sitting defecation posture is an easy posture to adopt, most users feel uncomfortable while defecate because the flow wastes out of the body thrown imperfectly. One of the reasons is due to the users sometimes feels they are having not completely emptied the bowels and need to go back to the toilet continuously.

1.3 Objective

Basically, the main purpose of this project is to redesign the existing toilet seat that gives comfort and happiness to users when using the toilet seat. The objectives of this project are as follows:

- a) Identify the problems of the current toilet design in the market
- b) Redesign the toilet seat that considers the proper body posture
- c) Validation of the redesign toilet seat based on Biomechanical Analysis

1.4 Scope

The focuses of this project is to make an improvements of the toilet seat in term of proper body posture when defecation process. Thus, to obtain an ergonomic toilet seats which are able to ensure the flow waste out of the body running smoothly, the existing toilet seat will be redesigned in order to achieve the mimic natural squat posture. Therefore, the suitable angle of the body posture and also the suitable height of toilet seat will be measured and then analysed using RULA Analysis of CATIA V5. Based on the data of existing and new ergonomic toilet seat design, the analysis conducted is also through the comparison based on the suitable angle of appropriate body posture that is required by the users. This project will concentrates on the characteristics of product design specification, conceptual designs, and the analysis conducted towards the propose design which are psychophysical analysis and biomechanical analysis.

Figure 1.1 shows the limitation and boundaries to accomplish this project. The data gathered from both gender; female and male of toilet users in FKP, UTeM in order to analyse the problems encountered by the users with the actual toilet design in the market and to determine the user satisfaction towards the ergonomic features of the new toilet seat design. This survey will be conducted to 60 students of 20-35 years old. The proposed design of toilet seat will be referring the anthropometric measurements data from the survey's respondents.

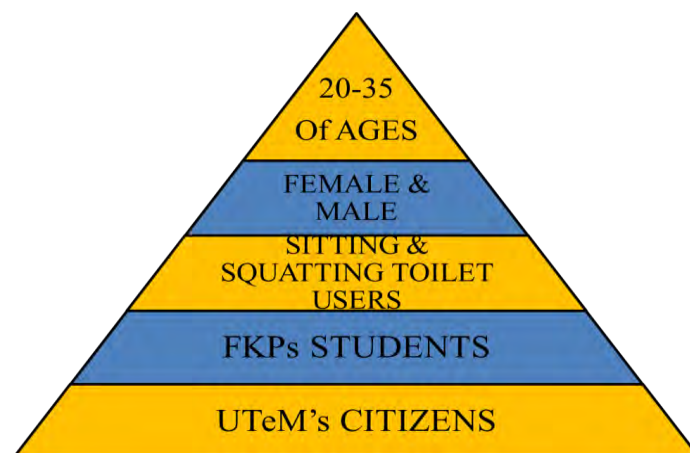


Figure 1.1: Project's Scope

CHAPTER 2

LITERATURES REVIEW

Literature review is the study of theory and relevant information related of this study. Researching the knowledge about redesigning method and some theoretical techniques which will be adopted to redesigning ergonomic toilet seat. Through this study, the process of collecting and gathering the data are obtained from various sources such as books, newspapers, magazines, journals, seminar papers, theses, and also through interviews with relevant parties.

2.1 Toilet Posture

Toilet is a fundamental starting point where each person directly deal with their own body and face anything provided, neither based on the table nor self-making (Molotch & Noren, 2010). According to Yomtov (2012), the toilet can save human lives and improve the human health more than any invention in history by clean waste removal and appropriate sanitation.

2.1.1 Sitting versus Squatting

There are a lot of relevant opinions relating to sitting and squatting. They are trying to prove that squatting is the best posture to defecate. Barclay (2012) said, *“For most people, the modern toilet doesn't cause any problems, but if we believe Slate's Lametti, squatting on top of the toilet could be a time-saver”* as well as *“the modern toilet has been sold to us as civilized, but the straining that sitting causes is not*

healthy". Although the modern toilet seat encourages a seated position, for defecating, squatting is better than sitting (Jian, 2011). Squatting required almost no straining but sitting required excessive straining and effort and at least three times more straining than squatting (Sikirov, 1988). According to Chia (2002), squatting is a natural posture and generates a state of relaxation and stillness. Since the beginning of civilization, people have known the highly beneficial effects of squatting.

Squats can be performed at a variety of depths, generally measured by the degree of flexion at the knee. Strength coaches often categorize squats into 3 basic groupings: partial squats (40 knee angles), half squats (70 to 100), and deep squats (greater than 100). However, no standardized measures of quantification have been universally recognized, and terminology can differ between researchers. Other modifying facts associated with the squat involve varying intensity of load, foot placement, speed of movement, level of fatigue, and position of load.



Figure 2.1: Natural and Unnatural Squatting

(Sources by: <http://www.oxypowder.com/squatting-while-defecating-what-you-need-to-know.html>)

Your midsection includes muscles, bowels, ligaments, intestines, and it's essentially an interconnected system of tubes and trails. Imagine your rectum as a garden hose. When you're seated, it's at an angle with a kink in it and it's not completely blocked but it's not going to operate at best capacity either. However, when you're squatted, the muscles in and around the area help reduce the kink and position your rectum in a

“straight-through” position that’s free of obstruction, this promotes smooth bowel elimination. Additionally, it prevents unnecessary straining and thus overcome the problems that arise (Sikirov, 1989).

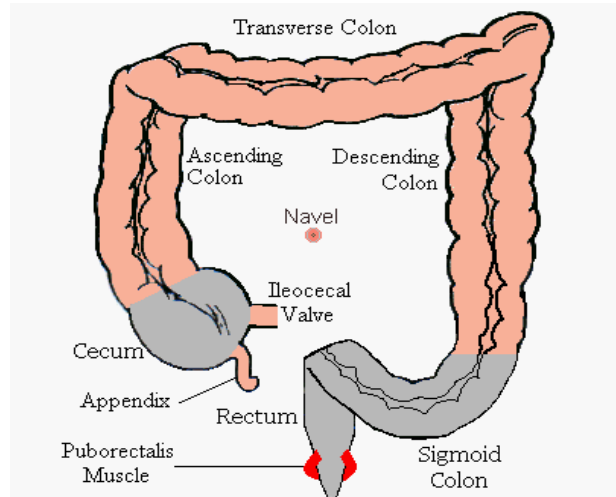


Figure 2.2: Transverse Colon
 (Source by: http://www.naturesplatform.com/health_benefits.html)

Figure 2.2 shows the transverse colon in human body. Eighty percent of colon cancers develop in the gray coloured areas, which cannot be fully evacuated in the sitting position. When sitting, the puborectalis muscle will chokes he rectum while the squatting will relaxes the puborectalis muscle and also straightens the rectum as show in Figure 2.3.

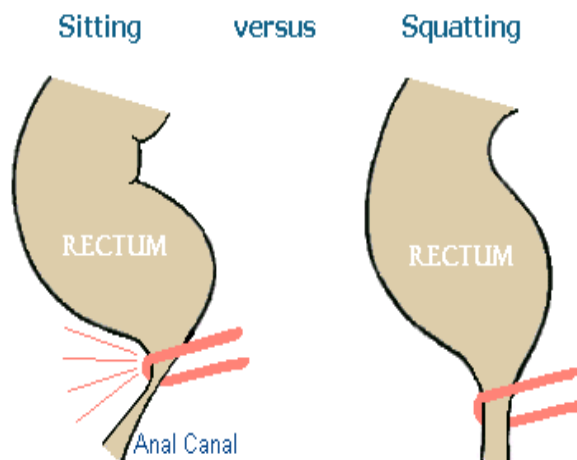


Figure 2.3: Rectum’s Position (Tagart, 1966)

2.1.2 Innovation Design an Ergonomic Toilet Seat

There are several innovations of toilet seat designs that are available in the market nowadays but the most interesting designs are Squatty Potty and LE PENSEUR Design. They are trying to make the human body in a squat position while using the toilet in order to achieve an effective popping.

2.1.2.1 Squatty Potty

Squatty Potty is the innovation that was created by Edward's family, which includes Meet Bill, Judy, and Bobby Edwards from Saint George, Utah. They are trying to solve some colon issues and came up with a natural and inexpensive solution that would help correct and heal the problems. This product is designed to fit around the existing toilet and easily stores out of the way when not in use. Figure 2.4 shows the design of the Squatty Potty toilet stool.



Figure 2.4: Squatty Potty Stool

(Sources by: <http://www.squattypotty.com/5-problems-with-sitting-on-your-toilet/>)

This stool will be able to make the knee above the hips, which creates the mimic squat posture and to get the proper alignment of the colon, which means the correct anorectal angle during elimination. According to Edwards, gravity will do the job when we reach the appropriate body angle.