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Integrating cultural perspectives in online ablution water usage monitoring: a design for sustainability

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Water is an important resource for performing ablution before prayer. However, lack of communication and information between prayer congregations regarding the amount of water used during ablution, the absence of environmental protection consciousness, and the impact of cultural behavior can be the factors causing wasteful water use during ablution. This study aims to design and implement an internet-based monitoring system that integrates cultural values in evaluating ablution water consumption. The correlation between cultural dimensions and preferences for an online monitoring system of ablution practices was examined using confirmatory factor analysis and structural equation modeling. The results showed that uncertainty avoidance, power distance, and long-term orientation were identified to significantly influence online monitoring preferences for ablution activities. The preferences of sensor accuracy, safety case to cover from water, and durable material were determined as the most important design specifications for online monitoring systems. The real-time evaluation of online monitoring was performed through smartphone applications and web-based interfaces. Considering cultural preferences when developing a water monitoring system strategy can increase awareness regarding environmental sustainability, advocate for conscientious water management, and control water usage. The inclusion of cultural value in the design process is expected to provide valuable insights for product designers when establishing design specifications. Additionally, it expands the usefulness of Hofstede's cultural theory in the context of the creation and development of products.

KEYWORDS

design communication, ablution, online monitoring system, cultural preferences, environmental issues, sustainability, sustainable product design

1 Introduction

As one of the five pillars of Islam, prayer (Salah) is a mandatory act of worship for all rational adult Muslims. Salah is performed five times daily at specific times: Fajr (e.g., before dawn), Dhuhr (midday), Asr (afternoon), Maghrib (just after sunset), and Isha (night). A ritual purification that entails the washing of specific body regions is required prior to the

performance of each prayer, known as Ablution (Wudu). Begin by establishing an intention, followed by the following: hand cleansing, mouth rinsing, and nose cleaning. The face is the subsequent area to be washed, followed by the arms up to the forearms. The head and ears are wiped with wet palms, and the feet are washed up to the ankles. This sequence is executed with precision and in the appropriate order. Upon completion, a supplication is recited to reaffirm one's faith in Abdullah et al. (2022). This unique cleansing ritual goes beyond just getting clean. It is also about finding a deep spiritual connection. Each step reminds Muslims to stay pure and humble. Following the set order helps them to be more disciplined and respectful in their worship. In this ritual, the conservation of water demonstrates Islam's commitment to environmental sustainability and the prudent utilization of resources. It reminds people to know how much water they use (Abid and Ansari, 2020). However, there is a big problem of using too much water during this ritual, especially in mosques. Much water is used during ablution. Lack of information about water saving, poor water systems, and lack of monitoring of how much water is used add to this problem (Akça Doğan et al., 2024).

Efforts have been made to reduce water use during ablution rituals. These efforts involve creating water taps equipped with sensor systems to help regulate water flow (Nazeer et al., 2023). Despite these advancements, individuals often need help to gauge the amount of water they use for ablution, leading to wastage. Introducing water monitoring for ablution practices could be crucial in addressing this issue (Abid and Ansari, 2020). Through the implementation of water monitoring systems, mosques, and other Islamic institutions can manage water usage during ablution activities. This initiative aims to raise awareness among individuals regarding their water consumption habits during ablution and encourage them to adopt water usage practices (Afrianto et al., 2023). Moreover, online water monitoring offers real-time insights into water consumption patterns, enabling the identification of areas where wastage occurs or inefficient practices are followed. These data can guide the adoption of conservation strategies and efficient utilization methods, such as installing water fixtures or conducting campaigns to conserve water during ablution routines. Additionally, online water monitoring supports the introduction of initiatives and measures aimed at saving resources. For instance, it can offer information to back up the implementation of specific water taps or sensors that regulate water flow while washing, ensuring that only the right amount of water is utilized. Furthermore, online water monitoring can potentially contribute to supporting the sustainability efforts of mosques and Islamic institutions (Thomson, 2021). However, accepting the implementation of online water monitoring systems can be challenging because of cultural value influences and traditional practices.

Culture can be essential in all aspects of human behavior and user preferences on online water monitoring in ablution activities (Ghazali et al., 2023). In some cultures, there is growing prominence in considering sustainable practices, including online monitoring systems to ensure that water is used efficiently during ablution. This is important in some regions where water scarcity is a pressing issue, and cultural norms are shifting to embrace conservation efforts. As advancements in technology continue to reshape the interaction with water resources, it is vital to consider the cultural values that shape attitudes and behaviors toward water usage, particularly in religious practices. By embedding cultural perspectives into the design and implementation of online water monitoring systems for ablution, these technologies can be effective in promoting water conservation and respecting diverse cultural values and traditions (Ploom et al., 2020). Online water monitoring for ablution activity holds great importance in Muslim communities (Afrianto et al., 2023). However, this study noticed a limited study concerning the development of online water monitoring systems, specifically for ablution activities in Muslim communities considering cultural preferences. Therefore, the specific cultural and religious significance of ablution in the context of Islam is required for the successful design and implementation of online water monitoring systems for ablution activities. The potential issues of uncontrolled water used during ablution activities are depicted in Figure 1.

The primary objective of this study is to design and implement an online monitoring system for water ablution activities, taking into account the cultural preferences of the users. The present work is structured into three distinct sections to achieve its objective. This part presents a comprehensive assessment of prior research on the relationship between culture and online monitoring preferences, as well as the formulation of hypotheses. The second stage of the study involves the assessment of the produced hypotheses through the utilization of confirmatory factor analysis (CFA) and structural modeling. The last section focuses on the creation and assessment of the prototype. The final part also elucidates the potential impact of behaviors and knowledge.

2 Culture and monitoring preferences

Culture comprises the acquired and transmitted modes of thought, emotion, and conduct that are indicative of the unique achievements of human societies. This extends to the material manifestations of these values. It is a collective system of knowledge, beliefs, procedures, attitudes, and artefacts within a community rooted in traditional ideas and values (Hofstede, 2001). Culture contains the ideas and behaviors necessary for an individual to be recognized as a member of a specific culture (Birukou et al., 2013). Behaviours, beliefs, and practices are significantly influenced by culture, particularly in religious rituals like ablution. For example, in individualist societies such as the United States or Western European countries, personal responsibility and autonomy are prioritized, which may result in a more personalized approach to water conservation during ablution. In contrast, the emphasis on community welfare and group cohesion in collectivist cultures, such as Japan or numerous Middle Eastern societies, may encourage a shared responsibility for sustainable water use. Furthermore, in masculine societies such as Japan or Germany, where competitiveness and efficiency are highly regarded, there may be an emphasis on the efficient utilization of resources during ablution. In contrast, feminine societies, such as the Netherlands or Sweden, prioritize the quality of life and the well-being of others. This may result in a more sustainable and nurturing approach to the use of ablution water.

The adoption of technology is significantly influenced by culture, which affects the attitudes, beliefs, and behaviors of individuals and groups toward innovations (Steers et al., 2008). In certain cultures, the emphasis is placed on tradition and stability, which can result in a cautious approach to the adoption of new technologies. This resistance frequently results from a preference for conventional methods and change skepticism. Conversely, other cultures may prioritize

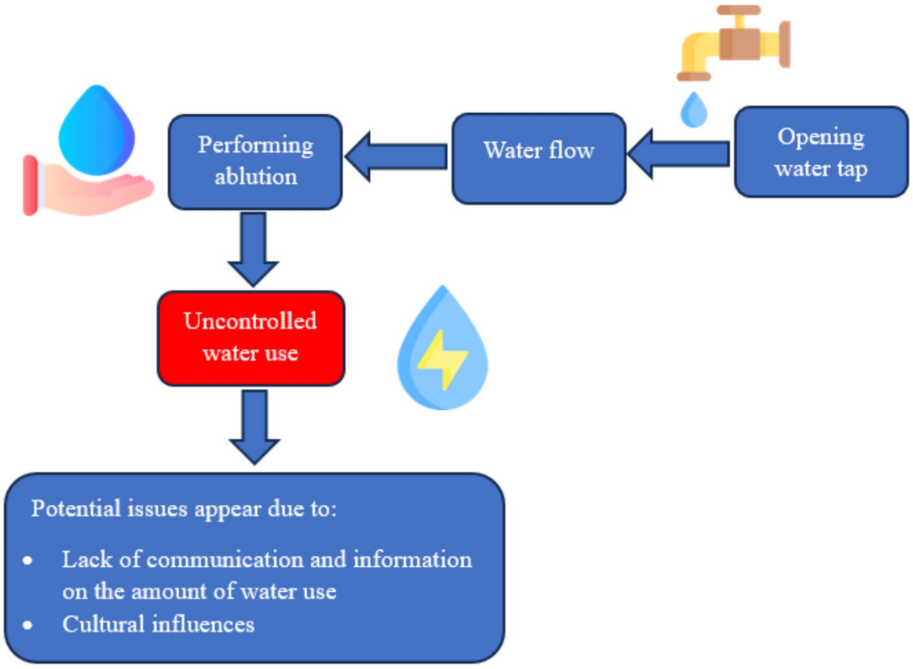

FIGURE 1
Existing issues during ablution activities.

innovation and progress, which may result in a more impassioned and rapid adoption of new technologies (Martínez-Caro et al., 2020). Furthermore, how information about new technologies is communicated and received can be influenced by cultural norms regarding communication, trust, and authority, which in turn affects adoption rates. For instance, in societies where community leaders or influencers are highly trusted, their endorsement of technology can substantially increase its acceptability (Al-Maroof et al., 2020). It is imperative to comprehend these cultural dynamics to effectively promote and manage the adoption of technology in a variety of settings.

Geert Hofstede, a pioneer in cultural studies, conducted a study in over 40 nations and identified five cultural aspects: individualism and collectivism, masculinity-femininity, power distance, uncertainty avoidance, and long-term orientation. Individualists are autonomous individuals indifferent to not being part of a community (Steindl and Jonas, 2012). Individualism is a psychological attribute characterized by individuals prioritizing their interests over those of the group (Frost et al., 2010). Individualists adhere to their ideas, whereas collectivist societies emphasize social unity, collaboration, and shared goals over individual endeavors, as stated by Hofstede (1993). Individualist characters tend to be more independent in decisions and consider personal preferences. Individuals in collectivist settings are more inclined to utilize internet technologies for ablution if they believe they are supported or practiced by their community members. In collectivist societies, peer pressure is commonly used to enforce adherence to society's standards and ideals. When monitoring internet tools for ablution becomes familiar in a collectivist Islamic society, individuals may feel obligated to utilize these tools to preserve social cohesion. Collectivist cultures may be more inclined to use such instruments due to their emphasis on communal efficiency and collaboration. Monitoring internet tools for ablution to improve the efficiency of practicing Islam in a group setting might lead to increased acceptance. Communal learning and information sharing are prevalent in collectivist cultures. Furthermore, using online monitoring tools for ablution is a way for the community to improve their compliance with Islamic civilizations via collective learning.

It is a widespread practice to classify men and women as masculine and feminine. This practice results in a substantial variation in gender roles between countries, necessitating the implementation of various effective remedies. De Mooij (2019) highlighted that the values vary widely from country to country, with some nations emphasizing assertiveness, competition, goal accomplishment, and success as masculine characteristics. In contrast, other cultures emphasize welfare, style, color, societal compulsion, modesty, and attractiveness as feminine characteristics. People who closely follow traditional masculine values may view using internet monitoring tools as a sign of dependency or weakness in carrying out a fundamental religious practice. They may think about the necessity of depending only on their knowledge and talents. Traditional masculine standards could influence one's confidence in one's religious self-efficacy, making individuals capable of carrying out religious practices independently (Pinna, 2020). This self-assurance could result in a hesitancy to utilize internet resources. Using internet technologies for religious rituals may be stigmatized, particularly if viewed as a contemporary or tech-savvy method (Barzilai-Nahon and Barzilai, 2005; McClure, 2017). Individuals who follow traditional masculine ideals may refrain from engaging in such behaviors to maintain their perceived masculinity. Male gender expectations may also include social pressure to adhere to a specific ideal of masculinity. If a subset of society follows these standards, they could dissuade their peers from using internet tools for cleansing rituals.

Power distance is the extent to which different national cultures acknowledge and receive unequal power distribution in society (Basabe and Ros, 2014). Power structures in society are typically associated with the concept of power distance, offering advantages to individuals based on their level of authority (Wang et al., 2020). In societies characterized by a significant disparity in power, individuals may be assigned predetermined roles within the social imbalance (Mikhailov and Kornilina, 2013). Power distance with low index views prioritizes maintaining and honoring natural equality in social interactions (Oyserman, 2017). In societies with considerable power distance, citizens often show great reverence for authoritative figures, such as religious leaders. If religious authorities or institutions support the use of internet monitoring technologies for ablution, individuals in these cultures may be more inclined to embrace and use them. Societies with high power distances may be concerned with spiritual practices as directed by religious management authorities (Kirkman et al., 2009). Water monitoring systems based on internet applications can provide precise and authoritative directions, making them more attractive to persons who prioritize rigorous adherence to religious customs. Cultures with high power distance may be more receptive to technology solutions for religious purposes if religious leaders approve these solutions. Internet resources might be considered a contemporary and effective method to meet religious duties. In societies characterized by high power distance, decisions and customs are often decided jointly and shaped by authoritative persons' views. If religious leaders or institutions endorse the use of internet tools for ablution, it might lead to a broad acceptance of these technologies in the community.

The uncertainty avoidance dimension refers to society's acceptance of complexities and is linked to humanity's pursuit of truth (Hillen et al., 2017). Individuals are more likely to be emotional and driven by anxious energy in uncertain circumstances. This attitude reflects the extent to which a culture has conditioned its members to experience discomfort or comfort amid chaotic circumstances. According to Hofstede (1993), unstructured situations are characterized by being distinctive, weird, surprising, and uncommon. Civilizations that accept uncertainty tend to be more tolerant of diverse opinions by aiming to establish minimal regulations and allow various philosophical and religious beliefs to coexist. The cultural aspect of uncertainty avoidance significantly influences individuals' choices regarding online monitoring systems in Muslim ablution rituals. Individuals with a high inclination toward uncertainty avoidance have a strong tendency toward predictability, stability, and unambiguous guidelines (Ayoun and Moreo, 2008). Regarding water usage for ablution, individuals may prefer an online monitoring system that offers accurate readings and immediate feedback on water consumption during the ritual. People with high uncertainty avoidance may prefer an online monitoring system that includes precise regulations and recommendations for appropriately completing ablution according to Islamic norms. The urge for clear standards and tight restrictions is motivated by a desire to minimize uncertainty and guarantee adherence to religious practices.

When preparing for the future, a person is ready to sacrifice instant satisfaction in exchange for long-term concern, perseverance, future consideration, and progress in the long run. Leisure time, freedom, and short-term concerns are all emphasized in a society that places shorter-term aims at the forefront of its priorities. Short-term personalities prioritize instant outcomes, confidence in their convictions, and accomplishing their present objectives (Bissessar, 2018). Johari et al. (2013) explained that cultural effects can significantly impact people's awareness and use of water taps during ablution activities. Cultural rules, civilizations, and beliefs influence how personalities behave and think about water protection (Koop et al., 2019). Some cultures prioritize purity and cleanliness through ablution. Additional water for better cleaning may cause individuals to focus on thoroughness during the cleansing process, perhaps consuming a significant volume of water. Cultural traditions and societal expectations can impact how individuals view water usage. Some societies believe that using too much water during ablution indicates piety or dedication. The cultural link between water usage and religious devotion may hinder people from prioritizing water conservation during cleansing rituals. To assess the correlation among cultural values and preferences on a monitoring online system for ablution activities, the hypotheses are illustrated in Figure 2.

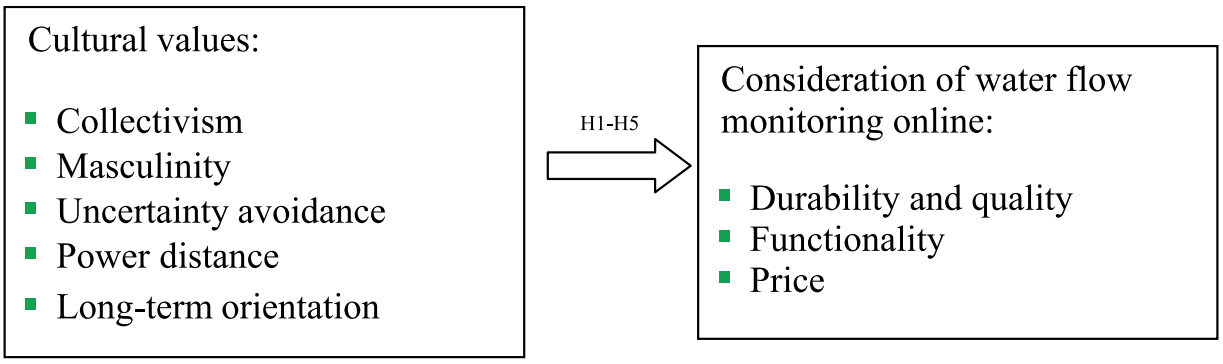

FIGURE 2
Hypotheses testing. H1: the online preferences for water monitoring are significantly influenced by collectivism. H2: the online preferences for water monitoring are significantly influenced by masculinity. H3: the online preferences for water monitoring are significantly influenced by uncertainty avoidance. H4: the online preferences for water monitoring are significantly influenced by power distance. H5: the online preferences for water monitoring are significantly influenced by long-term orientation.

3 Methodology

This research was classified into four phases: testing the hypotheses, design idea, technical requirement determination, and prototype. The purpose of evaluating the hypothesis was to verify the impact of cultural preferences on internet surveillance. This study adopted the application of partial least squares-structural equation modeling (PLS-SEM) and hierarchical component model (HCM) to assess the proposed hypotheses and evaluate the preferences for online monitoring qualities. The hypotheses were evaluated using the T-value satisfaction level, whereas online monitoring preferences were generated by considering the indicators' importance based on the latent variable's output (Hair, 2017). The study commenced with Confirmatory Factor Analysis (CFA) to validate the constructs, thereby confirming that each construct was accurately measured and reliable, thereby ensuring that the data was suitable for further analysis. This was succeeded by an assessment of the sampling adequacy and reliability to guarantee that the sample size was adequate and the measurement instruments were consistent. After these conditions were satisfied, Structural Equation Modelling (SEM) was employed to evaluate the hypothesized relationships between the constructs, thereby revealing the key factors and their relative significance. The design concept was subsequently developed based on the results of the SEM, ensuring that it was data-driven and by the validated constructs.

Understanding technological requirements and constructing a prototype for an online monitoring system for ablution activities are beneficial. Figure 3 depicts the sequence of this study.

4 Data collection

The data were gathered through an examination of the Muslim prayer practices of Malaysian citizens. The data were obtained via the administration of a questionnaire. The objective of administering the pre-test was to ascertain whether or not the participants had the requisite cognitive capacity to respond to the inquiries effortlessly. The questionnaire was directly disseminated to the participants to guarantee the quality of the respondents' answers and to uphold the standards of the responses. As suggested by Cohen (1992), the rule of thumb was adopted to determine the sample size required in the research. To ascertain the minimum sample size that would yield 80% statistical power, the arrowheads representing the derived structure based on several models with the most significant quantity were considered. The present investigation examined five cultural dimensions. This investigation ascertained a minimum sample size of 98 for the five arrowheads, accompanied by a minimum coefficient of determination (R^2) value of 0.25 at a 1% significance level. A total of 135 questionnaires were collected. Fifteen participants were excluded from the analysis due to their inadequate response to the questionnaire. The sample size used in this study was adequate for measurement, as indicated by the minimum criterion. The respondent profiles are detailed in Table 1.

As shown in Table 2, the Cronbach's alpha value should surpass the threshold of 0.7, indicating acceptable internal consistency for data measurement, as seen in Table 2. Moreover, a *p*-value below 0.001 obtained from Bartlett's sphericity test suggests that the data can be used for factor analysis. Additionally, the KMO measure exceeds the threshold of 0.5, enhancing scale reliability and internal consistency. Based on the findings, the data reliability is considered within an acceptable limit.

5 Data analysis

The CFA was tested using SmartPLS, a statistical tool. The measurement approach includes both reflective and formative measurements. HCMs were adopted to establish the correlations among the water monitoring system's quality and durability,

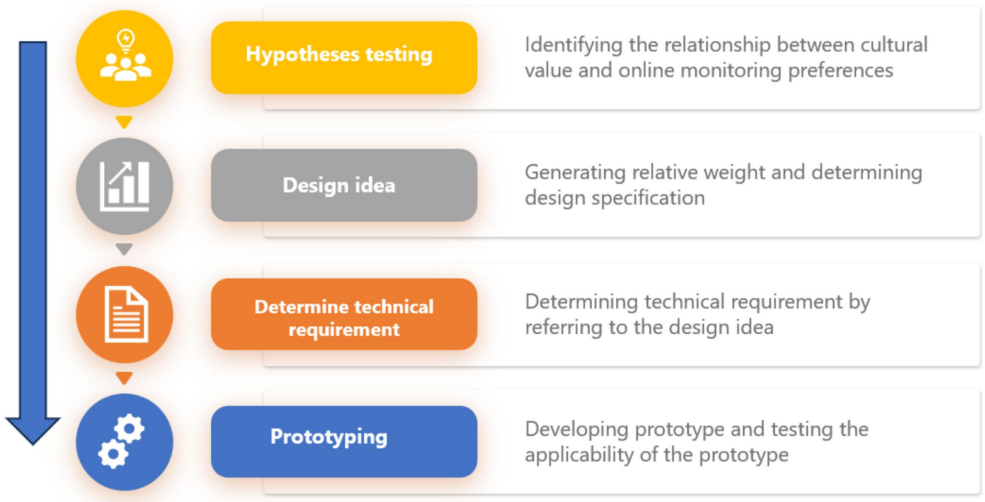

FIGURE 3
Flow of methodology.

TABLE 1 The background of the respondents.

Sampling criteria		Numbers	Percentages (%)
Gender	Male	88	65
	Female	47	35
Age (year)	17–25	67	50
	26–35	44	33
	36–44	18	13
	Above 44	6	3
Education level	Senior high school	15	11
	Diploma	28	21
	Degree	89	66
	Postgraduate	3	2

Ensuring that the correct dimension allows for additional analysis while collecting data is essential. One can assess the sample size and data reliability by employing Bartlett's sphericity test, Kaiser-Meyer-Olkin (KMO), and Cronbach's alpha.

TABLE 2 KMO testing for sample size and reliability test.

Result		
KMO for sampling-adequacy test		0.906
Bartlett's sphericity	Sig.	0.000
Cronbach's alpha		0.941

KMO > 0.5; Bartlett's should <0.001, Cronbach's alpha > 0.7.

functionality, and price. Both higher-order constructs (HOC) and lower-order constructs (LOC) are components of HCMs. This study classified the ablution online water monitoring system construct as HOC. In contrast, the constructs—quality and durability, functionality, and product price—were classified as LOC as they are composed of items with a second-order layer. Confirmatory factor analysis must be used to evaluate each construct and all construct indicators before conducting hypothesis testing (Hair, 2017). The classification of measurement is illustrated in Figure 4.

To determine the quality of the structured model, convergent and discriminant validity assessments for the variance formative and reflective measurement models are required (Hair, 2017). The average variance extracted (AVE), correlation coefficient, and factor loading are all examined to evaluate the convergent validity. They must be higher than 0.4 but lower than 0.7 to satisfy the factor loading requirements. Furthermore, the composite reliability (CR) value should be greater than 0.7, and the AVE value should be greater than 0.5. Even if CR is between 0.6 and 0.7, it is still within a range suitable for additional analysis in later phases of the research (Hair, 2017). If decreasing specific factor loadings affects the increase in the value of AVE and CR, then removing the lowest elements from the assigned construct would be preferable. Table 3 displays the steps in calculating the five cultural dimensions' convergent and discriminant validity.

After convergent validity was established, discriminant validity needed to be confirmed, and according to empirical standards, discriminant validity describes how different a construct is from other constructs (Hair et al., 2019). The heterotrait-monotrait ratio (HTMT) critical threshold should be lower than 0.85 to indicate acceptable discriminant validity (Henseler et al., 2015). The HTMT results for the cultural dimension's construct are shown in Table 4.

The formative measurement model was assessed after the completion of the reflective measures for both discriminant and convergent validities. Three constructs consisting of product functioning, product price, and durability and quality make up formative measurement in the model. To determine the formative measurement, this study should examine the variance inflation factor (VIF) and its external loading. For formative assessment, the outer loading must be more significant than 0.5, and the VIF should be less than 5 (Hair et al., 2019). This study confirmed that the VIF is lower than 5. The VIF calculation result is shown in Table 5.

Based on Table 5, all VIF values for the product's pricing, functionality, durability, and quality indicators are less than 5. This indicates that there are no issues with the data's collinearity. The following stage assesses the hypotheses once the formative measurement through discriminant and convergent validity reaches the critical threshold. Table 6 presents the results of the hypothesis.

According to the calculation of the results in Table 6, collectivism has no substantial influence on the choices of potential customers. The user preferences for the ablution water flow online monitoring system are strongly influenced by several factors, including uncertainty avoidance ($t = 3.841$, $p < 0.01$), power distance ($t = 2.313$, $p < 0.01$), and long-term orientation ($t = 2.101$, $p < 0.01$).

6 Discussion

The main aim of this research is to study online water monitoring consumption for ablution activities that consider cultural value influences. Based on the calculation in Table 6, uncertainty avoidance, dimension of power distance, and long-term orientation of cultural dimensions significantly influence the preferences for water consumption online monitoring systems. Looking into the link between avoiding uncertainty as a cultural preference and using online water tracking for Muslim ablution rituals shows a complicated

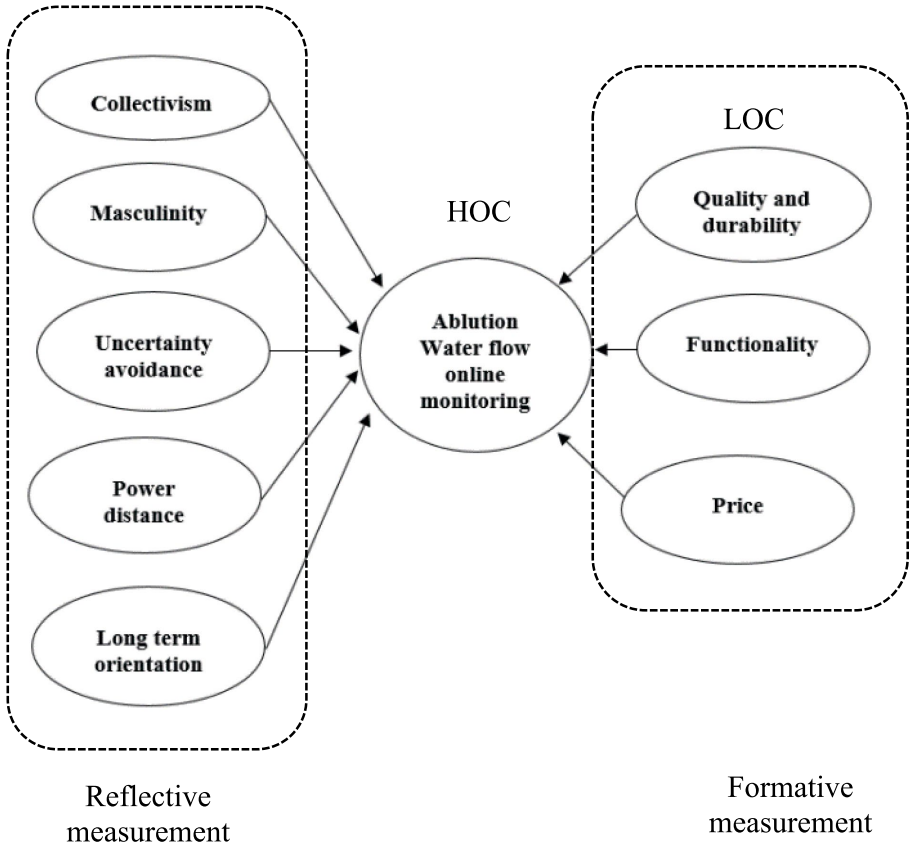

FIGURE 4
Classification of measurement.

web of beliefs, technological progress, religious practices, and the need to protect the environment. According to Watts et al. (2020), uncertainty avoidance affects people's desire for structured settings and clear rules. This could affect how Muslims who practice ablution feel about new technologies like online water monitoring. People who live in societies that try to avoid uncertainty may initially be sceptical about new technologies (Huang et al., 2019). This is why targeted efforts are needed to show how reliable and helpful these systems are. Even so, the religious importance of ablution and the focus on accuracy in rituals may make people more open to technologies that claim to be more accurate, as long as they are seen as reliable tools that fit cultural values. In the context of technology adoption, users from such civilizations could be more cautious and reluctant to adopt new technologies like an online monitoring system for ablution, especially if they perceive possible hazards or uncertainty, such as data privacy issues or the accuracy of the monitoring system. This resistance may affect the general acceptance rate hence the system should be built with strong, open security mechanisms and unambiguous user policies to allay these issues. The community needs to be involved to get cultural norms, new technologies, and environmental protection to work together better (Sunny et al., 2019). Community leaders and influencers should push for online water monitoring while being sensitive to cultural concerns and promoting water conservation as an essential part of more considerable environmental sustainability efforts.

In cultures with high power distance, hierarchical structures are generally more accepted, and there is a clear distinction between those in positions of authority and those who follow (Adamovic, 2022). Applying this cultural dimension to ablution water monitoring, it can be hypothesized that integrating online monitoring systems aligns with the cultural tendency to respect and adhere to established structures. Online monitoring allows individuals and authorities to manage and control water consumption during ablution rituals. The technology enables a transparent and accountable system where those in positions of authority can monitor overall water usage patterns and potentially implement guidelines or recommendations (Afrianto et al., 2023). Simultaneously, individuals can access real-time data, fostering a sense of control and awareness over their water consumption practices. By incorporating online monitoring, this approach caters to the cultural nuances of a high-power distance society, where centralized oversight and regulation are valued (Woods et al., 2021). It establishes a harmonious balance between individual empowerment and adherence to established norms, contributing to more efficient and regulated use of water resources during ablution rituals within the context of cultures characterized by high power distance. The power distance of cultural dimension preferences for online water monitoring in the context of ablution activities in Islamic culture in Malaysia becomes evident when examining specific attributes, particularly the emphasis on easy maintenance and low costs for maintenance. This correlation suggests that in cultures with higher power distance, there is a tendency for individuals to prioritize practical aspects that are more aligned with convenience and affordability (Wang et al., 2020). The hierarchical structure inherent in high power distance cultures

TABLE 3 Factor loading, CR, and AVE results.

Cultural value	Items	Factor loading	CR	AVE
Collectivism	Coll1	0.705	0.717	0.65
	Coll2	0.763		
	Coll3	0.851		
	Coll4	0.861		
	Coll5	0.831		
	Coll6	0.684		
Masculinity	Mas1	0.647	0.777	0.668
	Mas2	0.751		
	Mas3	0.767		
	Mas4	0.730		
Uncertainty	UAI1	0.671	0.723	0.706
	UAI2	0.844		
	UAI3	0.886		
	UAI4	0.863		
	UAI5	0.891		
Power distance	PDI1	0.812	0.701	0.685
	PDI2	0.831		
	PDI3	0.666		
	PDI4	0.836		
	PDI5	0.803		
Long-term orientation	LTO1	0.773	0.873	0.727
	LTO2	0.707		
	LTO3	0.818		
	LTO4	0.862		
	LTO5	0.768		

AVE should be >0.5; CR > 0.7 stands for composite reliability.

TABLE 4 Discriminant validity for cultural dimensions.

	Collectivism	Masculinity	Uncertainty avoidance	Power distance	Long-term orientation
Collectivism	0.810				
Masculinity	0.125	0.532			
Uncertainty avoidance	0.421	0.124	0.423		
Power distance	0.254	0.326	0.332	0.424	
Long-term orientation	0.211	0.137	0.235	0.218	0.721

HTMT < 0.85 shows discriminant validity.

TABLE 5 The VIF for cultural preferences in Malaysia.

Durability and quality	VIF	Product functionality	VIF	Product price	VIF
Daq 1	1.053	Pf 1	2.271	Pp 1	1.425
Daq 2	1.126	Pf 2	1.539	Pp 2	1.741
Daq 3	1.114	Pf 3	1.849	Pp 3	1.645

VIF > 5 indicates a collinearity problem.

may contribute to a preference for technological solutions that are not only effective but also require minimal effort and resources to maintain. The desire for easy maintenance and cost-effectiveness in this context may stem from a reliance on centralized authority and a pragmatic approach to adopting technology from a cultural point of view. In addition, In societies with high Power Distance, hierarchical

TABLE 6 Structural equation model results.

Hyp.	Description	Path coefficient	Std. error	*t*-value	Result
H1	Collectivism → Ablution water flow online monitoring	0.047	0.129	0.364	Not supported
H2	Masculinity → Ablution water flow online monitoring	−0.012	0.118	0.101	Not supported
H3	Uncertainty avoidance → Ablution water flow online monitoring	0.321	0.084	3.841*	Supported
H4	Power distance → Ablution water flow online monitoring	−0.263	0.114	2.313**	Supported
H5	Long-term oriented → Ablution water flow online monitoring	0.204	0.097	2.101**	Supported

*$p < 0.01$, **$p < 0.05$, ***$p < 0.1$.

systems and authority may be more accepted, which may affect how consumers view and use the technology. Users from high Power Distance cultures, for instance, might be more likely to embrace technology without hesitation if religious or communal leaders support it. On the other hand, in low power distance cultures—where equality and individualism are more stressed—users may expect more autonomy and control over their engagement with the system. Emphasizing user control and customized options to better match the expectations of such users, could affect the design and deployment tactics.

The research indicates that long-term orientation, as a cultural value dimension, plays a significant role in shaping preferences for online water monitoring in the context of ablution activities within Islamic culture in Malaysia. This is particularly evident in the alignment of the preference for long-term usage with easy maintenance and availability of spare parts (Wallin Blair et al., 2020). The correlation suggests cultures with a higher orientation toward the long-term value of durability and sustainability in technological solutions. In this context, individuals are inclined to prioritize products that offer extended usability and are designed for ease of maintenance and repair, ensuring sustained functionality over time (Reig et al., 2022). The interplay between long-term orientation and the preference for specific product attributes underscores the importance of understanding cultural dimensions in guiding product development strategies that cater to the nuanced preferences and values of the target audience. Users from cultures with high Long-Term Orientation may be more willing to embrace the technology in the framework of the online monitoring system for ablution activities if they believe it will lead to long-term advantages including better water conservation, increased religious observance, or better health outcomes. Thus, the design and communication techniques for the technology could stress its long-term advantages, so complementing the ideals of these societies.

6.1 Prototype development

It is commonly known that a product's design preferences are arbitrary and influenced by factors such as the price of the product, its utility, and its design (Bloch, 1995). To ensure that product development aligns with customer demands and preferences, designers must ascertain user preferences early in the design process. Through an online monitoring system, the study determined the technical characteristics of the water flow meter by using the outer weight results from structural equation modeling (SEM) analysis. By exhibiting the strength of the links between cultural aspects and customers' preferences for online water monitoring through outer weight outcomes, SEM is a statistical approach that examines the interactions between certain variables. By examining the external weight ranking, designers can ascertain the most essential technical requirements and set the design objectives for online water monitoring. Consider outer weight of user's culture preferences based on SEM result.

As illustrated in Figure 5, the outer weight results were calculated from the value of SEM. This weight was used to determine the technical specification and assign a weightage ranging from 1 to 5 by relating the decision and consideration factors, such as the product's ability to be produced. These factors include technical, capital investment, and workers or human resources capability. The consideration for giving weightage to user preferences in specific product design attributes has been adopted by several researchers, such as Ginting and Ishak (2020), who conducted a study on product design by combining analytic hierarchy process (AHP) and quality function deployment (QFD), and Kirgizov and Kwak (2022) who adapted Kansei engineering and QFD in determining customer orientation in product design. Once all technical standards have been identified, the next step is multiplying user preferences by designer weight. The outcome of this multiplication can be utilized to determine the priorities for the online water monitoring system's design and relative weighting. Table 7 describes the consumers' choices based on the SEM results and the technical specifications for the online monitoring design.

Table 7 shows that the first three design goals of the prototype are water resistance, sensor accuracy, and consideration of durable materials. The next stage is to develop an online water monitoring prototype after ascertaining the user preferences. Determining the circuit layout and connections, turning the schematic into a hardware prototype, and testing the prototype's functionality are the three stages of the suggested prototype development process. The input and output of the prototype's design circuit are shown in Figure 6. The ESP8266's digital pins and GPIO2 can both be connected to the digital sensor known as the water flow sensor. The sensor is attached to and powered by a 5 V source, and the ESP8266 module is connected to the OLED display. The OLED display will be linked to the 3.3 V pin of the

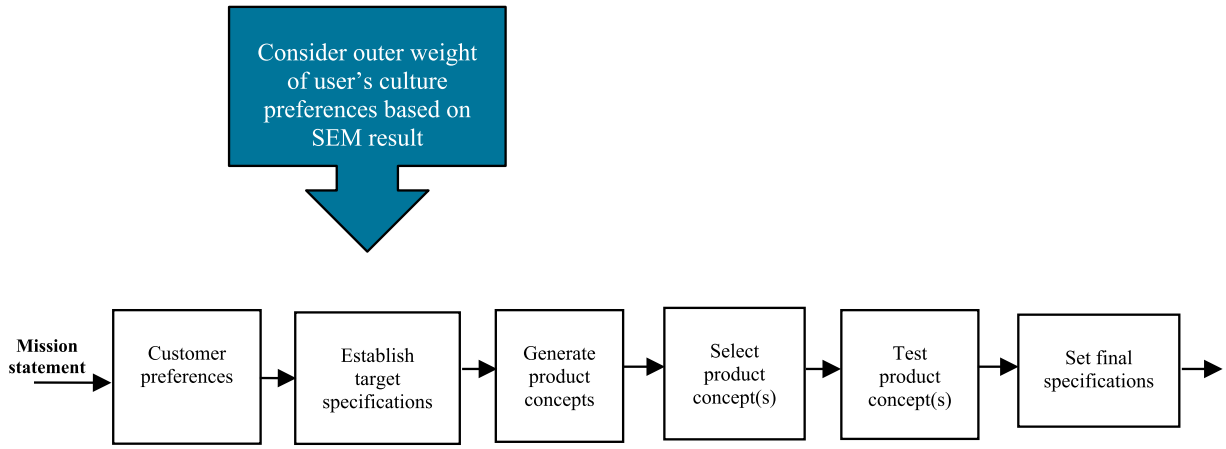

FIGURE 5
Considering outer weight results from SEM to determine the technical specification of the online monitoring system.

TABLE 7 User preferences and technical requirements.

User preferences	Weight (A)	Technical requirement	Weight (B)	Relative weight (A × B)	Design priorities
Maintain easily	0.601	Consideration of users' self-maintenance and low cost to buy a spare part	3	1.803	6
Can be monitored easily	0.486	Consider real-time monitoring	4	1.944	4
Measurement accuracy	0.47	Sensor accuracy	5	2.35	1
Water resistance	0.419	Safety case to cover from water	5	2.095	2
It can be used for long-term	0.402	Consider durable materials	5	2.01	3
Estimation of water consumption	0.384	Inform the cost estimation of monthly water usage	5	1.92	5
Have monitoring display	0.373	Use OLED display and mobile display to monitor	4	1.492	7
Affordable price	0.345	Use low-cost materials	3	1.035	8
Easiness of use	0.332	Can be installed easily by the user	3	0.996	9

NodeMCU as it operates on 3.3 V. The circuit for smart water monitoring is depicted in Figure 7.

An internet of things (IoT)-based water flow meter was developed using a prototype with a water flow sensor and the NodeMCU ESP8266. A 0.96 inch OLED screen shows the entire volume and water flow rate. After that, the device is connected to the IoT server. The Home Assistant server will receive information about the water level and flow rate, which can then be observed.

Figure 8 illustrates the components utilized in this water monitoring system to determine the rate at which water flows. The hardware used for controlling, displaying, measuring sensors, and transmitting data are the four primary components of the IoT. In a system that is intended to measure turbidity, the NodeMCU is the principal controller that has been implemented. When it comes to transmitting data over the IoT, it makes use of an ESP8266 Wi-Fi module. An I2C LCD, also known as a liquid crystal display, is utilized as the screen to display the data values for the measurement of water flow rate. All of the data gathered will be transmitted and plotted in the spaces provided by the Home Assistant database platform. The data obtained by the NodeMCU is displayed on a serial monitor, designated as COM5. All of the information gathered by sensors is saved in the database known as Home Assistant. However, the built-in real-time tracking features of the internet monitoring system attracted users. This feedback shows that the online monitoring tool effectively satisfied user expectations and gave useful help in raising awareness of water usage during ablution activities. Developed and tested inside a challenge, the prototype might not completely reflect the wide spectrum of usage scenarios and environmental circumstances it would come across in actual settings. Variations in water pressure, different kinds of facilities, and possible user rejection of technological monitoring in religious activities are elements influencing the performance and acceptance of the system.

As shown in Figure 6, the online monitoring system can be viewed on two different displays: the application and the computer. The online monitoring system's functionality was evaluated at a mosque, where it was successfully installed and tested. The information provided by the

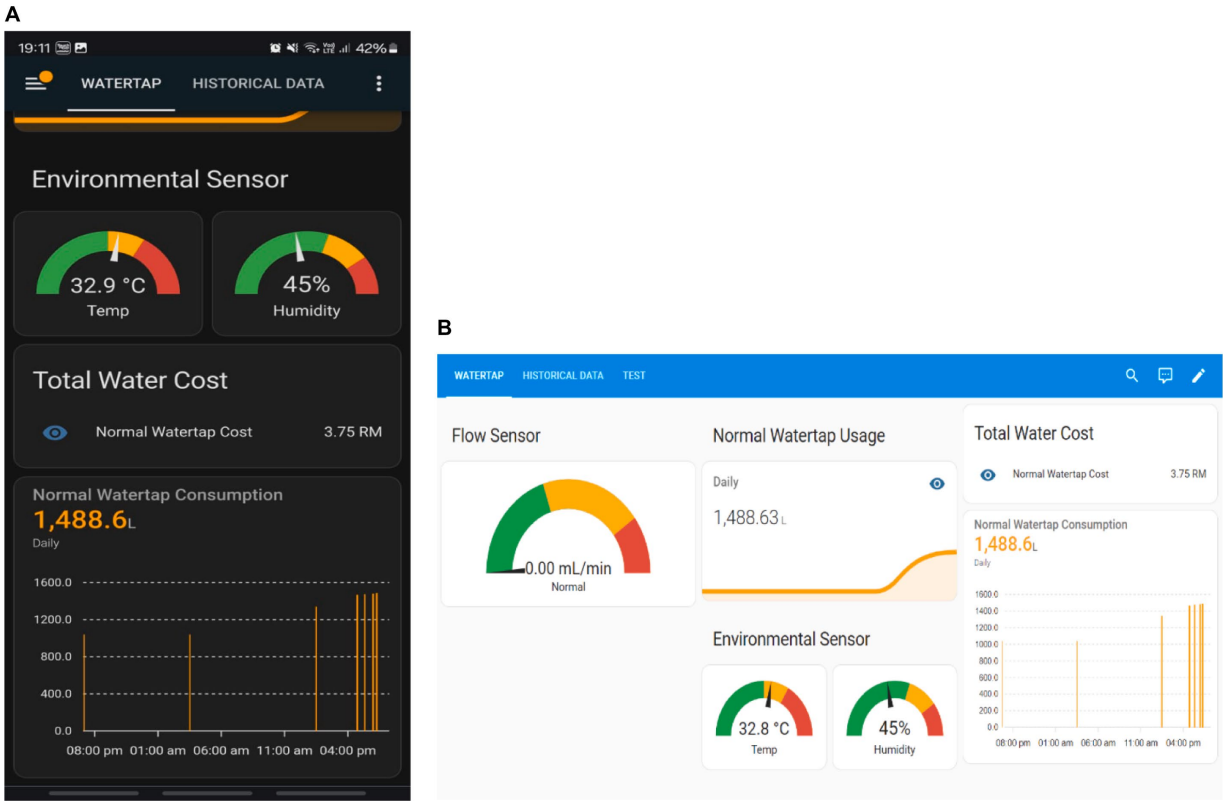

FIGURE 6
The display of the monitoring system for **(A)** mobile phone application and **(B)** personal computer.

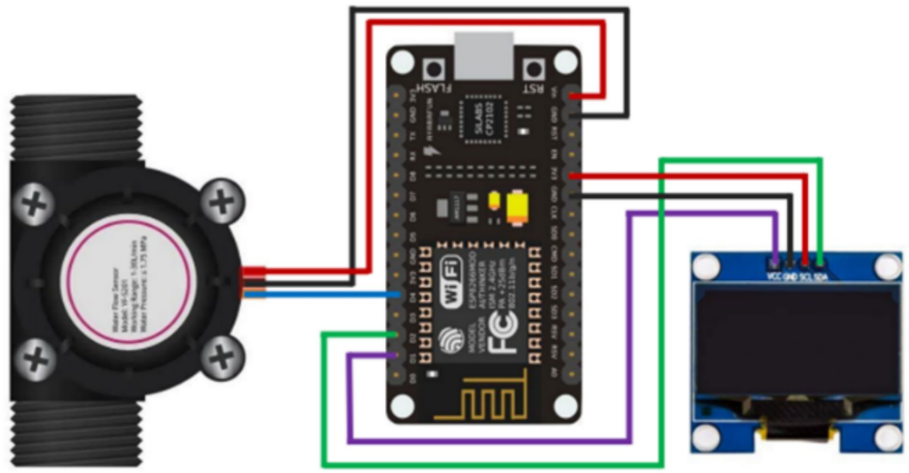

FIGURE 7
Circuit of a smart water monitoring system.

display can be utilized to determine the overall amount of water consumed for activities involving ablution. This makes it possible for the administration or management of the mosque to monitor and analyze the patterns of water usage, locate any potential areas for water saving, and guarantee that water resources are utilized effectively. Mosque managers can make educated decisions on the upkeep of ablution facilities, the scheduling of cleaning and conservation efforts, and the implementation of initiatives to decrease water waste and promote sustainability when they have access to real-time data on water usage information.

In addition, several important factors surround the possibility of scaling the prototype for more general application in various cultural environments. Although the basic procedures of ablution (Wudu) are identical across Islamic civilizations, there are

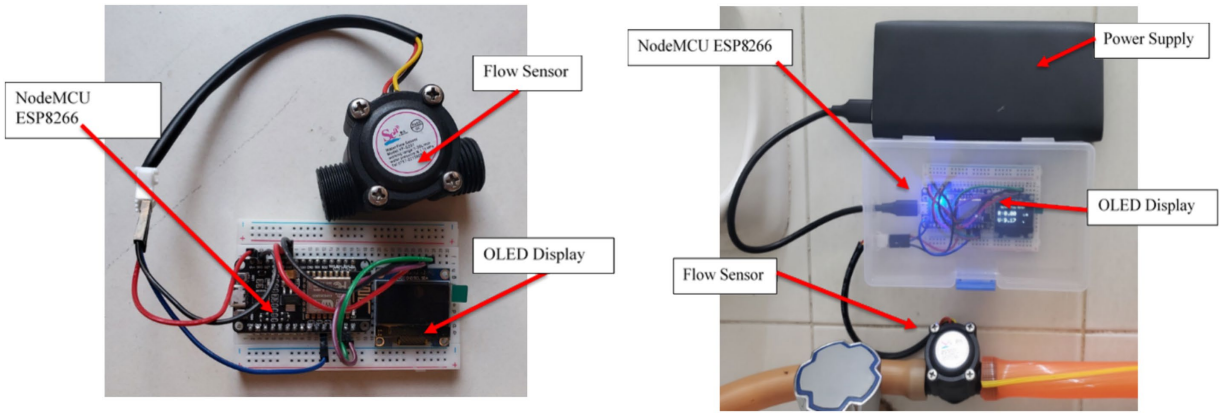

FIGURE 8
Hardware prototype on a breadboard.

variances in behaviors, water use habits, and interpretations of religious requirements that could need modification of the template. Language and communication are vital; a multilingual interface and culturally relevant messaging help to promote water-saving behaviors. Ensuring user approval also depends on customizing the user interface (UI) to fit regional preferences including visual design and navigation. Furthermore, including the prototype with local water conservation projects, especially in areas experiencing water shortage, may improve its significance and impact. Along with relationships with local businesses to enable distribution, scalability should be enabled by a modular architecture that lets for simple customization and deployment across several environments.

The impact of cultural values is a critical factor that must be considered when establishing the design specification. Cultural factors should be duly considered during the design process, as stated by Salmi and Sharafutdinova (2008) and Bloch (1995). This is because the cultural factor possesses the capacity to impact the inclination of the consumer or user during the product selection process. The current study aims to determine how a water tap's technical specifications, which align with user preferences and accommodate the cultural context of ablution activities, promote water conservation. This determination was made by identifying significant hypotheses and the outer weight through structural modeling. Utilizing the generated information makes it feasible to narrow the focus to the technical specification. However, apart from the primary priority decisions, an additional stipulation necessitates attention.

7 Conclusion

The conclusions of this study show the importance of considering the behavioral patterns of users, which are impacted by their cultural values, in designing an online monitoring system for the consumption of ablution water using the system. Five cultural value elements were investigated to ascertain the influence that these factors have on users' preferences for such systems. The method of applying external weights generated from the findings of structural modeling has been adopted, and it is considered an innovative strategy for developing the design specifications of the monitoring system. The process of designing the online monitoring system considers cultural values to guarantee that it satisfies the functional requirements and is in accordance with the cultural norms, beliefs, and traditions of various user groups. This acknowledges that these communities have a wide range of cultural features. User acceptance, adoption rates, and general satisfaction with the system have been positively impacted and improved due to the integration of cultural preferences.

The incorporation of cultural variables improves the inclusiveness, accessibility, and responsible water usage among users of the monitoring system, which is in line with the overarching goals of sustainability. In addition to fostering constructive connections and trust between designers and users, the design process also helps identify potential disputes and misunderstandings that may arise while determining design specifications. It is necessary to have a culture-centric strategy to improve the market performance of online monitoring systems. This demonstrates a genuine understanding of the cultural diversity that brings our global world together. The findings of this study contribute to better theoretical knowledge and practical application. To achieve the goal of obtaining knowledge, it broadens the application of Hofstede's cultural theory to the process of product design. This method can be applied to discover ecologically friendly aspects in product design to effectively handle concerns regarding sustainability, particularly monitoring the amount of water consumed during activities involving ablution.

8 Limitation and future direction

Increasing the sample size and incorporating people from various cultural backgrounds would improve the applicability of our results. However, this was not possible in this study due to time and resource restrictions. Consequently, the sample may not accurately reflect the wider population, especially concerning cultural diversity. This constraint implies that the results should be approached with care when applying them to diverse cultural settings. Nevertheless, the research approach and methodology employed in this study can be utilized in future research endeavors to corroborate and broaden our findings, by incorporating a more varied and extensive sample.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

IG: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. TT: Writing – review & editing, Visualization, Formal analysis. II: Writing – review & editing, Writing – original draft, Project administration, Funding acquisition. RM: Writing – review & editing, Funding acquisition, Conceptualization. SH: Writing – review & editing, Visualization, Validation, Project administration, Methodology, Funding acquisition. HA: Writing – review & editing, Resources, Methodology.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2024.1411711/full#supplementary-material

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