DESIGN AND DEVELOPMENT PORTABLE WATER SAVING FOR ABLUTION

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

By

MUHAMAD HAKIMI BIN ROMELI

B051310259

940727-06-6247

FACULTY OF MANUFACTURING ENGINEERING

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.).

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Dr. MOHD SHAHIR BIN KASIM

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ABSTRAK

Wuduk adalah aktiviti kebersihan di kalangan umat Islam sebelum melakukan ibadah dengan membasuh beberapa bahagian anggota badan. Sistem terkini yang digunakan untuk berwudhu adalah dengan menggunakan paip air dan kebiasaanya botol spray digunakan jika melakuan aktiviti luar. Namun, beberapa masalah telah didapati seperti kadar pembaziran air yang tinggi apabila menggunakan pili air manual. Selain itu, ketetapannya pada suatu tempat juga memberikan masalah kepada pengguna untuk berwudhu. Selain itu, penguna juga menghadapi kesukaran dengan cara penggunaan botol spray. Jadi, penghasilan sistem wuduk jimat air mudah alih mampu membantu untuk menyelesaikan masalah kesukaran dan pembaziran air serta membolehkan aktiviti wudhu dilakukan di mana-mana sahaja. Projek ini telah bermula dengan kajian di sekitar Masjid Al-Kauthar di Maran, Pahang dengan mengumpul data daripada 30 responden dan hasilnya telah dianalisis dengan menggunakan Rumah Kualiti (HOQ) bagi mencari keperluan produk. Pugh Matrix telah digunakan bagi pemilihan reka bentuk yang terbaik. Untuk ukuran yang lebih terperinci dan Rang Undang-Undang Bahan (BOM), lukisan terperinci dan lukisan agihan telah disediakan untuk maklumat lebih khusus mengenai reka bentuk produk. Projek ini diteruskan ke peringkat fabrikasi dimana proses mengukur, menanda, memotong, prototaip dan pembangunan sistem elektronik telah berlaku. Pembuatan sistem wudhu jimat air mudah alih ini berlaku dengan mengaplikasi muncung kabus yang menggantikan muncung paip biasa dan ini membolehkan sistem menimatkan lebih banyak air berbanding output normal. Reka bentuk projek ini adalah untuk menjimatkan air dengan menukarkan aliran air yang normal kepada kabus dan ia juga mampu mengawal aliran kabus dengan menggunakan sensor. Selain itu, ciri-ciri mesra pengguna dan bahan yang digunakan mampu memudahkan pengguna untuk menggunakannya. Tambahan pula, produk yang telah siap dibina telah dianalisis mengikut kadar aliran jisim air dan analisis masa terhadap penggunaan air. Dari analisis yang dibuat, ia menunjukkan produk yang membolehkan untuk menghasilkan kadar aliran air yang rendah iaitu 0,079 L/min dan mampu mengurangkan air sehingga 94% dan berupaya untuk mengawal output juga menjimatkan sehingga 40%. Mengikut keupayaan hasil produk dan analisis yang menyatakan 94 ml purata air yang digunakan untuk 1 kitaran wuduk, produk ini boleh digunakan sehingga 32 orang bagi setiap 3L untuk berwuduk. Jadi, ia menunjukkan produk mampu menyimpan banyak air dan sesuai untuk aplikasi yang berkadar besar.

ABSTRACT

Ablution is the cleanliness activity among Muslims before doing the ritual activity that involved with washing the several parts of the human body. The latest system that used to perform ablutions is by taps water and for outdoor activities, usually using a spray bottle. However, some problems have been found as high levels of water wastage when using manual taps water, resolutions at a place that gives problems to users and the difficulties faced by consumers when doing outdoor activities if using a spray bottle. So, developments of portable water saving able to resolve difficulties and water wasting problem and enabling ablution activities to be performed in anywhere. The project was started by surveying at around Masjid Al-Kauthar at Maran, Pahang by collecting data from 30 respondents and the result had analysed using House of Quality (HOQ) for finding the product requirement. After that, the product requirement received has been referred for sketching 3 the design idea and had analysed all the sketches using Pugh Matrix for selecting the best design. For detailed dimension and Bill of Material (BOM), detail and exploded drawing was prepared for more specific about the product. The project is proceeding to development stage that occur by measuring, marking, cutting, prototyping and electronic system development. The development of portable saving water ablution system is occurring by making it with mist nozzle that replaced the normal pipe nozzle and enable to saving more water against normal output. The design of this project is technically to save water by converting strong flow of water to become mist and it is also controlling the mist flow by applying sensor. Moreover, its user-friendly properties and material used can make people easier to deal with it. Furthermore, finished product had analysed according to water mass flow rate and time analysis against water usage. From the analysis stage, it is shown the product enable to produce a low water flow rate, which is 0.079 L/min which can reduce until 94% of water used and ability to control the output, the reducing on unnecessary water flow until 40% could be occurring. According to the ability of a product and analysis result which is 94 ml of average water used on 1 cycle ablution, the product could serve until 32 persons per 3L for ablution. So, it shows the product able to save more water and suitable for mass application.

DEDICATION

This project is dedicated to UTeM, my Main Supervisor,

Dr Mohd Shahir Bin Kasim,

My beloved parents who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve,

Mr Romeli bin Mohamad & Mdm Sarimah binti Ya'akub,

My family who has supported me and also not forget to FKP Technicians and everyone that helps me directly or indirectly in making of this project until its successfully finish.

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LIST OF ABBREVIATIONS

PPBUH	-	Peace be upon him
MHM	-	"Meterai Hijau Melaka"
EXCO	-	State Executive Council
QFD	-	Quality Function Deployment
HOQ	-	House of Quality
MSW	-	Municipal Solid Waste

LIST OF SYMBOLS

%	-	Percent
s	-	Second
mm	-	Millimeter
ft.	-	Feet
in	-	Inch
v	-	Volume
t	-	Time
min	-	Minutes
ml	-	Millilitre
l	-	Litre

CHAPTER 1
INTRODUCTION

This section describes the background, objectives, problem statement and scope of the project. Finally, this section ends with an overview about the end of the reporting year. The background is discussing about the improving a portable ablution system or device that solve the waste water and application compatibility problem during ablution activity among Muslim patients at hospitals and the fundamental knowledge about it. Lastly, the objective explained on the goals should be achieved in this subject and the scope encompasses everything what should have been done in this project.

1.1 Background

This project is related to Muslims ritual activity in daily life which is ablution or Wudhu and now days most people forgot that ablution also one of the sources of water waste because of excessive water usage during ablution. Before that, ablution is a ritual washing performing by Muslims that includes minimal of water usage to ensure cleanliness before performing prayer or another ritual activity generally include washing of hands, face, mouth, nose, arms, swabbing on head, ears and feet Johari N.H *et al.* (2012). Based on the Quran, *Sunnah* and the Scholars consensus, the ritual ablution rituals have a few rules and manner when performing the ritual. This ritual activity is involved by small amount of water usage, which is referred on the Islamic historical records indicated that Prophet Mohammad [peace be upon him] used to make ablution using one ‘‘Mudd’’ of water (Hadith from Bukhari and Muslim). Other than that, Al Mamun *et al.* (2014) and another prove said the water usage during ablution is equivalent to 0.544 L of water, anyhow the correct amount is less than 1 L.

To minimize the problem, this project also trying to follow the initiative of Malacca Government that is "Meterai Hijau Melaka" (MHM) to achieve green technology city state in 2020. This initiative is approved by the State Executive Council (EXCO) on 16th December 2014. MHM is a certified green building rating method for new development in Melaka. This initiative involves with six criteria and one of criteria that must be considered is water efficient. Responding to the government within reach of the green technology city, the analysis and design of the product must help on solving water waste problem during ablution activity.

1.2 Problem statement

In this part, several problems had found based on research and observation. First, some of the mosques have used the traditional system of ablution which is a courtyard with a pool of clear water in the center, but in most mosques the ablutions are found outside the walls means using the tap water. When used the tap water, there is too much water wasted during ablution because the water flow from the tap is fast and flow continuously without controlled it. So, it will waste the unnecessary water. Handle taps consume extra amounts of water during the moments of opening and closing because of using hands in turning the tap handles. Thus, cannot benefit of flowing water and related to the traditional ablution system that cannot be control the water flow during ablution. Besides, Ghanem (2008) also had confirmed that using slow closure mixer taps wastes about 30 % of the amount of water consumed during ablution. In ablution process, the tap is usually left running, much good water is wasted in the process Suratkon *et al.* (2014). It can be said that about half of the tap water flows directly to the drain without any contamination Al Mamun *et al.* (2014).

Besides, the other ways for ablution is using bottle spray but it is not comfortable to use according to forces required by pumping it for producing mist. Other than that, usually portability of bottle spray can cause difficulties for carriers by increase the amount of goods carried. Other than that, the usage of plastic bottle for ablution possibly can increase the factor of solid waste as mention in EPA, U. (2009), 12.8% of Municipal Solid Waste (MSW) is coming from plastic waste. Other than that, 50 billion and over the number of plastic bottles had used, but only 23% of them had been recycled (Ban the bottle website, 2013). According to water spray usage, it possibly can cause moisture in application place and

possible can cause dirty on that places according fungal growth. Because of that, it is quite difficult for traveler in ablution especially when in airplane toilet due to a relative narrow area and fulfill the people from another culture wants that concern about dry condition. The other limitation of this device is the application is limited to the number of users and related to scope, this current device is not suitable to use for mass application which is assumed 30 persons per 5L and wetting the application place.

In Malaysia, set of Malaysia Standard has been developed as a guideline for the developer and designer to build public facilities which can be accessible by the vulnerable group such as elderly and disabled population to provide design specification. Therefore, it is necessary for praying facilities designed to promote an adequate environment for the elderly and disabled, considering their needs, capabilities, abilities and limitations. Even though ablution space is considered as one of the important public facilities, especially in countries with high Muslim populations, there are numbers of design guideline for mosque, but still lacking in guideline, research or document specifically for ablution area. But the design prepared for ablution facilities is fixed to the one place and it gives limitation to the users to be more flexible for ablution.

Elderly people commonly referred as population having one or more illnesses other than having movement or functional problem. Improvement in health care services in existence of active elderly people, which prefer to live independently, demands the development of facilities which able to adapt to their capabilities and abilities also increasing to conduct their daily activity including praying facilities. As a Muslim, ablution facilities must be considered as a daily activity that has been conducted wherever they are Siti Zawiah (2015). Some of patient at the hospital have limitation on their movement because of their illness. This situation is particularly difficult for them to carry out activities for ablution.

1.3 Objective

i) To design and develop the saving water portable ablution system

ii) To analysis the ability of product for saving water during ablution activity and affordable for mass application

1.4 Scope of study

The project is focused on developing the new product according to the product requirement that had translated based on public survey using House of Quality (HOQ) method. Besides, this project followed by designing the product design and doing some screening and scoring analysis to rank the design according to design requirement. The chosen product will be redrawing using CATIA software for the detailed dimension. Other than that, the CES Edupacks is used for the material selection for each part of the product for several requirements. Besides, the project is focused on the analysis of water flow rate against nozzle type and analysis on water consumption against times during ablution activity. The limitation of this project is the water pressure from the water pump applied to the product which is 143.4 kPa. Therefore, the project is following the scope of study below.

a) Design portable ablution system.
b) Fabricate portable ablution system.
c) Implement designed ablution system.
d) Rectification of designing ablution system
e) Compare the efficiency for saving water before and after applying misting and sensor concept
f) The analysis uses a mass flow rate equation

1.5 Chapter Overviews

The final project covers five chapters that including introduction, literature review, methodology, results and discussion and lastly conclusion. Chapter 1: Introduction; introduces the need to study about wasting water during ablution that is divided in the introduction of study, problem statement, objectives, scopes as well as the significance of the study.

In chapter 2: Literature review; covers that the information that found from various sources such as books, journals, articles and websites. Topics that related to the study of water wasting during ablution activities included here. The experimental apparatus, methods and procedures for data analysis will be discussed on chapter Methodology which is in

Chapter 3. The Chapter 4 will discuss about the survey result and the analysis on the product which is the water flow rate analysis and water usage against times during ablution activity. Here, the justification will be given with respect to the results obtained primarily related to the objectives. Finally, the chapter of conclusion will summarize the report and suggestions for future work are also included in this chapter.

CHAPTER 2
LITERATURE REVIEW

Chapter 2 will explain about literature review. The issues that will be discussed are about the original system of ablution and the disadvantages, cause and effect of disadvantages, the method and the component involved.

2.1 Introduction

The aim of this study is to design the portable ablution system that's able to solve the water waste problem during ablution activity and comfortable to use for mass application. This chapter reviews and explains about the past study that had done. Literature review examines respectively to the source and describes to justify the statement with proof of research or study in related fields.

2.2 Original system

The initial system of the ablution ritual uses massive amount water, in Musholla and mosques, especially where the water is permitted to run free and drain away during ablution activity. As quotes in the Hadith, Prophet Muhammad reminded Muslims to avoid wastage, even though when performing cleaning ritual or ablution prior to prayer. Wudhu' requires a Muslim to wash exposed body part with clean water but not excessively. The small amount water that was used by the Holy Prophet Muhammad prayer and peace is upon him (PPBUH) for the performance of ablution activity is similar with one full palm. Based on the Islamic historical records state that Prophet Mohammad [peace be upon him] used one ''Mudd'' of water to make ablution activity [Hadith from Bukhari and Muslim] which is equivalent to

about 0.544 L of water. (Al Mamun *et al.*, 2014). Others prove slightly higher evaluations, but, anyhow the correct amount is less than 1L.

Besides, saving water is very important nowadays according to an increasing population of people in the world. Defra (2008) has said water is one of the most valuable resources in the world and it is very important to sustain life. However, while the source of water is practically constant in quantity, pressure on resources is set to rise due to increasing demand because of population that increasing rapidly, especially in urban areas that because of changing lifestyle as a main factor. (EA, 2009). In Malaysia, most ablution systems are made up simply of the row of water taps with drainage through carry the water to the main drains.

2.2.1 Original system structure

2.2.1.1 Tap water

Usually the traditional ablution system had used tap water as a main part of the system. Tap water is water supplied with a tap (valve) that also used include drinking, washing, cooking, and the flushing of toilets. In ablution case, water tap is the main part that can affect the rate of water flow during ablution activity. It is because, uncontrollably tap causing the water flow out without in use increasing the rate of water become waste. Some of the information had found based on the several journals which is the analysis on the relationship between time and rate of water used during ablution. Based on the experiment by Abu Rozaiza (2002), during ablution activity, Muslim have used high quantity of water and it is a different evaluation of the average amount of water used had observed in previous studies. The amount of water used had measured among 40 Masjids and 2 holy Masjids. As a result, he found that 3-7L of water per person had used during ablution at a time. However, the different results had determined from another study, which is 2.5–4.5 L/individual in some masjids, schools and governmental buildings. State by Ghanem (2008) he confirmed that 30% waste of water consumed when using slow closure mixer taps. In addition, extra amounts of water consumed during the moments of opening and closing because of using hands in turning the tap handles. It is cannot give benefit of flowing water.

Some innovations have done on tap water for example the standard tap water have applied with electronic sensors to overcome the water waste problem. This project had done by Besari *et al.* (2009) where the automation applied on ablution system which is built in camera as a sensor and servomotor as an actuator. The improvement had done based on his study which is can be able to save 1-7L of water during ablution. Their experiments revealed that manual ablution consumes about 2–9 L/individual in about 40–80 s of time where, using their automatic ablution machine decreased water consumption to about 2–3 L/individual in about 55–70s.

The same case study also had been done by Roubi A. Zaied (2015) regarding to water use and time analysis. From the study, his state that the washing of feet only used 22.7-28.8% of ablution water and washing the facial portion is the largest water waste occurs. Moreover, until 30-47% amount of wasting water consumed in ablution can be reduced if the water release at the moment need. This statement had approved by analysis on 100 cases between several types of tap water. As shown in Table 2.1 and Table 2.2 below, the analysis of the time spends and water used during every each of ablution activities from mechanical knobs tap and automatic tap had done in his analysis.