

Analysis of the Efficiency of Using Water for Wudu in Modern Mosque Plumbing Systems

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Abstract. This study focuses on analyzing the efficiency of water usage during ablution in mosques, aiming to identify the factors causing inefficiency and propose solutions aligned with sustainability and Islamic values. Ablution is essential for Muslim prayer, yet modern mosques often neglect water efficiency, leading to waste and high operational costs. A mixed-methods approach was employed, combining observations, water discharge measurements, and surveys from 35 congregants at an urban mosque. The results showed an average ablution water consumption of 2.47 liters per person, with significant variation, primarily due to faucet usage behaviors. The survey also revealed that 45.71% of participants viewed water use as inefficient, with mixed responses regarding the implementation of automatic faucets. These findings underscore that water conservation cannot be achieved solely through technical solutions like sensor faucets or water recycling systems. Instead, it requires integrating Islamic values and education to encourage behavioral change among mosque-goers. By promoting awareness and responsible water use, mosques can become role models in environmental conservation. This study highlights the importance of combining technical engineering solutions with spiritual values, contributing to a more sustainable and efficient use of resources in mosque facilities while adhering to Islamic principles.

Keywords: Ablution Water Efficiency; Behavioral Change; Islamic Values; Mosque Sustainability; Water Conservation.

1. INTRODUCTION

Water is an important element in the practice of Islam, especially in wudu, which is a prerequisite for prayer. In modern mosques, plumbing systems have been implemented to provide comfort for worshippers, but water efficiency is often not a priority. Clean wudu water is generally disposed of directly into the sewer system without any system for reuse. This phenomenon contradicts the Islamic principle that prohibits wastefulness (*israf*), as emphasized in the hadith of the Prophet Muhammad SAW, which forbids excessive use of water, even when performing wudu in a river.

The increasing need for sustainable water management requires systematic efforts to review and analyze the efficiency of mosque plumbing systems. Mosques not only serve as places of worship, but also have the potential to set an example in environmental conservation by integrating religious values with sustainable practices. In this context, water conservation is not merely a technical issue, but also a spiritual responsibility that reflects balance, cleanliness, and stewardship of nature.

Previous studies on water use in mosques have generally focused on the technical aspects of plumbing design or theoretical simulations of water usage, without the active participation of managers or congregations. This has led to a research gap, where technological innovation

has not been fully aligned with social acceptance and religious legitimacy.

Therefore, this study aims to analyze the efficiency of water use in modern mosque plumbing systems, identify factors causing inefficiency, and formulate technical solutions in line with sustainability principles. The novelty of this research lies in the integration of a technical-analytical approach with community participation based on sharia values. Thus, the research results are expected to produce solutions that are not only technically efficient, but also contextual, applicable, and accepted by the congregation as a tangible form of environmentally friendly worship.

2. MATERIALS AND METHODS

This study uses a mixed-method design by combining quantitative, descriptive, and participatory approaches. The quantitative approach is used to measure the volume of water used for wudu, while the descriptive approach serves to analyze the overall condition of the mosque's plumbing system. The participatory approach was applied by involving mosque administrators and congregations in the process of identifying problems and formulating solutions so that the research results are applicable and acceptable to the user community.

This study lasted for six months, beginning with a literature review and initial observations on the concept of water efficiency, the design of plumbing systems in places of worship, and an examination of Islamic values related to resource conservation. The mosques selected for the study were chosen based on inclusion criteria, namely mosques with modern plumbing systems, a relatively high number of regular worshippers, and located in urban areas. Mosques that still use traditional water distribution systems or do not have permanent wudu facilities were excluded from the study.

The research subjects consisted of mosque administrators and congregants who used the wudu facilities. Primary data was obtained through direct observation of the number of taps, duration of water use, and consumption patterns of congregants, supplemented by semi-structured interviews with mosque administrators regarding challenges in water management. In addition, measurements of wudu water volume at the taps were taken using measuring containers and water flow meters to determine the average consumption per person. Secondary data was obtained from literature related to water conservation, sustainable plumbing design standards, and Islamic teachings on the prohibition of waste.

Quantitative data was analyzed descriptively by calculating averages, efficiency percentages, and identifying points of waste. The results of this analysis formed the basis for developing alternative technical simulations, such as the implementation of automatic taps,

simple recycling systems, or water storage tanks for wudu. Qualitative analysis of interviews was used to understand the perceptions and level of acceptance of the congregation towards the proposed solutions.

Based on the analysis results, a prototype of a more efficient and environmentally friendly wudhu water management system was developed. This prototype was then tested in a pilot mosque, and the results were evaluated to assess its effectiveness in terms of savings, ease of use, and acceptance by worshippers. The final stage of the research was an overall evaluation and the preparation of technical recommendations in the form of simple and educational guidelines that could be applied in other mosques. These recommendations not only emphasized technical solutions but also integrated Islamic values to encourage water-saving behavior as a form of worship and environmental responsibility.

3. RESULTS AND DISCUSSION

Result

Measurements of water usage for wudu produced the data shown in Table 1. The volume of water used ranged from 1.47 liters to 3.73 liters, with an average of 2.47 liters per person. The duration of wudu varied from 27 seconds to 98 seconds, with an average time of 50.46 seconds. The water flow rate from the tap showed a minimum value of 0.022 liters/second, a maximum of 0.124 liters/second, and an average of 0.054 liters/second. This data shows that there are significant differences in water usage among worshippers even though they perform the same worship activities.

Table 1. Water Measurement Data.

Parameter	Minimum	Maximum	Rata-Rata
Volume Air (Liter)	1,470	3,730	2,474
Durasi Waktu (Detik)	27,000	98,000	50,457
Debit Air (L/s)	0,022	0,124	0,054

The results of the observation show that variations in water usage are mainly influenced by how worshippers operate the faucet. With conventional faucets, some respondents leave the water running throughout the entire wudu process, resulting in higher water volume and flow rates. Meanwhile, worshippers who are more careful in turning off the faucet when moving on to the next step use less water.

This phenomenon indicates that individual behavior plays a major role in determining

the efficiency of water use for wudu. In addition, interviews with mosque administrators revealed that the high variation in water usage has a direct impact on increasing the mosque's monthly water operating costs.

Table 2. Results of Interviews on the Efficiency of Ablution Water.

Pertanyaan	Pernyataan (%)						
	Ya	Tidak	Tidak Penting	Kurang Penting	Penting	Cukup Penting	Sangat Penting
Apakah Anda merasa penggunaan air wudhu di masjid sudah efisien?	54.29	45.71					
Apakah Anda pernah mematikan keran saat mengusap anggota wudhu tertentu?	40.00	60.00					
Menurut Anda, apakah air wudhu yang terbuang masih bisa dimanfaatkan kembali?	54.29	45.71					
Apakah Anda setuju jika masjid menggunakan keran otomatis berbasis sensor?	48.57	51.43					
Menurut Anda, apakah biaya air masjid saat ini cukup tinggi?	65.71	34.29					
Seberapa penting menurut Anda hemat air dalam wudhu?			0.00	0.00	3.50	34.29	37.14
Apakah Anda bersedia mendukung program konservasi air di masjid?	34.29	65.71					

The questionnaire results from 35 respondents show that only 34.29% of worshippers consider the use of wudu water in mosques to be efficient, while 45.71% believe otherwise. A total of 40.00% of worshippers admitted to turning off the tap to reduce water usage, while the other 60.00% have not done so consistently.

When asked about the potential for utilizing wasted ablution water, 54.29% of respondents agreed, while 45.71% disagreed. The congregation's views on the implementation of sensor-based automatic taps were relatively balanced, with 48.57% agreeing and 51.43% disagreeing.

In addition, 65.71% of respondents considered the cost of water for the mosque to be quite high, while 34.29% considered the cost to be reasonable. Regarding the importance of water conservation during wudu, 37.14% of worshippers stated that it was very important, 34.29% considered it quite important, and 28.57% considered it important. In response to the

final question, the majority of worshippers (65.71%) stated that they were willing to support water conservation programs in mosques.

The results of the observations and congregants' responses show a consistent pattern. Most congregants do not have the habit of turning off the tap when moving between stages of wudu, resulting in wasted water. However, the majority of congregants are aware that the cost of water at the mosque is quite high and that water conservation is important in worship.

Responses to the implementation of sensor-based automatic faucets remain divided, with some worshippers welcoming the innovation, while others remain hesitant due to habit. This shows that social acceptance of new technology requires additional education.

Discussion

Research conducted at one mosque showed that the average water consumption for wudu reached 2.47 liters per worshipper with a duration of approximately 50 seconds. There was considerable variation between individuals, ranging from 1.47 liters to 3.73 liters, which was mainly influenced by the behavior of worshippers in operating conventional taps. Some worshippers leave the faucet open throughout the entire wudu process, while others turn off the faucet when moving between stages, resulting in significant differences in water consumption. This situation leads to increased water inefficiency, which directly impacts the mosque's operational costs.

These findings are in line with previous studies that emphasize that individual behavior in controlling faucets greatly determines the level of water consumption for wudu. Other studies have even reported that the use of automatic faucet technology can reduce water usage by up to 30%. However, the questionnaire results show that the congregation's acceptance of this innovation is still divided, with 48.57% agreeing and 51.43% rejecting it. This supports the previous view that the successful implementation of conservation technology in mosques is greatly influenced by social factors and religious customs.

In practical terms, the results of this study confirm that although technical solutions such as automatic taps or wudu water recycling systems have great potential, their success is highly dependent on the awareness of the congregation. Thus, mosques play an important role as centers of education that integrate Islamic values regarding the prohibition of israf or wastefulness into water conservation programs. Efficiency in the use of wudu water cannot only be achieved through technical engineering, but also needs to be understood as part of the congregation's spiritual responsibility towards nature.

The limitations of this study are that it only covers one mosque with 35 respondents, so

the results cannot be generalized to all mosques with different conditions, such as mosques in rural areas or with larger congregations. In addition, this study does not consider other technical factors, such as variations in water pressure and plumbing design, which also have the potential to affect consumption. Further research needs to be conducted by comparing several mosques in different locations and conducting direct trials of the automatic faucet prototype in order to provide a more comprehensive picture of its effectiveness in saving water.

Overall, this study proves that in modern mosques, the use of wudu water is still inefficient due to the behavior of worshippers who are accustomed to using conventional taps without considering waste. Although some worshippers are aware of the importance of water conservation, acceptance of new technology is still divided, requiring a combination of technical solutions and Islamic values-based education to create a more effective water conservation system.

4. CONCLUSION

This study shows that the use of wudu water in modern mosques is still inefficient. Measurements taken at one mosque show that the average volume of wudu water reaches 2.47 liters per worshipper with considerable variation, mainly influenced by the use of conventional taps. These findings are in line with the questionnaire results, where most worshippers are aware of the importance of water conservation, but the habit of turning off the faucet is not consistently practiced. Responses to the implementation of sensor-based automatic faucet technology are also divided, confirming that successful water conservation in mosques requires the integration of technical solutions and education based on Islamic values.

Thus, it can be concluded that water conservation efforts in mosques are not merely a technical issue, but also a spiritual and social responsibility of the congregation. Mosques, as centers of Islamic activity, have great potential to set an example in the application of sustainability principles, both through more efficient plumbing systems and educational programs that instill awareness of the need to avoid waste (*israf*). Further research is recommended to involve more mosques with diverse conditions and to conduct trials of water-saving technology implementation in order to obtain a more comprehensive picture of the effectiveness of conservation programs.

ACKNOWLEDGEMENTS

The author would like to express his deepest gratitude to the mosque administrators and congregation who actively participated in this research by providing valuable data and input.

Thanks are also extended to the supervising lecturer and colleagues for their constructive suggestions and guidance, which have enriched the quality of this research. Support from community leaders and technical staff in facilitating field observations and measurements is also greatly appreciated. Finally, the author is very grateful to the experts for their appropriate and constructive advice and input, which has enabled the results of this research to be presented more effectively.

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