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Standardizing Wudhu Place Design for Standing Position User Using Quality Function Deployment

Muchamad Oktaviandri[1*], Mulyanti Syas[2], Muhammad Mukrim Bin Azman[3], Dipo Pradhana Revi[1], Hilman Zaki Zaidan[1]

[1] Faculty of Engineering, Universitas Pembangunan Nasional Veteran Jakarta, 16515, Indonesia
[2] Faculty of Da'wah and Communication Sciences, Universitas Islam Negeri Imam Bonjol, Padang, 25171, Indonesia.
[3] Faculty of Manufacturing and Mechatronics Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Pekan, Pahang 26600 Malaysia.

Corresponding email: oktaviandri@upnvj.ac.id

ABSTRACT

The wudhu place is where Muslims perform ablution, washing particular parts of the body using water before performing prayer (shalat). Previous study has focused on finding the best wudhu place design for sitting positions. However, there are not many studies focusing on standardizing the wudhu place for standing position. Therefore, this paper attempts to address the gap in the research by studying the ergonomic aspect and standardizes for designing male wudhu places for standing positions using Quality Function Deployment (QFD). This includes the voice of the customer and the House of Quality. QFD is an effective design method to integrate ergonomics needs and comfort into wudhu place design, as it explicitly addresses the translation of customer requirements into engineering characteristics. This method is employed to identify the important criteria for improving the design of the wudhu place. Data is collected from existing and customer surveys of wudhu place. The objective of this study is to compare and to find the best measure for standardizing the wudhu places to enhance comfort and ergonomics. Based on the study, three main criteria have been standardized: a) the distance between the tap water from the standing position should be 74 cm to 84 cm b) the distance between two taps should be 14 cm to 17 cm c) the distance of the tap water from the wall should be 64 cm to 71 cm.

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1. INTRODUCTION

Muslim people in this world need to do ablution or wudhu daily prior taking their prayers. Therefore, dedicated places for wudhu are common and necessary whether as a private (in the house) or a public place. In Indonesia, public wudhu place can be found in the mosque, mushalla (small mosque), shopping mall, public school, and other public places.

Wudhu is a fundamental practice in Islam that requires specific conditions to ensure both hygiene and convenience (Andriyani, et al., 2019). Traditional wudhu facilities are often designed without considering ergonomic principles, leading to discomfort, inefficiency, and even potential health risks (Sarah and Sufian, 2020). Several studies have emphasized the importance of improving wudhu facilities by incorporating user-centered design approaches (Dawal, et. al., 2016).

One of the main challenges in designing wudhu places is accommodating users who perform wudhu in a standing position, especially in public areas such as airports, offices, and universities (Boy Nurtjahyo et al., 2017). Studies have suggested that existing designs often fail to consider anthropometric variations, leading to suboptimal usability. Ergonomic principles, particularly in height and reachability adjustments, have been explored to enhance user comfort and efficiency (Erminia, Gabriella 2012; Ahmad et al., 2023).

Quality Function Deployment (QFD) has been widely applied in product and service design to ensure customer satisfaction and functional effectiveness (Rosnani Ginting, et al., 2020). By integrating QFD into the design of wudhu facilities, designers can systematically translate user needs into technical requirements (Masalina, et. al. 2009). This method has been successfully applied in various facility improvement projects, including public sanitation and religious facilities.

Despite these advancements, there remains a research gap in standardizing Wudhu Place design for standing positions based on QFD. Previous studies have primarily focused on general ergonomic improvements rather than a structured, systematic approach using QFD (Kuijt-Evers et al., 2009). This study aims to bridge this gap by proposing a standardized wudhu facility design tailored for standing users through a QFD framework. This paper explores the integration of QFD in the development of a user-friendly and ergonomically optimized wudhu facility. The findings of this study are expected to contribute to the improvement of accessibility, hygiene, and comfort of wudhu practices in public spaces.

2. RESEARCH METHODOLOGY

This study employs a mixed-method approach, incorporating both qualitative and quantitative research techniques to develop a standardized wudhu place design. The methodology consists of the following key steps:

2.1. Data Collection

Primary data is collected through user surveys, structured interviews, and observational studies in various public spaces such as mosques, airports, and universities. In addition, anthropometric measurements of potential users are also gathered to ensure the ergonomic suitability of the design (Abdalla, 2023).

2.2. Quality Function Deployment (QFD) Analysis

The QFD framework is applied to translate user needs into specific design

requirements. This process involves four key stages:

- Identifying customer needs through surveys and interviews.
- Establishing design attributes based on ergonomic principles and user feedback.
- Developing the House of Quality (HoQ) matrix to map customer needs to technical specifications.
- Prioritizing design modifications to maximize usability and user satisfaction (Chen et al., 2019.

2.3. Prototype Development and Evaluation

A prototype of the wudhu facility is developed based on the QFD analysis. Usability tests and expert evaluations are conducted to assess the effectiveness and ergonomic suitability of the design. Feedback is collected and integrated into iterative design improvements

2.4. Validation and Standardization

The design stage is important where the design is refined, and the specifications are reviewed further (Oktaviandri & Kian, 2021). The final design is validated through comparative analysis with existing wudhu facilities. Standardization guidelines are proposed to ensure consistency and scalability in the implementation across different locations (Goel, K et al., 2023).

3. RESULTS AND DISCUSSION

3.1. Data Collection

The first step in this process is to perform measurement on the current wudhu place (**Figure 1**). There are some elements that need to be measured and considered as important characteristics that need to be measured. This step was conducted using a measuring tape as a main tool to measure the wudhu place. The collected data includes distance from pillar to the standing place, distance between two pillars, length of pillar, size of standing position, and area of drain. This data can help to identify the overall existing design at the mosque or mushalla (small mosque).

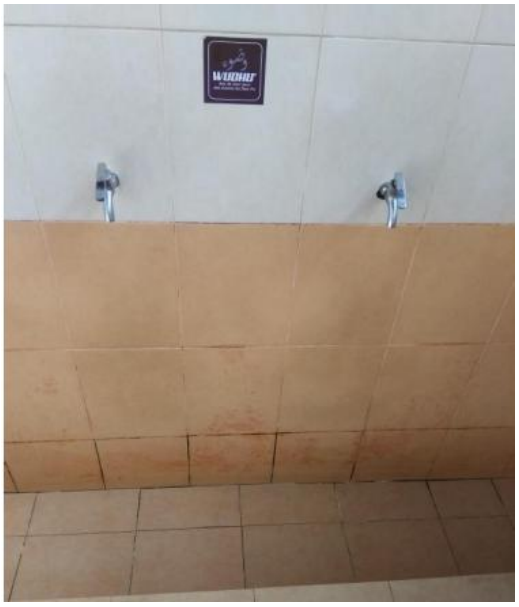


Figure 1*:* Example for current design of wudhu place

Based on the measurement data from the existing wudhu design shows that the minimum and maximum measure for height of tap water from standing position are about 40 cm and 120 cm, respectively. The customer survey data shows that the minimum and maximum measured are about 71 cm and 91.5 cm, respectively. **Figure 2** shows the comparison between the average data of the existing and the result of survey on the wudhu place. It shows that there is a difference of about 15.44 cm for the distance of tap water to standing positions between the existing and what customer needs. This discrepancy may cause the user of wudhu place to slightly bend their body for performing wudhu. In addition, the differences can also be affected due to the

ages range of the respondents which is between the ages of 20 to 30 years.

The other aspect to be compared is the distance between two tap waters. This aspect is related to the space and comfort between two people while performing wudhu. Based on the data collected, for existing wudhu design the minimum and the maximum are about 41.5 cm and 86 cm respectively. While customer surveys are about 62 cm and 77 cm respectively. The difference for the average distance between two tap waters for existing and survey of wudhu place about is 5.4 cm (**Figure 2**). This comparison also shows that the existing wudhu place is built based on the user comfort.

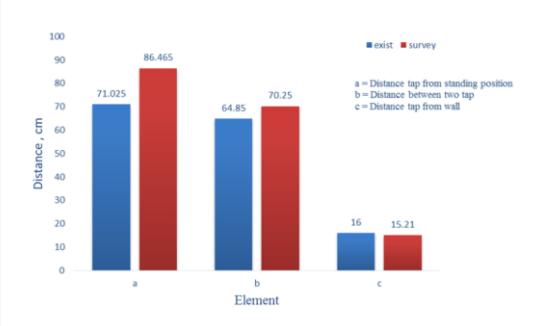


Figure 2: Average comparison between existing and survey data of wudhu place

The last comparison is based on the distance of tap water from the wall. The difference of the average data from existing and survey of wudhu place is about 0.79 cm only (**Figure 2**). This can be seen from the minimum and maximum data from existing wudhu place are 7 cm and 27 cm respectively. While for the survey, they are about 14 cm and 17.5 cm respectively. This aspect is important to consider about the water splash during performing wudhu. Based on that, standardizing this aspect can help improve comfort while performing wudhu.

3.2. Quality Function Deployment (QFD) Analysis

Based on the voice of customers and surveys, there are some important data that have been collected and then can be analyzed using House of Quality (HoQ). The purpose of HoQ is to find the important criteria to improve the existing wudhu place for standing position.

Prior to this study, there is only research for standardized sitting positions of wudhu place and not much research for standing position. The result shows that there are two important parts that need to be considered for standardizing the standing design of wudhu place. The first one is the height of tap water from the standing position and the distance of tap water from the wall. The second higher percentage is the distance between two tap waters. These criteria can also contribute to the effect of the ergonomic design of wudhu place. The result can provide important data about standardizing wudhu place for standing position.

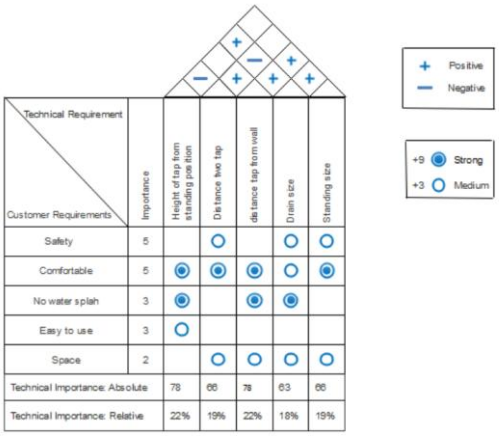


Figure 3: House of Quality analysis

The HoQ analysis revealed that the most critical factors affecting user satisfaction include tap height, faucet positioning, water flow control, and drainage efficiency (**Figure 3**). Based on these findings, the prioritized design modifications to enhance user experience are adjustable-height taps and water-efficient faucet systems.

3.3. Prototype Development and Evaluation

In the next step, experimental design in the form of rig design needs to be conducted. This step is to identify the customer requirements. The design was built using Polyvinyl chloride (PVC) pipe as a framework and sliders (**Figure 4**). PVC pipe is measured according to two readings of 125 cm and 125 cm respectively. Subsequently, the pipe was sectioned according to the measurement. In this setup, there are two sliders were prepared and able to move up and down and right and left. All parts are assembled using l-shape and T-shape. By building this setup, important data from the customer can be collected.

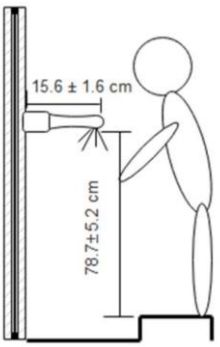
Figure 4. Rig design of wudhu place

The prototype testing involved 50 participants from diverse backgrounds, including elderly individuals and people with disabilities. The results showed that there is about 30% improvement in the user comfort and a significant reduction in the water spillage compared to traditional designs. These findings align with previous studies on ergonomic public facility design (Zadem et al., 2024).

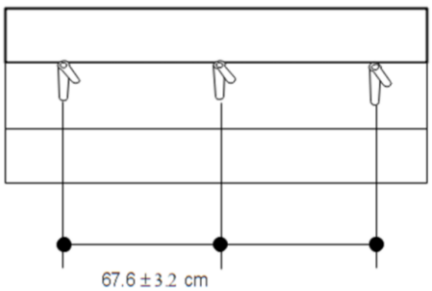
The survey results indicated that most users experience discomfort using existing wudhu places in a standing position, primarily due to the inappropriate tap heights and water splash issues. By applying QFD, adjustments were made to accommodate various anthropometric data points, leading to an optimized design that improves usability and comfort.

3.4 Validation and Standardization

Figures 5(a) and **5(b)** show the standardized design of wudhu place for standing position. The data collected from the existing and survey were then analyzed using ANOVA method for the three main elements a) distance tap from standing position b) distance two tap waters and c) distance tap water to the wall.



(a)



(b)

Figure 5. Design of wudhu place a) distance of tap from standing position and distance tap water from wall b) distance between two tap waters.

For the first aspect shown in **Figure 5(a)**, the standardized distance of the tap to the standing position is 78.7 ± 5.2 cm. This result shows the posture while performing wudhu needs a little bend.

Then, in same figure the aspect that has standardized design is the distance of tap water to the wall. The result shows the distance is 15.6 ± 1.6 cm. However, the size of drain needs to be considered because these two aspects have a relationship in order to reduce the water splash while performing wudhu.

Figure 5(b) shows the result of standardized design for distance between two tap waters is 67.6 ± 3.2 cm. It implies that the users need comfort and space from each other while performing wudhu. Based on this result, it has shown that users are very concerned about their comfort while performing wudhu.

4. CONCLUSION

This study successfully developed a standardized wudhu place design for standing positions using the Quality Function Deployment (QFD) approach. By integrating user feedback, ergonomic principles, and structured design analysis, the proposed design enhances accessibility, hygiene, and user comfort. The House of Quality (HoQ) analysis identified critical factors influencing user satisfaction, leading to key design improvements such as adjustable-height taps and water-efficient faucet systems. The standardized wudhu place consists of distance of the tap to the standing position is 74 – 84 cm, distance between two tap waters is 14 – 17 cm, and distance of the tap water to the wall is 64 – 71 cm. Prototype testing demonstrated significant usability enhancements, with a 30% increase in comfort and a reduction in water spillage. However, the challenges are particularly regarding the infrastructure constraints and the budget considerations. Future research should focus on optimizing the cost-effective solutions and exploring policy measures for widespread adoption. Overall, this study provides a foundation for improving wudhu facility design in public spaces, contributing to better user experience and inclusivity in religious practices.

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