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Water Conservation in Ablution: An Evaluation of Mist Spray Devices and Their Financial Impact on Water Usage and Sustainability in Communal Facilities

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ABSTRACT

This paper examines the efficacy of mist spray apparatuses in diminishing water consumption during the process of ablution, an activity that accounts for substantial water usage in religious sites and other communal facilities. The primary objective is to evaluate the potential of these mist spray devices for effective conservation of water in such settings. The methodology incorporates thermal camera image processing, paired with the use of mist spray devices, to monitor and quantify water usage during ablution at selected locations. The research design encompasses three (3) distinct objectives. In the empirical portion of the study, selected participants are mandated to perform ablution using both a conventional faucet and a faucet equipped with a mist spray device. Water consumption is measured for both methods. A comprehensive dataset is assembled, encompassing both pre- and post-ablution thermal camera images, which serves as the basis for machine learning training and validation. Furthermore, each participant is interviewed to assess their comfort level while using the mist spray device. The findings of the study indicate that the utilisation of mist spray devices can considerably mitigate water consumption by an impressive margin of more than 97%, without compromising user comfort or the validity of the ablution, as verified through machine learning processed thermal images. The study observed a peak water conservation measurement of 56.6 ml, equivalent to 0.10 Mudd. The study's findings also validate previous research, affirming that conventional faucet water consumption during a typical ablution averages 5L per person. Theoretically, implementing the proposed solution in Sultan Haji Ahmad Shah Mosque could drastically reduce water consumption to roughly 23,000 litres per month. This could result in substantial cost savings of approximately RM1219 per month or RM14,628 per year. These significant findings have profound implications for water sustainability and conservation, particularly in regions with scarce water resources.

INTRODUCTION

Water, albeit recognised as a fundamental human necessity, only constitutes approximately 0.3 percent of the global water resources available for consumption (Earth's Freshwater, n.d.). Numerous regions worldwide are already grappling with water scarcity, with over one billion individuals lacking access to safe drinking water (Jury & Vaux Jr, 2007) and two-thirds of the global population live under conditions of severe water scarcity at least 1 month of the year (Mekonnen & Hoekstra, 2016). This alarming statistic serves as a prominent indicator of the urgent need to safeguard our water sources. The demand for water continues to rise in correlation with the global population; however, several factors, notably human activities, are causing the depletion and pollution of water supplies and promoting their oblivious use. Furthermore, changes in population on water shortage over 1950 to 2005 are roughly four (4) times as important as changes in water availability due to long-term climatic change (Kummu et al., 2010). Consequently, it is imperative to consider and implement practical solutions to curb water usage.

The concept of water usage pertains to the systematic stewardship of water, aiming to avert wastage, mismanagement, and exploitation of this resource. The objective of effective water efficiency planning is to optimise usage without compromising comfort or performance (Loucks & van Beek, 2017; *The Water Conservancy Home*, n.d.; Zeinalie et al., 2021). The optimisation of water resources and economic growth faces significant constraints due to various limitations, including defining land usage in relation to water, considering population needs in terms of water availability, accounting for industrial water usage, and addressing water requirements for urban areas (Qu et al., 2024). This procedure involves gauging the water volume utilised during specific activities across different genders, ages, cultures, lifestyles, and environmental contexts, to identify the most feasible and practical solution (Gleick, 1996). In 2020, the per capita daily domestic water consumption for Peninsular Malaysia and the Federal Territory of Labuan was 245 litres, significantly exceeding the United Nations' benchmark of 165 litres per person per day. The elevated level of water usage is attributable to the notably low water tariffs, with Malaysians paying an average rate amongst the lowest in Southeast Asia (*Malaysia Department of Economic and Social Affairs*, n.d.). The threat to Water Security has been exacerbated by climate change's impact on water infrastructure. The destruction of water infrastructure or alterations in water resource availability can compromise the water supply, with surface water from rivers and reservoirs accounting for over 97% of the water supply (ASEAN Working Group for Water Resources Management (AWGWRM), 2013). During the 2013 and 2014 drought periods, several dams in Malaysia experienced water levels falling below critical thresholds. The Department of Irrigation and Drainage (DID) Malaysia, which reports daily on water levels in 23 dams, noted that these levels surpassed the danger and critical marks (Abdulah et al., 2014).

Given the high cost associated with constructing new municipal water supply infrastructure (Gorelick et al., 2022), the primary focus should be reducing demand. Various techniques can be employed to decrease demand from municipal water supplies, including rainwater harvesting (Ali & Sang, 2023; Raimondi et al., 2023; Yao et al., 2023), grey water recycling (Kordana-Obuch et al., 2023; Van de Walle et al., 2023), drip-irrigation (Mahmud et al., 2023), leak maintenance (Moock et al., 2023), and the use of water-efficient fixtures (Amin et al., 2023; Jawaid, 2023; Shajal, 2023) such as showerheads, faucets, and toilets. Given the ubiquity of faucets at the endpoint of the water distribution network, enhancing faucet design and installed efficiency is critical for improving water efficiency.

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According to a narration from Abdullah bin ‘Amr R.Anhuma, when Rasullullah PBUH noticed Sa’d performing ablution, he asked him, "What is this extravagance?" Sa’d responded, "Can there be any extravagance in ablution?" Rasullullah PBUH replied, "Yes, even if you are on the bank of a flowing river". (Muhammad bin Yazid Ibn Majah al-Qazvini, n.d.) Given this hadith and with the global population of Muslims at 1.8 billion estimated to increase by 70% in 2060 (Hackett & Mcclendon, n.d.), it is crucial for Muslims to adopt techniques that reduce water consumption. With ablution being a prerequisite for 5 daily prayers, a reduction in water consumption through any implemented technique would have a significant impact. This not only enhances water efficiency and reduces costs for the mosque but also aligns with the Maqasid Shariah. Therefore, this research aims to determine the water consumption level during ablution with and without a mist spray device at identified locations. It proposes to conduct a thorough analysis of the efficiency of the device in reducing water consumption and its coverage on the skin using thermal image processing and machine learning, with practical recommendations.

METHODS AND MATERIALS

Process Flow

Figure 1 presents the schematic illustration of the proposed system design. The system commences its operation upon the detection of a hand or an obstruction, which triggers the infrared (IR) sensor. Subsequent to this detection, the electric valve actuates, initiating the water flow. Without detection of hand or an obstruction, the electric valve will remain inactive. This will prevent any water flow. A self-tapping nozzle is the preferred. This choice is due to its efficiency. The volume of water utilised is computed during water flow. This information is subsequently alerted to the user via a Light Emitting Diodes (LEDs). The LEDs will be light up according to a specific capacity of water. An important component of the system is the use of a thermal camera to detect the water coverage on user’s body. YOLOv5 deep learning model is utilised to perform assessment of user’s coverage. The feedback from this assessment is informed to the users. Users are advised whether the current coverage is sufficient or further water is required. The system aims to significantly reduce water consumption. An IR sensor is utilised to detect obstruction thus used to manage water flow during ablution, while a mist spray device is installed to decrease the overall water flow significantly. The system integrates these components to function optimally and provides a viable solution for minimising water usage. This approach ensures efficient water conservation.

A total of 36 students from diverse backgrounds within the university campus were approached for data collection related to image processing datasets. The dataset was divided into training (29 students) and validation (11 students) groups. However, only 7 students participated in the water consumption evaluation process over the course of one (1) week with nationality as the demographic’s questions were asked. This evaluation aimed to measure water usage based on nationality, with most participants hailing from Organisation of the Islamic Cooperation (OIC) nations. Each student’s water consumption was measured once after ablution at different intervals for each prayer session they attended at the mosque, hostel musollah or faculty musollah. The location was selected as the central location for this study due to its strategic position where the students usually went for the five (5) daily prayers. For the conventional faucet, mosques and hostel musollahs were selected, whereas for the mist spray system, the faculty musollah was chosen due to its installation within the faculty compound.

Fig. 1. System Flow Chart

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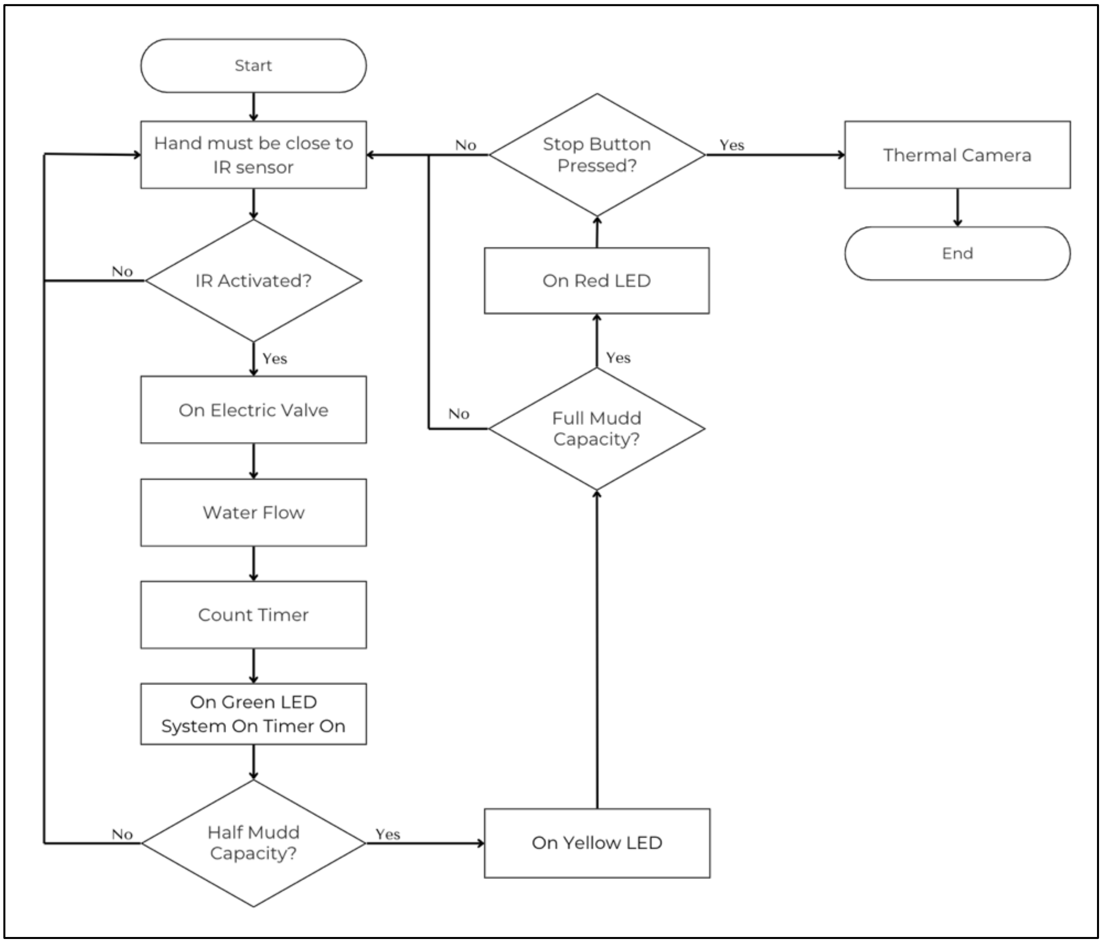


Source: Authors (2024)

System Architecture

The ritual purification process, known as ablution, is an integral part of the Islamic cultural and traditional practices. However, it can have a considerable influence on water consumption. A potential strategy for mitigating this impact involves the employment of an innovative mist spray nozzle system, comprising an infrared (IR) sensor, an electrically operated valve, and their associated control circuitry. The IR sensor's primary function is to ascertain the presence of an individual undertaking the ablution. Upon successful detection, the electric valve is triggered, dispensing water as shown in Figure 2 (Centre Left). Water mist albeit very low in volume, is sufficient for the purification ritual according to Shariah provided that strict guidelines are followed. To cater for specific requirements of the individual engaging in the ablution, an electric valve is used to precisely control the volume of water dispensed by user. Such an adjustments can contribute to a further decrease in water usage and associated costs as different user may have different style in performing ablution.

Furthermore, the incorporation of a three (3) level LED lights could also significantly enhance user experience by informing user their used water capacity as shown in Figure 2 (Left). The green LED light functions as a system indicator and a low water level warning; the yellow LED light signifies medium water level, while the red LED light alerts the user to maximum water capacity as shown in Figure 2 (Left). This feature facilitates timely user awareness of water consumption. This feature allows user to take necessary action before water is depleted. Integrating user awareness and system is key in ensuring that an environmentally beneficial water conservation, preservation of water resources, and a reduction in associated costs could be achieved.

Utilising an infrared (IR) sensor in conjunction with a timer and required codes written in Arduino UNO, the system is able to compute and indicate the exact quantity of water used during the ablution process. To trigger the timer, an IR sensor's is used to detect the presence of a person performing ablution.

Upon completion of the ritual, the timer either stops automatically due absence of the person or through hard reset as shown in Figure 2 (Centre Right). We can calculate the precise amount of water consumed during the ablution by recording the time duration during which the IR sensor detects the person. The time information is then processed by Arduino and the amount of water consumed in millimetre is then displayed on the serial monitor in real-time. This feature allows user to regulate their own water usage during ablution more efficiently, giving way for a more sustainable water management. The mist spray installed at the current faucet is shown in Figure 2 (Right).

Left Centre Left Centre Right Right

Fig. 2. Green, Yellow and Red Indicator Light with Red Switch On with mist spray installed (Left), Flow of water when IR Sensor Triggered without mist spray (Centre Left), Stop Push Button (Centre Right), Mist Spray Installed Zoom View (Right)

Source: Authors (2024)

Machine Learning Using Thermal Images

The use of thermal images in this project are particularly useful for the identification of temperature variations on a human body. To enable the model to differentiate between a dry and wet skin using thermal images, images of pre- and post-ablution were captured in different lighting and environmental condition. These images were then utilised to train the YOLOv5 machine learning model in this project.

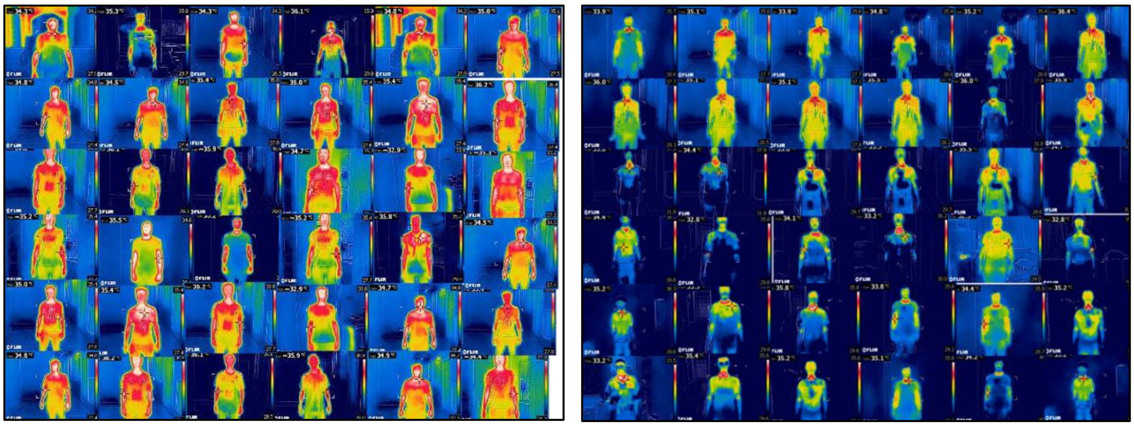
The project implementation using YOLOv5 is divided into three (3) different stages – pre-processing, training, and validation to allow for a structured approach and effective model development. During the preprocessing stage, thermal images were cropped and resized to augment the model's performance. While in the training stage, the model is trained to identify the characteristics of water on human skin. Substantial number of images were processed by the YOLOv5 during the training stage to develop the model. These images were separated into two (2) datasets a post- and pre-ablution. The post-ablution contains images of individuals with their bodies covered in water and a lower temperature on the skin, while pre-ablution contains images of individuals with their bodies dry and at a higher temperature. The presence of water on the body lowers the skin's body temperature, resulting in a shift in the thermal image's colour from red to yellow to blue on the affected area. This colour shift enables the model to identify and classify the image accordingly. In order to have a comprehensive and robust dataset, images for pre- and post-ablution were collected at a mosque in an open ablution area at different prayer times. Further, improve the accuracy of YOLOv5 model, a fine-tuning using additional training data and adjustment of the model's hyperparameters has been performed.

RESULTS AND DISCUSSION

Datasets

Thermographic images may depict the individual's body as unusually cold when in the proximity of water. It is essential to factor in this influence while interpreting thermal imagery and to duly accommodate it during the analysis of temperature readings. A primary rationale behind employing thermal camera for detecting water coverage in this project is their ability to discern temperature variations.

The dataset delineated below underscores the stark contrasts between individuals who have performed ablution and those who haven't. A meticulous collection and examination of data reveal clear discrepancies in the attributes and responses of individuals within these two (2) categories, as depicted in Figure 3. This information plays a pivotal role in comprehending the impacts of ablution as perceived through the lens of a thermal camera, and in providing the YOLOv5 model with an appropriate image for training.



Left Right

Fig. 3. Image Dataset showing effect of water on skin body on ablution. Before (Left) After (Right)

Source: Authors (2024)

Training and Validation of Dataset

The process of annotating datasets holds significant relevance in the application of YOLOv5 (You Only Look Once version 5) within the domain of supervised machine learning. This process is integral for the machine learning model to acquire the ability to discern specific objects or features within a given image.

A lack of annotations would render the model incapable of understanding the characteristics it ought to identify within the image. By facilitating the model with annotated data, it learns to form an association between particular features in the image and their corresponding labels. This association significantly enhances the model's precision in identifying objects or features in the image. Training a machine learning model with a diverse collection of annotated data aids in its capacity to generalise to novel, unseen images. This is attributed to the model's exposure to a broad spectrum of variations of the objects or features it aims to recognise. YOLOv5 adopts the technique of using bounding boxes to identify objects within an image. These boxes are characterised by the coordinates of their corners. Consequently, image annotation is paramount in defining these boxes and training the model to recognise objects within them as shown in Figure 4. Furthermore, annotated data is employed to train and examine YOLOv5.

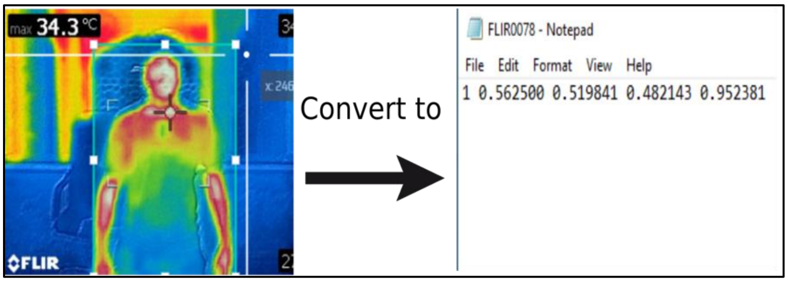


Fig. 4. Image to Coordinate Conversion

Source: Authors (2024)

In this research, the application of the YOLOv5 algorithm in conjunction with a thermal camera for the detection of water coverage has been examined. The YOLOv5 model, renowned for its adeptness at object detection within graphical data such as images and videos, was subjected to 65 epochs of training. The training set comprised thermal images with and without water presence. The model displayed a commendable level of accuracy, as evidenced by the mean average precision (mAP) of 0.842 and a mAP50-95 score of 0.842. The model was thus capable of classifying novel thermal images into categories of 'water-containing' and 'water-absent'. The high mAP and mAP50-95 scores are indicative of the efficacy of the YOLOv5 model in detecting water coverage within thermal images. Figure 5 provides a visual representation of the model's predictions concerning the presence and absence of water coverage.

Notably, the model did not err in any of its predictions. Figure 6 displays the model's impressive accuracy level, which stands at 0.995. The data encapsulated in these figures suggest that after undergoing 65 epochs of training, the model's precision has reached a state of stability. Consequently, additional epochs are not anticipated to contribute significantly to the enhancement of the model's accuracy. This is due to the already high level of precision the model has achieved. The importance of determining the optimal number of epochs, in this case, 65, should be underscored. The mere increase in epochs does not necessarily result in improved accuracy. The current results reflect a significant enhancement in accuracy. Furthermore, the overall loss in predictions has been effectively reduced.

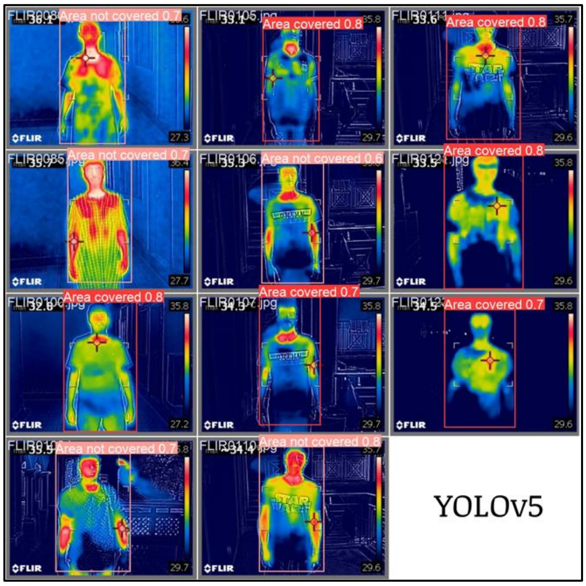


Fig. 5. Validation Images

Source: Authors (2024)

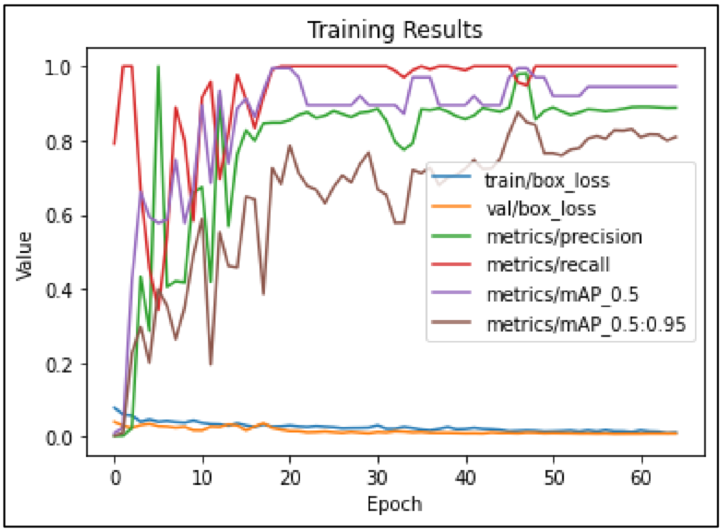


Fig. 6. Training Results

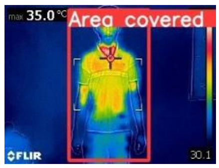
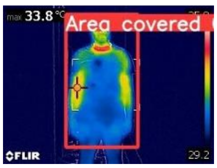
Source: Authors (2024)

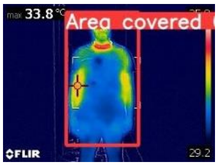
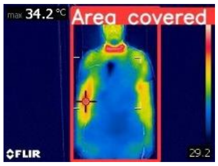
Comparison

The implementation of a mist spray apparatus within a faucet with thermal imaging verification represents an innovative approach aimed at enhancing water efficiency during the act of ablution. Table 1 epitomises the efficacy of the mist spray mechanism in ensuring comprehensive coverage of requisite body regions for ablution without impinging upon comfort or the validity of the ablution process. Findings drawn from the research indicate a marked reduction in water usage as a result of employing the mist spray, with potential savings of up to 97.9% in comparison to the use of a conventional faucet. These outcomes are especially significant as they underscore the capacity of mist spray technologies to function as a sustainable and efficient alternative or even in certain condition a substitute for a Muslim to perform their ablution.

Further, based the study, it was discovered that the mist spray device could successfully cover the necessary body surface area for an ablution as required by Shariah without diminishing the user's comfort levels. This finding was corroborated by participants who reported negligible differences between the use of conventional faucet and mist spray, when asked about their comfort level and skin's coverage. This crucial discovery suggests that the mist spray offers equivalent levels of comfort and coverage as traditional techniques, with superior water efficiency. The data showcased in Table 2 constitutes a robust testament to the potential of the mist spray project reducing water usage between 93% to 97.9% contributing substantially towards curbing water consumption and fostering sustainable practices during ablution. The mist spray technology's potential extends beyond water conservation to enhance the comfort and efficiency of ablution, including a reduction in residual water on the skin removing the use of paper towels. The result of this study suggests compelling evidence in favour of incorporating mist spray technologies within different build environment such as mosques or musolla ablution areas, public restrooms, and residential properties.

Table 1. Comparison for Before and After Ablution Using Conventional Faucet and Mist Spray

Users	Before Ablution	Ablution using conventional faucet	Ablution using mist spray	Percent of water saved
1		 4.9 l	 183 ml	96.3%
2		 5.3 l	 142 ml	97.9%
3		 4.1 l	 96 ml	97.3%
4		 6.2 l	 163 ml	93.0%

5			5.8 l	 153 ml	97.4%
6			6.3 l	 192 ml	96.9%
7			4.8 l	 164 ml	96.6%

Source: Authors (2024)

Measure the Daily Ablution in The Mosque

Table 2 presents the findings of a comprehensive investigation aimed at evaluating the water consumption during the religious ritual of ablution amongst individuals hailing from various countries. The research was executed on a select group of five (5) prayer-goers from distinct nations, and the amassed data was employed to compute the mean water consumption per region. The findings divulged that the mean water consumption during ablution amidst the participants was significantly high. It was observed to be approximately eightfold the volume of water traditionally suggested by the Prophet. The volume used by the Prophet has a quantity known as 'Mudd' and equivalent to 544 millilitres (Zaied, 2017).

Table 2. Ablution Water Consumption Using Conventional Faucet

Nationality	Location	Subuh (Dawn)	Zuhur (Mid-Day)	Asar (Late Afternoon)	Maghrib (Sunset)	Isyak (Nightfall)	Average	No. of Mud Used
Egypt	Musollah	5.4 l	5.8 l	5.1 l		5.9 l	5.6 l	≈ 8.5
Yemen	Mosque	5.0 l	4.8 l	5.1 l	4.7 l	4.5 l	4.8 l	≈ 7
Ethiopia	Mosque	5.8 l	5.1 l		5.1 l	4.8 l	5.0 l	≈ 8
Malaysia	Mosque	6.2 l		6.8 l			6.5 l	≈ 10
Bangladesh	Mosque	5.1 l				4.4 l	4.6 l	≈ 7
Syria	Mosque	5.5 l	5.2 l	5.7 l		5.0 l	5.2 l	≈ 8
Mauritania	Mosque	5.9 l	5.5 l	5.8 l		5.9 l	5.7 l	≈ 9
						Average	5.3 l	

Source: Authors (2024)

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The mean water consumption measured in the study was found to be around 5 litres. This corroborates nearly to the prior study conducted by Mohamed et al., 2016 shown in Table 3. The data displayed in the Table 2 indicate that water consumption fluctuates amongst the nations, with Malaysia reporting the highest usage at 6.5 litres and Bangladesh registering the lowest usage at 4.6 litres. These findings highlight the need for additional research and sustainable awareness to public regarding the importance of reducing water usage during ablution. The excessive water consumption observed in the study compared to the ones used by the Prophet could potentially have detrimental consequences for the environment and water resources in the long run. Available measures indicate relative Mudd measurement maybe a good indicator needed to ensure water consumption is optimised as later shown by Table 4.

Table 3. Amount of Water Used During Ablution

User	Quantity of Water(l)	Time Taken (s)
1	5.6	50
2	5.0	46
3	5.3	55
4	4.7	48
5	4.9	43
6	6.3	59
7	5.1	52
8	4.3	42
9	4.5	43
10	5.5	47
Average±Std Dev	5.12±0.59	48.5±5.6

Source: Mohamed et al. (2016)

It is critical to acknowledge that each study was conducted with a limited sample size, thus the findings should be interpreted cautiously. Further research using a larger sample size and a wider range of countries is essential to support these findings. Nevertheless, the outcomes of this investigation offer valuable understanding into the current water usage habits during ablution and could be beneficial in guiding future initiatives to advocate for more sustainable water usage. The overarching aim of the study is to foster awareness about potential water wastage during ablution and to motivate individuals to adhere to the Prophet's recommended water usage.

The data measured during this project delineated in both Table 2 and Table 4 underscore the substantial water conservation accomplished via the deployment of the mist spray within different nationalities. Malaysia still reporting the highest usage at 187.5 ml even through mist spray deployment. The integration of an Infrared (IR) sensor, which instigates the water flow exclusively when a hand is detected, coupled with a tri-LED sensor system to signify the residual water capacity for users, has resulted in a remarkable reduction in water consumption by over 97%. This is achieved without any compromise on user comfort and the validity of the ablution process. The empirical evidence strongly suggests that the mist spray project has been notably successful in curtailing water usage during ablution. Indeed, the system has surpassed its initial goal of emulating the water usage by Prophet PBUH during ablution, instead realising a peak water conservation of 56.6 ml, tantamount to 0.10 Mudd.

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Table 4. Ablution Water Consumption with Mist Spray Adapter Installed

Nationality	Location	Subuh (Dawn)	Zuhur (Mid-Day)	Asar (Late Afternoon)	Maghrib (Sunset)	Isyak (Nightfall)	Average	No. of Mud Used
Egypt	KOE		152.0 ml	120.0 ml			136.0 ml	0.25
Yemen	KOE		53.0 ml	60.0 ml			56.5 ml	0.10
Ethiopia	KOE		102.0 ml	95.0 ml			98.5 ml	0.18
Malaysia	KOE		190.0 ml	185.0 ml			187.5 ml	0.34
Bangladesh	KOE		143.0 ml	132.0 ml			137.5 ml	0.25
Syria	KOE		89.0 ml	79.0 ml			84.0 ml	0.15
Mauritania	KOE		161.5 ml	150.5 ml			152.0 ml	0.27
						Average	130.4 ml	

Source: Authors (2024)

Practical Application

The optimal theoretical location for our study is the Sultan Haji Ahmad Shah Mosque. This mosque is strategically situated at the core of the International Islamic University Malaysia's primary campus in Gombak and serves as a nexus between dormitories, administrative structures, and academic offices. The mosque can accommodate a maximum of 9,000 individuals at any given time. In terms of amenities, the masjid houses two (2) ablution areas distinctly designated for males and females. Additionally, men have access to three (3) supplementary external ablution facilities. The mosque's ablution water is disposed of through concealed pipe drains, while stormwater is collected in the open drains encircling the mosque. A noteworthy limitation is the absence of a dedicated water meter, making it challenging to ascertain the precise quantity of water consumption each month. However, the mosque's management office estimates that the average attendance on a typical working day (excluding Fridays) is approximately 3,000 individuals. Consequently, the projected water consumption for a 30-day period, assuming full attendance (with Friday taken as typical workday) and a water consumption rate of 5 litres per person, amounts to 450,000 litres per month. According to water rate as published by Suruhanjaya Perkhidmatan Air Negara (*Suruhanjaya Perkhidmatan Air Negara*, n.d.), this translates to an approximate cost of RM 1278. Our proposed solution involves the installation of a mist spray system. We anticipate that this will significantly decrease the water consumption to about 23,000 litres per month, resulting in a substantial cost-saving of approximately RM1219 per month or RM14,628 per year.

CONCLUSION

The research adopted a mechatronics-oriented framework to explore innovative strategies for water conservation. The study examined the integration of a mist spray nozzle and a thermal imaging system, aimed at minimising water usage whilst preserving its efficacy. The mist spray nozzle proved adept in significantly reducing water consumption without compromising the coverage of the targeted area. The thermal imaging system demonstrated precision in detecting whether specific areas were sufficiently covered, thus ensuring sustainable water use. The research findings underline the potential of mechatronics-oriented solutions in tackling the urgent need for water conservation. It is advisable that additional studies and development efforts be undertaken to refine the system and extend its applications to other water-sensitive scenarios like agriculture and industry. The study also proposes that comparable research be executed to discover other innovative water conservation strategies. The practicality and feasibility of

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implementing a mist spray system have been corroborated, exhibiting a 97.5% reduction in water consumption and a significant anticipated cost saving of RM14,629 per year in the identified location. The integration of the mist spray device is a manifestation of the harmonious blend of Islam, science, and engineering, making it a worthwhile implementation. It epitomises sustainable contemporary living aligned with Islamic teachings.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Basondowah Hussein Hassan contributed significantly to this research project by designing the methodology, conducting investigations, curating and analysing data, and drafting the original manuscript. Additionally, Basondowah Hussein Hassan played a crucial role in validating the results obtained. Syamsul Bahrin Abdul Hamid provided invaluable contributions to this study by conceptualising the research, reviewing and editing the manuscript, supervising the project, and conducting formal analyses. Syamsul Bahrin Abdul Hamid's supervision ensured the quality and integrity of the research process, while their review and editing enhanced the clarity and coherence of the manuscript.

REFERENCES

Abdulah, N. A., Jusoh, J., & Kassim, A. R. (2014). Capacity Development to Support National Drought Management Policy.

Ali, S., & Sang, Y.-F. (2023). Implementing Rainwater Harvesting Systems as a Novel Approach for Saving Water and Energy in Flat Urban Areas. Sustainable Cities and Society, 89, 104304. https://doi.org/https://doi:10.1016/j.scs.2022.104304

Amin, M. M., Dorra, E. M., & Hosny, O. A. (2023). Optimization of Urban Water Consumption in Residential Buildings. Sustainability, 15(10), 7952. https://doi.org/https://doi.org/10.3390/su15107952

ASEAN Working Group for Water Resources Management (AWGWRM). (2013). Malaysia 2013 Report

(Water Supply Management).

Earth's Freshwater. (n.d.). https://education.nationalgeographic.org/resource/earths-fresh-water/

Gleick, P. H. (1996). Basic Water Requirements for Human Activities: Meeting Basic Needs. Water International, 21(2), 83–92. https://doi.org/10.1080/02508069608686494

Gorelick, D. E., Gold, D. F., Asefa, T., Svrdlin, S., Wang, H., Wanakule, N., Reed, P. M., & Characklis, G. W. (2022). Water Supply Infrastructure Investments Require Adaptive Financial Assessment: Evaluation of Coupled Financial and Water Supply Dynamics. Journal of Water Resources Planning and Management, 149(3), 04022084. https://doi.org/10.1061/JWRMD5.WRENG-5863

Hackett, C., & Mcclendon, D. (n.d.). Christians Remain World's Largest Religious Group, But They Are Declining in Europe. In Pew Research Center. https://www.pewresearch.org/short-reads/2017/04/05/christians-remain-worlds-largest-religious-group-but-they-are-declining-in-europe/

Jawaid, S. (2023). A Review of Life Cycle Assessment of Water Efficient Technologies in Buildings. Journal of Water Resource Research and Development, 6(1), 42–46. https://doi.org/http://dx.doi.org/10.5281/zenodo.7884954

Jury, W. A., & Vaux Jr, H. J. (2007). The Emerging Global Water Crisis: Managing Scarcity and Conflict Between Water Users. Advances in Agronomy, 95, 1–76. https://doi.org/https://doi.org/10.1016/S0065-2113(07)95001-4

Kordana-Obuch, S., Starzec, M., Wojtoń, M., & Słyś, D. (2023). Greywater as a Future Sustainable Energy and Water Source: Bibliometric Mapping of Current Knowledge and Strategies. Energies 2023, Vol. 16, Page 934, 16(2), 934. https://doi.org/10.3390/EN16020934

Kummu, M., Ward, P. J., Moel, H. de, & Varis, O. (2010). Is Physical Water Scarcity a New Phenomenon? Global Assessment of Water Shortage Over the Last Two Millennia. Environmental Research Letters, 5(3), 34006. https://doi.org/10.1088/1748-9326/5/3/034006

Loucks, D. P., & van Beek, E. (2017). Water Resources Planning and Management: An Overview. Water Resource Systems Planning and Management, 1–49. https://doi.org/10.1007/978-3-319-44234-1_1

Mahmud, N. A., Sabil, A., Hisham, N. N., Siraj, S., Adnan, N. A., & Md Amin, N. D. (2023). Sustainable Living: Alternative Green Structure Module Design for Home Self-Food Production. IOP Conference Series: Earth and Environmental Science, 1205(1), 012085. https://doi.org/10.1088/1755-1315/1205/1/012085

Malaysia Department of Economic and Social Affairs. (n.d.). Retrieved April 7, 2024, from https://sdgs.un.org/basic-page/malaysia-34130

Mekonnen, M. M., & Hoekstra, A. Y. (2016). Four Billion People Facing Severe Water Scarcity. Science Advances, 2(2), e1500323. https://doi.org/10.1126/sciadv.1500323

Mohamed, R., Adnan, M. N., Mohamed, M. A., & Kassim, A. H. M. (2016). Conventional Water Filter (Sand And Gravel) for Ablution Water Treatment, Reuse Potential, and Its Water Savings. Journal of

Sustainable Development, 9(1), 35–43. https://doi.org/https://doi.org/10.5539/jsd.v9n1p35

Moock, M. R., Williams, B., & Bender, J. (2023). Creating a Comprehensive Survey and Preventative Maintenance Plan for Water Piping Infrastructure on a Historic College Campus. 2023 Systems and Information Engineering Design Symposium (SIEDS), 84–89.

Muhammad bin Yazid Ibn Majah al-Qazvini. (n.d.). Sunan Ibn Majah (Vols. 1–425).

National Geographic Society. (2024). Earth's Freshwater. https://education.nationalgeographic.org/resource/earths-fresh-water/

Qu, Y., Song, B., Cai, S., Rao, P., & Lin, X. (2024). Study on the Optimization of Wujiang's Water Resources by Combining the Quota Method and NSGA-II Algorithm. Water 2024, Vol. 16, Page 359, 16(2), 359. https://doi.org/10.3390/W16020359

Raimondi, A., Quinn, R., Abhijith, G. R., Becciu, G., & Ostfeld, A. (2023). Rainwater Harvesting and Treatment: State of the Art and Perspectives. Water, 15(8), 1518.

Shajal, A. K. (2023). The Impact of Green Buildings on Urban Sustainability and Energy Consumption. Journal of Sustainable Urban Futures, 13(6), 11–21.

Suruhanjaya Perkhidmatan Air Negara. (n.d.). https://www.span.gov.my/

The Water Conservancy Home. (n.d.). Retrieved April 7, 2024, from https://thewaterconservancy.org/#programs

Van de Walle, A., Kim, M., Alam, M. K., Wang, X., Wu, D., Dash, S. R., Rabaey, K., & Kim, J. (2023). Greywater Reuse as a Key Enabler for Improving Urban Wastewater Management. Environmental Science and Ecotechnology, 16, 100277. https://doi.org/10.1016/J.ESE.2023.100277

Yao, J., Wang, G., Jiang, X., Xue, B., Wang, Y., & Duan, L. (2023). Exploring The Spatiotemporal Variations in Regional Rainwater Harvesting Potential Resilience and Actual Available Rainwater Using a Proposed Method Framework. Science of The Total Environment, 858, 160005.

Zaied, R. A. (2017). Water Use and Time Analysis in Ablution from Taps. Applied Water Science, 7(5), 2329–2336. https://doi.org/10.1007/s13201-016-0407-2

Zeinalie, M., Bozorg-Haddad, O., & Azamathulla, H. M. (2021). Optimization in Water Resources Management. Springer Water, 33–58. https://doi.org/10.1007/978-981-33-4295-8_2/COVER