



DEVELOPMENT OF A PORTABLE ABLUTION SYSTEM FOR MUSLIMS FROM ERGONOMICS APPROACH

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ABSTRACT

Ablution is Muslim's act of washing oneself before performing prayers. This ritual only involves several parts of the body. However, during this process, water was wasted too much which interchanging between body parts even though Islam urges Muslim to reduce water usage during ablution. Other than that, the newly developed design will check for its ergonomic since comfortability and safety are essential for establishing a product. Hence so, this research is proposing a new design of an ablution system. This ablution system designed as a portable and user-friendly system for all ages to be used. The design for this ablution system does consider the ergonomics of human position. It also proposes a way to conserve the wasted water from ablution process. Design is made from the suggestions from RULA analysis by CATIA V5. This analysis proposed a better angle for better measurement of the proposed design. Finally, the study concluded with limitations and future research directions.

Keywords: ablution, portable system, ergonomics ablution.

INTRODUCTION

Ablution is a cleaning process that uses water to wash a part of the body before performing prayer. It involves certain parts of the body, which is the face, both hands, head, and feet in correct sequence. Over the years shows a vast interest in designing an ablution workstation according to the users' convenience. Many ideas and designs established near the prayers house such as Mosque and Musollah. It varies since it depends on human behavior as it will influence Muslim in performing ablution.

In Islamic hadith, water that needs for a Muslim to make a ritual ablution is only about half to two liters. Usually, a process of ablution required six to nine liters of water in volume. Some of Muslim use water with austerity, but some will waste the water [1]. Innovations have been developed for Muslim to the conservation of water when making a ritual ablution in daily life, as discussed in Table-2.

These designs were made in many ways using low until high technology. Besides conserving the water, this kind of invention also can ease the process of make ritual ablution. An ablution device should, however, follows the requirement of Muslim behavior despite its function and design. The previous study explains that ergonomic is beyond to safety and health.

Nevertheless, the most problem when a Muslim makes a ritual ablution is the place station of ablution when the designer does not consider all types people of Muslim such as sick people, older adults, and disabled person. Most of the designer build the ablution station for only an average person. The design of ablution station in Mosque which using the pipe system will consume more water in ablution process.

In Islam, Muslims were compulsory to conserve water because wasting is one of devils' temperaments.

Most of the research, the design of ablution station needs about six to nine liters of water to make the full ablution process. The wasting of water will be one of the main problems in making the ritual ablution.

At the end of this study, we proposed a new design ablution device. This design will consider human needs, ergonomics, wastewater conservation and portability. The ergonomic factors of the design must also take into consideration for better portable ablution device where it is suitable in design and useful product for Muslim to make the ablution process. It also must easy to carry everywhere and suitable for the traveler and organizer of the ceremony.

METHODOLOGY

Research Framework

A survey conducted to find previous innovations to find their novelties and ideas behind their suggestions. These innovations are only those who recorded inside a journal or patent. After that, conceptual ideas of a new design of ablution system proposed. Ergonomics studies to investigate the best body posture for each body part involves will be done. It is essential as researchers want to develop a new ablution device satisfying all the criterion.

Ergonomic Study of Ablution

Ergonomic defined as an applied science concerned with designing and arranging things so that the interaction between human and things can be optimized [2][3]. Each application, things, and workstations should be designed in an ergonomic condition as it is a human need to feel safe and comfortable while working. In Malaysia, there are several designed for ablution system that is ergonomic and suitable for the behavior of Muslim.



An ablution ritual also needs ergonomic condition, especially in designing the ablution system places due to the high percentage of Muslim regularly practices their religious duties. There are also study on the guideline on the designing of ablution spaces in the mosque [4].

The main propose for this research was to design a tool to maximize the using of water while doing ablution. The tool that produces must be in the ergonomic condition and safe for people to use it ergonomically. The system should consider safety used, essential factors such as redesign the system to improve the posture of the body, comfort, and convenience must consider avoiding fatigue and poor work quality.

RULA or Rapid Upper Limb Assessment [5] proposed to evaluate the individual posterior. The RULA was an analysis that designed for easy use need for an advanced degree in ergonomics. The evaluator uses RULA analysis in Catia V5 software of an ergonomic assigns the score for each body region such as upper arm, lower arm, wrist, neck, trunks, and legs.

This software analyzes the posture analysis of making ritual ablution. One of the RULA assessment is as the tools consider biomechanical and postural load requirements of the job task. In the Catia V5 software, a single score represents the level of Musculoskeletal Disorders (MSD) risk generated after the evaluation of the body posture, force, and repetition on the manikin provided.

MSD risk divided into four score level. Score 1-2 indicates that the posture is acceptable if it is not maintained or repeated for extended periods; score 3-4 shows that further investigation is needed and changes may be required; score 5-6 are medium risk showing that

investigation and changes are required soon; while score more than 6 are high risk where investigation and changes are required immediately.

Design of Portable Ablution System

The new concept design of the developing ablution system should obey four features, which is portability, user friendly, ergonomically, and water preservation. Portability as to make people more comfortable with making a ritual ablution without using the mosque space or other than that. It is crucial since this system needed in condition that has no proper ablution places such as during event or lack of ablution space area. User friendly as all people able to use it, considering tedious mechanical and electrical components. The idea is that it is suitable for any range of age. It must be made in user-friendly mode as elders and youngsters can use it without any problems. Besides, this new concept should be able to preserve water consumption.

A new concept design of an ablution designed in Solidworks software based on the humans needs obtaining from market survey analysis. The function and the way how to use this portable ablution included in the manual.

RESULT AND DISCUSSIONS

For the ergonomics analysis, researcher applies CATIA V5 to check the suitable design positioning when taking ablution. The single score represents the level of MSD risk was generated as in Table-2 to show whether the position is ergonomic or not. In the Catia V5 software, the manikin used to set up automatically or manually. It will show the height and length each part of the body. It is either in the standing or sitting position.

Table-1. Ergonomics test results.

Ergonomics Test Result				
Posture	Initial		Final	
	Score	MSD risk level	Score	MSD Risk Level
Hand	4	Low	3	Low
Face	5	Medium	3	Low
Right hand until elbow	6	High	3	Low
Left hand until elbow	5	Medium	3	Low
Part of head	3	Low	3	Low
Right Leg (toe to ankle)	7	High	6	High
Left leg (toe to ankle)	7	High	6	High

Posture editor used to edit the manikin posture in making the ritual ablution. Each of the part regions must be edit to a suitable degree of freedom. In this analysis, the manikin adjusted until it gets the best score in MSD risk level.

From hand analysis, the original score is 4 (low-risk MSD). The level of MSD risk is still available and not

a risk. However, after inserting the load 0.1kg, the score changes to 3. It shows that it is an ergonomic position in set up to make ritual ablution in the standing position.

Next, manikin analyzed for face position. The original score is 5 and changes of position is needed to get a suitable position and low score than 3. After altering the position, which changes the degree of freedom which the



full spine (Lumbar and Thoracic) to 23.221°. The final score changes to 3 which is acceptable.

For washing right hand until elbow, the first score is 6. After the change's degree of the arm position to 74.389° has been made the final score is 3. It shows that this position is better than before. As for left hand until elbow, the first score obtained is 5 which it needs further investigation. The final score is 3 when the degree of thoracic change of 4.897°. It shows that this position is better than before.

Washing the head was another part of abluion which need to be clean. Initial RULA analysis value is 3. This score was acceptable and in a good position in making the ritual abluion. It shows that the position is low risk even after inserting the load 0.1kg the score still maintained with score 3. It shows that it is an ergonomic position in set up to making ritual abluion in the standing position.

For leg (toe to ankle) cleaning, the analysis starts with the right leg. The original score was 7. It shows that this position is not suitable for making the ritual abluion. It indicates that need investigation and changes are required immediatly. It has a high risk for the users in that kind of position. After changes, the score from the RULA analysis still higher which is 6 but it still has a medium risk which better than 7.

Same goes for the left leg where the original score was 7. It shows that this position is not suitable for making the ritual abluion. It has a high risk for the users in that kind of position. From the RULA analysis shows that this position in making the ritual abluion using the portable abluion is not suitable, so it follows the users' comfortability whether they want to be in the sitting or standing position.

After all the analysis done, the measurement was taken from the suggestion by RULA analysis (Example of RULA analysis as in Figure-1). This measurement used to design PAS.

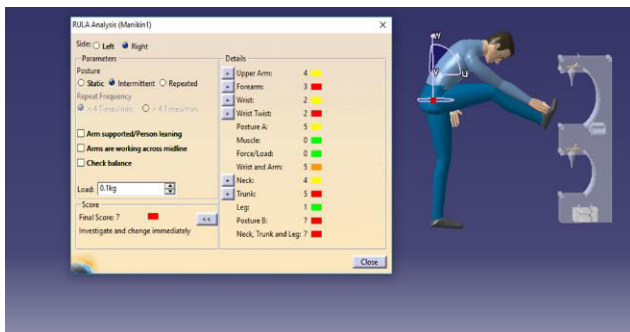


Figure-1. RULA analysis for leg.

PAS designed as a portable device and user-friendly machine. It operates manually, where ones just need to insert up to 1500ml of water bottle on top of the machine. The cap upon the machine can be removed and attached to the bottle.

The bottle with PAS caps just needs to be inserted on top of the machine. Water controlled by switches on the side of PAS flows down to all the piping system intended. One will control upper body abluion, while the other use for the foot. After finished washing face, head, and hand, Muslims just need to close the switch and then follows by feet. It is an initiative to reduce water consumption when they took abluion.

Figure-2 shows the design of a portable abluion system (PAS). It built-in two different levels, targeting only the essential body parts involved for abluion. The first level for face, head, and hand while the second level was for feet. It has been made into separate compartment as we considering water consumption used for abluion process at each body parts.

After all the process involved in abluion process completed, wasted water collected at the bottom of PAS, where this water can use for other purposes. In Islam, this water is not suitable to be reuse for retaking abluion, but it is still clean water for another usage. Here PAS will reduce water consumption after taking abluion. The procedure summarizes in Figure-3.

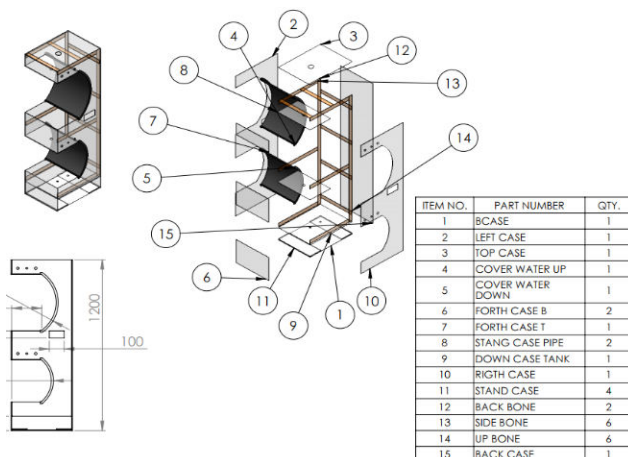
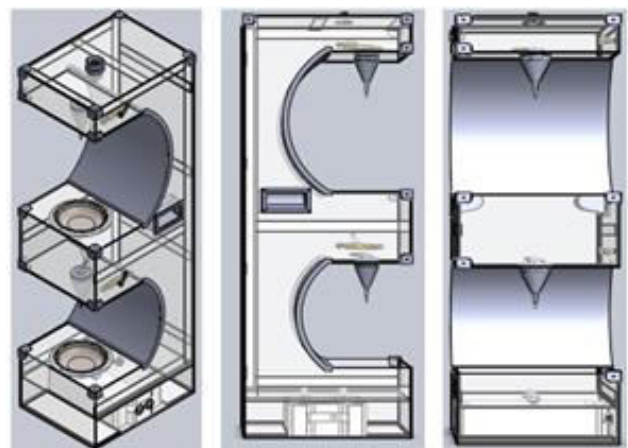


Figure-2. Portable abluion system design.

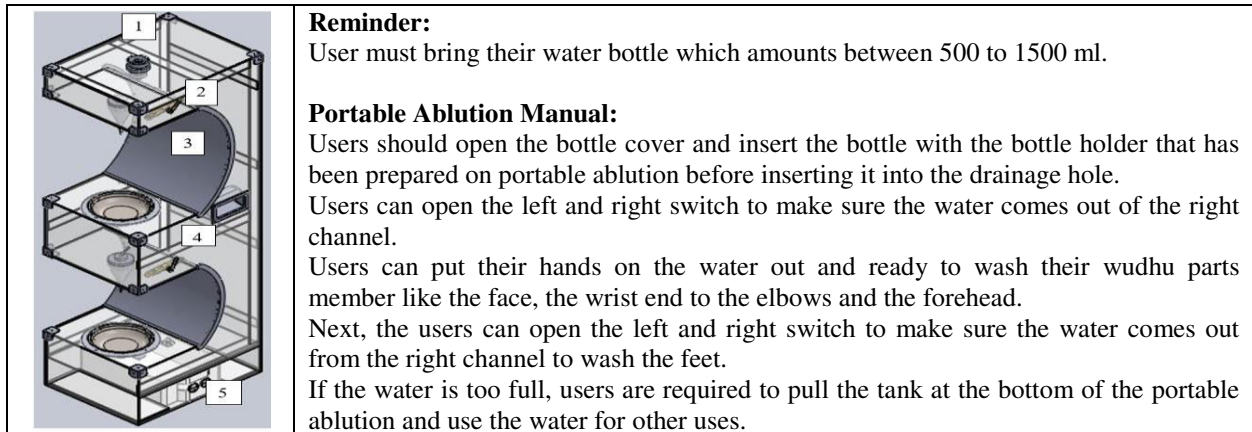


Figure-3. Manual instruction for PAS user.

**Table-2.** Innovations of ablution system.

Year	Name of Invention	Description
2017	Design of an ablution workstation among the wheelchairs users [6]	Their research is on the analysis of ablution workstation for the disabled population using the wheelchairs in Malaysia. Based on their research, in Malaysia, a set of Malaysian Standard developed as a guideline for the designer to build facilities which can be accessible by the disabled and elderly population. The design specification is provided for the disabled person to ensure they can access the public facilities. Based on this research study, they were using the RULA analysis by CATIAV5R19 software to test the available ablution design for disabled people who use the wheelchairs. The results outcomes are considered several factors such as the right posture within the limitation and ability of the disabled people, especially the wheelchair user and pertinent anthropometric dimensions for designing the ablution workstation.
2016	SmartWUDHU[7]	Development of the portable ablution machine with the solar system, which would save the water when making a ritual ablution. The system that they provide will control the flow of water and indirectly save the water. The design can maximise the usage of water from being wasting. The system that uses the solar panel as the source of the power to control the flow of water when the sensor detects the user's hand. The sensor used to identify the user's hand is an infrared sensor. The system that uses the solar is supported by the 12V lead-acid in the night to make sure the system runs smoothly even there is no light of the sun. Both solar power and 12V lead-acid control by battery charger controller.
2016	Image Processing Automatic Ablution Machine[8]	Development for ablution system by skin detection. The machine will detect skin and will apply the image processing technique. The central part of this machine divides into two which is the Logitech Quick Cam E-3500 Plus PC Camera and Arduino UNO controller. These two central parts are vital to actuate the servo motor to open or close the tap according to the skin detected. When the machine has detected the presence of skin, the tap is automatically open. It can more save water than the tap is open manually when making the ritual ablution.
2008	Auto Wudhu Washer [9]	Auto Wudhu Washer enables an individual to perform ablution in a standing position. The research of the study shows that the Auto Wudhu Washer is the world first automatic pre-prayer personal washing. There are two types of Auto Wudhu Washer which have been developed by AACE Technologies that suitable to individual needs and groups of the public.
2009	Sensory System Ablution System [10]	This machine is environment-friendly and allowed Muslim making an ablution ritual without spillage of water. It uses the camera as the sensor and servo motor as the actuator that embedded to the crane which to turn and open it if there is an object under the crane. It also uses an adaptive method which can detect how much water use every time a people making an ablution ritual. An example is how much water used for washing mouth then washing the nose. It not only useful for ablution activity but the daily activity such as hand wash, kitchen, and bathroom.
2007	Wudu Pal [11]	They were designed for wudu and istinja'. It is one of a design solutions for Muslim to make instinja' which washing the intimate areas before performing ablution for prayers. The benefits of this product are compact, portable, hygienic, and discrete. It is in a compact size which can carry in the pocket or purse. It has a litre of water which more than water bottles customarily used to make ritual ablution. After each use disposes of leftover water, fold it back and easily store in the given pouch again for use next time for an ablution process. However, a preview of user customers mostly said that this product not long-lasting because made of plastic and quickly damaged.
2007	WuduMate Compact [12]	Provide the next generation of washing appliances for ablution in prayers room, homes, and mosque. This product is easy to install at the building, and supplied with an optional seat handle, making it easier for the elderly and infirm to stand and sit. It also designs together with some taps, in each case the tap spout located in the most comfortable position for wudu, with the direction of water-flow designed to minimise splashing to make sure the users clothe is not wet in making the ritual ablution.



CONCLUSIONS

An ergonomic study using the CATIA V5 software by RULA analysis is one of the methods to show a suitable position in making the ritual ablution using the portable ablution. Each part region of the body can be modified in the manikin to get the best final score. Based on the analysis the overall average of the position in making ritual ablution is available and still can be accepted. It shows that users and consumers need their comfortability on the position in making the ritual ablution whether they can be in the standing or sitting position.

For wasted water conservation, researchers hope that the method suggested in the design of PAS should be enough. However, several studies should be made afterwards. PAS will be fabricated and tested as an actual ablution system. Data obtained from the process will imply the effectiveness of PAS.

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REFERENCES

- [1] R. A. Zaied. 2017. Water use and time analysis in ablution from taps, *Appl. Water Sci.*, 7(5): 2329–2336, doi: 10.1007/s13201-016-0407-2.
- [2] J. Dul and W. P. Neumann. 2009. Ergonomics contributions to company strategies, *Appl. Ergon.*, 40(4): 745–752, doi: 10.1016/j.apergo.2008.07.001.
- [3] A. Samsudin, N. Rosli, and A. N. Ariffin. 2017. Stability analysis of explicit and implicit stochastic Runge-Kutta methods for stochastic differential equations, *J. Phys. Conf. Ser.*, 890(1), doi: 10.1088/1742-6596/890/1/012084.
- [4] A. Aman, S. Z. M. Dawal, and N. I. A. Rahman. 2017. Design and analysis of wudu (ablution) workstation for elderly in Malaysia, doi: 10.1088/1757-899X/210/1/012069.
- [5] M. Lynn and N. Corlett. 1993. RULA: A survey method for the investigation of work-related upper limb disorders. *Appl. Ergon.*, 24(2): 91–99.
- [6] S. Z. M. Dawal, N. I. A. Rahman, and A. Aman. 2017. Wudu (Ablution) workstation design analysis for wheelchair user in Malaysia.
- [7] A. Suratkon, C. M. Chan, and T. S. Tuan Ab Rahman. 2014. SmartWUDHU: Recycling ablution water for sustainable living in Malaysia. *J. Sustain. Dev.*, doi: 10.5539/jsd.v7n6p150.
- [8] M. R. . (Submitted) Nur Ramiza. 2015. Automatic Ablution Machine Based on Image, Universiti Teknikal Melaka Malaysia .
- [9] Automated wudhu machine to help Muslims save water | The Star Online. <https://www.thestar.com.my/news/community/2008/12/03/automated-wudhu-machine-to-help-muslims-save-water> (accessed Mar. 22, 2020).
- [10] A. R. A. Besari, R. Zamri, A. Yusaeri, M. P. Md.Dan, and A. S. Prabuwo. 2009. Automatic ablution machine using vision sensor. *IEEE Symposium on Industrial Electronics and Applications, ISIEA 2009 - Proceedings*, vol. 1, pp. 506–509, doi: 10.1109/ISIEA.2009.5356425.
- [11] WO2014189352A1 - Disposable ablution pack - Google Patents. <https://patents.google.com/patent/WO2014189352A1/en> (accessed Mar. 22, 2020).
- [12] GB2460093A - A splash guard for a wudu unit - Google Patents. <https://patents.google.com/patent/GB2460093A/en> (accessed Mar. 22, 2020).