A Novel Design of Ergonomic Ablution Place at Mosques in Arar, Saudi Arabia

By Shahrin Azuan bin Nazeer[®], Mohammad Akram Randhawa, Maher Sayel Alshammari, & Abdulhakim Bawadekji[®]

FEATURE AT A GLANCE: Currently, there are hardly any uniform design specifications for the construction of ablution places at mosques in Saudi Arabia. Designs of ablution places are usually copied from designs of ablution places in other mosques or based on individual perspectives. Based on the researchers' anecdotal observations, most of these designs are nonergonomic, uncomfortable, and less user-friendly for ablution in either sitting or standing position, especially for the elderly. In such designs, water splashing is common because of inappropriate heights of platforms or seats, insufficient distances between seats and faucets, and improper shapes and depths of water drain. The purpose of the present study is to present the design of a novel ergonomic ablution place to ensure comfortable, safe, and hygienic conditions. The design is particularly related to the size and height of seat, height and distance of faucet from the seat, depth and slope of water drain, and height and width of the platform. The design was implemented at four mosques in Arar, Saudi Arabia. Modifications at ablution places were made according to the proposed design and were appreciated by the local community. The design was communicated to the Directorate of Mosques in Arar and agreed upon for implementation in other mosques.

KEYWORDS:

ergonomic, ablution place, design specifications, comfortable, safe, hygienic, mosques, Saudi Arabia **n Islam, ablution (or "wudu") is a vital** part of ritual purification, which refers to the physical and spiritual cleanliness of a person before prayer or for holding and reading the Holy Quran. The procedure includes washing of hands, mouth, nose, face, arms, and feet with water and gentle massage of head and ears with wet hands. Besides spiritual benefits, the procedure helps to keep oneself hygienic. Thus, in every mosque, there is an ablution place for performing ablution.

Various designs for the ablution place in mosques exist throughout the world (Zaied, 2017). In Saudi Arabia, like other Muslim countries, there is no uniform design of ablution places at mosques. Most of these designs are copied from other mosques or based on individual preferences. Moreover, they are not ergonomic and are uncomfortable for making ablution in either sitting or standing positions. An ergonomic design here relates to architectural design that is efficient and comfortable for ablution.

The following are a few examples of difficulties encountered in making ablution with currently available facilities. Figure 1 shows ablution places with washbasin, the height of the washbasin often makes it difficult to wash feet and may cause a person to fall when raising a foot above the knee level. Thus, using a washbasin is often inconvenient and unsafe to perform ablution. For ablution places with a platform and seats, the size, height, and distance of the seat from the faucet are usually inappropriate. Making ablution is inconvenient in a sitting position if the faucet is too close to the seat, or the faucet is low (Figure 2). If the person manages to sit, water splashes on his

feet and clothes because the feet are close to the drain (Figure 3).

In many cases, ablution platforms are without seats, or the faucets are at a low level. This makes it uncomfortable to perform ablution either in standing or sitting positions because the users must bend their back or knees (Figures 4 and 5). Bending is dangerous for the elderly because it may trigger back or knee pain, particularly when they suffer from arthritis of knee or hip joints. Also, ablution places sometimes become unhygienic because ablution wastewater splashes on the person or one next to the person due to shallow and flat drain. It is also difficult to keep the area clean due to lack of platform or insufficient height of the platform (Figure 6).

There are only a few published research regarding praying facilities and the ablution places in mosques. Abdul Rahman et al. (2018) explored the physical conditions of ablution places in selected mosques in Kuala Lumpur and Selangor, Malaysia, focusing on their ergonomic aspects, user-friendliness, and safety. The study found that in most places the seats have appropriate size and height, but the distance between the seats and the faucet, and the platform height are unsuitable. Dawal et al. (2016) conducted a study to design an ergonomic ablution place for disabled and elderly. Hamid et al. (2015) presented a conceptual design for an ablution place for prayer rooms in shopping centers. Moch et al. (2013) proposed an ergonomics design based on body part movements while doing ablution. Johari et al. (2013) presented a design for performing ablution with minimum water usage. Besari et al. (2009) proposed an automatic



Figure 1. Difficult to wash feet in wash basin.



Figure 3. Feet are virtually inside the drain and water splashing on feet and clothes.



Figure 2. Seats are too close to water tap.

ablution machine using a vision sensor that would help to save water. The designs recommend by these investigators are meant to be convenient for persons with specific conditions, especially the elderly and disabled persons, or are related to water saving. However, the designs are a bit costly and perhaps not applicable to every mosque.



Figure 4. No seats, an elderly person cannot sit like a young man.

Mokhtar (2003, 2006) presented some designs of ablution places in mosques. In these designs, the drain for the flow of water is very shallow. The grating over the drain is provided, perhaps, to avoid splashing of water, but does not seem to solve the problem. Besides, it is not easy to clean the area under the grating regularly and dirt with colonies of microorganisms can accumulate underneath.

Many design limitations contribute to difficulties in performing ablution using the existing ablution facilities in mosques. These include the improper height of seats and



Figure 5. Not easy to make ablution in sitting position (no seat) or while standing (water tap is too low). (a) Sitting position. (b) Standing position.

platforms, inappropriate height of faucet, and distance of faucet from seats, and unsuitable shape and depth of drains. As such, the present article proposes a novel design of ergonomic ablution place and elaborates on the implementation of these suggestions in mosques located in Arar.

DESIGN OF ERGONOMIC ABLUTION PLACE

The following suggestions are for constructing an ergonomic design ablution place that is efficient, comfortable, and hygienic in a mosque. They focus on the seat, faucet, platform, and drain.

- *Seat*: For an average man with 5'8" height, the seat should be about 36.57 cm (1.2 ft) high, which is the average length of a human leg, knee to ankle (Jervas et al., 2016; Zivicnjak et al., 2003). Moreover, there should be adequate space for leg position and proper footrest. The existing space for legs is mostly around 15.24 cm (0.5 ft). Whereas it should be around 45cm (1.5 ft), corresponding to the length of the thigh, average 43 cm (Jervas et al., 2016). To accommodate feet while sitting on the seat, the distance between seat and drain should be 30.48 cm (1 ft) because the usual size of the human foot is about 22.86 to 25.4 cm (9–10 in.; Mohanty et al., 2015).
- *Faucet*: The recommended height of the faucet is about 36.57 cm (1.2 ft) from the ablution platform which corresponds to the height of the seat, and the distance between the seat and the faucet around 45.72 cm (1.5 ft), corresponding to the length of human arms (Moch et al., 2013; Mohanty et al., 2015).



Figure 6. The drain is very shallow and water falling from the tap or wudu would splash on feet and clothes.

• *Platform*: The platform should be easy for stepping up and down. One step platform should be less than 38.1 cm (1.25 ft). If higher, an extra step at 15 to 21 cm (0.5–0.7 ft) should be provided (Yurconic, 2001).



Figure 7. Design of two-steps ablution place, applied at Zainab Binti Jahash mosque in Joharah and Yasin Mosque in Musaadia, Arar, Saudi Arabia. (a) Top view. (b) Isometric view. (c) Side view. (d) Front view.

• *Drain*: Most of the existing drains are around 30.48 to 39.62 cm (1–1.3 ft) wide and deep and have a flat surface, which results in the water splashing on the floor and inadequate water flow. To avoid the splash and allow easy flow of water, the drain should be added using a slope (about 50° to 60°) on both sides.

This article proposes two types of ablution platforms, considering the space available for construction of the ablution place and the existing designs of the ablution place in most of the mosques. First, a *two-step ablution place*, with a wider platform, seats at the top of the platform, and applicable when enough space is available and platform height is more than 1ft (Figure 7). Second, a *single-step ablution place*, with a narrow platform, seats raised from the floor, and applicable when space for ablution place is less and platform height is below 1 ft (Figure 8). Dimensions for two-steps and single-step ablution places are given in Tables 1 and 2, respectively.

IMPLEMENTATION OF PROPOSED ABLUTION PLACE

The suggested designs above were implemented in four mosques in Arar, Saudi Arabia: Zainab Bint Jahash Mosque

and Jaafer Bin Mohammad Mosque in Joharah, Yassin Mosque, and Alaqeed Mosque in Musaadia.

- Zainab Bint Jahash Mosque in Joharah: Its premodification ablution place was akin to that depicted in Figure 2 but with a higher platform and was modified according to a two-step design, that is, wider platform and seats at its top. The platform was mounted with white marble stones and a drain, and the front wall was laminated with light bluegreen ceramic tiles. Stainless steel automatic mixers for cold and warm water installed as faucets and press and pour stainless steel containers were fixed for soap. Figure 9a depicts the front view of the ablution platform, which has two steps and seats on its top. Figure 9b shows the side view of the platform and the drain. The drain has slopes, on both sides, which prevent splash of water falling from the faucet and the water used for ablution. Figure 9c demonstrates comfort and convenience in making ablution while sitting.
- *Alaqeed Mosque in Mosaadia*: Figure 5 depicts the ablution place before and Figure 10 after modification according to the single-step design, due to the narrow platform and insufficient space between the ablution area and toilets. The seats are raised from the floor (Figure 10a), the drain has slopes on both sides to prevent splash of water (Figure



Figure 8. Design of single-step ablution place, applied at Alaqeed Mosque in Mosaadia and Jaafer Bin Mohammad Mosque in Joharah, Arar, Saudi Arabia. (a) Top view. (b) Isometric view. (c) Side view. (d) Front view.

Table 1. Proposed New Dimensions for Two-Steps Ablution Platform

No.	Component	Dimension (ft)
1	Platform height	1.5
2	Seat height	1.2
3	Seat width	1
4	Distance between seat and drain (foot clearance)	1
5	Drain height	1.5
6	Drain width	1
7	Distance between seat and water tap	2
8	Water tap height from ablution platform	1.5
9	Drain slope	0.33
10	Distance between seats	2

Table 2. Proposed New Dimensions for Single-Step Ablution Platform

No.	Component	Dimension (ft)
1	Platform height	1
2	Seat height	<i>X</i> + 1.2
3	Seat width	1
4	Distance between seat and drain (foot clearance)	1
5	Drain height	1
6	Drain width	1
7	Distance between seat and water tap	1.5
8	Water tap height from ablution platform	1.5
9	Drain slope	0.33
10	Distance between seats	2

Note. X is the platform height.



Figure 9. Modified ablution place at Zainab Bint Jahash Mosque in Joharah, Arar, Saudi Arabia. (a) Front view of the ablution platform, which has two steps and seats on its top. (b) Side view of the platform and the drain, which has slopes, on both sides to prevent splash of water. (c) Comfort and convenience in making ablution while sitting.



Figure 10. Modified ablution place at Alaqeed Mosque in Mosaadia, Arar, Saudi Arabia. (a) Seats are raised from the floor. (b) Drain has slopes on both sides to prevent splash of water. (c) Seats are comfortable for making ablution in sitting position.

10b) and seats are comfortable for making ablution in sitting position (Figure 10c).

• Yassin Mosque in Mosaadia and Jaafer bin Mohammad Mosque in Joharah: Premodification ablution places of these mosques are shown in Figure 4. Figure 11 shows the changes made at Yassin Mosque: Figure 11a depicts the front view of the platform showing a step to get up the platform, as the original platform was high, and seats raised from the step as the original platform was narrow; Figure 11b depicts the side view showing drain, which is deep enough; and Figure 11c depicts ease and comfort in making ablution while sitting. Figure 12 shows modifications made in Jaafer bin Mohammad Mosque, not much different from those in Yassin Mosque.

SURVEY FOR LOCAL COMMUNITY FEEDBACK

The opinion of the local community regarding the achieved improvements was obtained with a survey using a structured questionnaire. The survey was implemented at Zainab Bint Jahash Mosque in Joharah. Due to various nationalities of Muslims coming to the mosque, the questionnaire was prepared in Arabic, English, and Urdu. The sample questionnaire in English is attached as the appendix and has six questions.

The survey involves the distribution of 50 questionnaires to persons attending daily prayers in the mosque, and 36 questionnaires were returned. This achieved a response rate of 72%, which is adequate because response rates of around 60% are usually considered acceptable for most studies (Fincham, 2008).



Figure 11. Modified ablution place at Yasin Mosque in Mossadia, Arar, Saudi Arabia. (a) Front view of the platform showing a step to get up the platform and seats raised from the step. (b) Side view showing drain, which is deep enough. (c) Ease and comfort in making ablution while sitting.



Figure 12. Modified ablution place at Jaafer bin Mohammad Mosque in Joharah, Arar, Saudi Arabia. (a) Front view of the ablution platform, which has two steps and seats on its top. (b) Side view of the platform and the drain, which has slopes, on both sides to prevent splash of water. (c) Comfort and convenience in making ablution while sitting.

Table 3 presents the result of the survey. About 94% of the respondents were satisfied with the design and none were unsatisfied. While 83% of the participants considered the design as much better than the previous one, 72% of them were ready to use it daily. Also, 67% were very likely to recommend the new design for other mosques. Thus, the results indicate a positive disposition to the proposed design.

DISCUSSION

The present study proposes a novel design for improving ablution places in mosques (Figures 7–8), applied in four mosques: Zainab Bint Jahash Mosque, Alaqueed Mosque, Jaafer Bin Mohammad Mosque, and Yassin Mosque in Arar (Figures 9–12). The salient features of the designs not adequately implemented in previous studies are

- The design promotes comfort and convenience in making ablution. This is because of (a) suitable height and size of the seat, (b) a place for placing feet in front of the seat, and (c) an appropriate height and distance of the faucet from the seat.
- Avoidance of splash of water falling from the faucet or washing hands and face, due to slopes on both sides of the drain and sufficient depth of the drain.
- Easy to keep ablution place clean and more hygienic, because of the platform with suitable height and open

Question 1: Satisfaction	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied	Missing
Overall impression	31 (86%)	3 (8%)	1 (3%)	0	0	1 (3%)
Quality	24 (67%)	2 (6%)	0	1 (3%)	0	9 (25%)
Safety	22 (61%)	5 (14%)	0	0	0	9 (25%)
Convenience	28 (78%)	0	0	0	0	8 (22%)
Question 2: Expression	Very happy	Нарру	Neutral	Unhappy	Very unhappy	Missing
	25 (69%)	3 (8%)	0	0	0	8 (22%)
Question 3: Comparison with the previous design	Much better	Better	Same	Worst	Lot worse	Missing
	30 (83%)	4 (11%)	0	0	0	2 (6%)
Question 4: Recommendation for other mosques	Very likely	Likely	May be	Unlikely	Very unlikely	Missing
	24 (67%)	4 (11%)	5 (14%)	0	0	3 (8%)
Question 5: Usage frequency	Few times daily	Once daily	Few times a week	Once a week	Few times a month	Missing
	21 (58%)	5 (14%)	4 (11%)	1 (3%)	0	5 (14%)

Table 3. Survey Results, Showing Respondents in Each Case

drain with slopes, which make the area suitable to clean with detergents regularly.

• Easy for stepping up and down the platform, only one step when less than 1.2 ft, and if higher, provision of an extra step at 15 to 21 cm (0.5–0.7 ft).

The results of the survey (Table 3) conducted for obtaining the opinion of the residents of Zainab Bint Jahash Mosque in Joharah, regarding convenience in making ablution and improvements in the ablution place over previous design also show a positive response by the respondents. The proposed design and the survey findings have been communicated to the Department of Mosques in Arar, which agree to implement them, especially in new mosques. The proposed designs can guide the construction of suitable and hygienic ablution place in mosques of other cities of Saudi Arabia and other countries.

CONCLUSIONS AND RECOMMENDATIONS

The article has presented a novel ergonomic ablution place to ensure comfortable, convenient, and hygienic conditions. The article proposes two designs for the ablution place: one with two steps, a wider platform and seats constructed on the top of the platform; and another with a single step, a bit narrow platform, and seats raised from the floor. The suggested designs were applied in four mosques in Arar. The survey conducted to evaluate the new ergonomic ablution place in one of these mosques generated positive responses by 81% of users. The Department of Mosques in Arar accepted the suggestions of the new design to implement in existing and new mosques. The proposed designs can inform the construction of more appropriate ablution place in mosques across Saudi Arabia and other places.

APPENDIX

Questionnaires for the Assessment of Ablution Place Use Satisfaction

On behalf of the Northern Border University, we want to make sure that changes made in the ablution place of your mosque are much better and convenient than before. We shall be grateful if you could kindly complete this questionnaire for that purpose.

1. How satisfied are you w	ith the new ablution place, in	terms of the following	?				
(1) Excellent	(2) Very good	(3) Good	(4) Poor	(5) Very poor			
1. Overall impression	1	2	3	4 5			
2. Quality	1	2	3	4 5			
3. Safety	1	2	3	4 5			
4. Convenience	1	2	3	4 5			
2. How happy are you with	n the present ablution place?						
(1) Very happy	(2) Happy	(3) Neutral	(4) Unhappy	(5) Very unhappy			
3. How do you compare the present ablution place with the previous one in this mosque?							
(1) Much better	(2) Better	(3) Same	(4) Worse	(5) A lot worse			
4. How likely are you to recommend this ablution place design to other mosques?							
(1) Very likely	(2) Likely	(3) Maybe	(4) Unlikely	(5) Very unlikely			
5. Please indicate how often you use the ablution place in the mosque:							
(1) A few times a day	(2) At least once a day	(3) Once a week					
(4) A few times a week	(5) A few times a month						
6. Would you like to make any further comments, not addressed in this survey?							

We wish to thank you for taking the time to provide us this feedback. It will help us to further improve the design of the ablution place in the future.

Sincerely,

Project Investigators, Deanship of Scientific Research, Northern Border University, Arar, Saudi Arabia

REFERENCES

- Abdul Rahman, J., Kamarudin, Z., Abdullah, M. H., Jasmani, I., & Ramli, N. (2018). Physical and safety features of ablution spaces in the mosques of Selangor and Kuala Lumpur. *IOP Conference Series: Materials Science and Engineering*, 401, Article 012020. https://doi.org/10.1088/1757-899X/401/1/012020 401 012020. DOI:10.1088/1757-899X/401/1/012020
- Besari, A. R. A., Zamri, R., & Yusaeri, A. (2009). Automatic ablution machine using a vision sensor. 2009 IEEE Symposium on Industrial Electronics and Applications, 1, 506–509. https://doi.org/10.1109/ISIEA.2009 .5356425
- Dawal, S. Z., Mahadi, W. N. L., Mubin, M., Daruis, D. D. I., Mohamaddan, S., Razak, F. A. A., Rahman, N. I. A., Wahab, M. H. M. A., Adnan, N., Anuar, S. A., & Hamsan, R. (2016). Ablution workstation design for elderly and disabled people in Malaysia's mosques. *Iranian Journal of Public Health*, 45(1), 114–124.
- Fincham, J. E. (2008). Response rates and responsiveness for surveys, standards, and the journal. American Journal of Pharmaceutical Education, 72(2), 43. https://doi.org/10.5688/aj720243
- Hamid, A. B. A., Wahab, M. H. A., Alias, A., & Rahmat, N. (2015). Ablution design: The concepts and design criteria. In *Proceedings of the 2nd International Colloquium of Art and Design Education Research* (pp. 487–496). https://doi.org/10.1007/978-981-10-0237-3_48
- Jervas, E., Anele, T. I., Uloneme, G. C., Okeke, C. U., Iwuoha, G., Eke, C. C., & Osuchukwu, I. W. (2016). Lower extremity measurements in the

prediction of body height of the Igbos. *Open Anthropology Journal*, 1(1), 15–22. https://doi.org/10.17140/ANTPOJ-1-104

- Johari, N. H., Hassan, O. H., Anwar, R., & Kamaruzaman, M. F. (2013). Human behaviours influence framework of the ablution tub design. *IEEE Business Engineering and Industrial Applications Colloquium* (pp. 750–752.) https://doi.org/10.1109/BEIAC.2013.6560233
- Moch, B. N., Puspasari, M. A., Muslim, E., & Hardian, R. (2013). Designing an ergonomics-based public ablution place for the Indonesian population using a posture evaluation index and virtual environment method. *International Journal of Ergonomics*, 3(1), 15–24.
- Mohanty, B. B., Agrawal, D., Baisakh, P., Samantsinghar, P., Kumar, S., & Chinara, P. K. (2015). A study of different parameters of human extremities and its relationship with human height in residents of eastern India. *Tanta Medical Journal*, 43(1), 1–8. https://doi.org/ 10.4103/1110-1415.154557
- Mokhtar, A. (2003). Challenges of designing ablution spaces in mosques. Journal of Architectural Engineering, 9(2), 55–61. https://doi.org/10.1061/ (ASCE)1076-0431(2003)9:2(55)
- Mokhtar, A. (2006). Design guidelines for ablution spaces in mosques and Islamic praying facilities. American University of Sharjah.
- Yurconic, M. (2001). Design specifications for supplier provided stairs, footstools, platforms corporate ehs design & engineering. https://supplier.intel. com/ehs/toolstairs.pdf
- Zivicnjak, M., Narancić, N. S., Szirovicza, L., Franke, D., Hrenović, J., & Bisof, V. (2003). Gender-specific growth patterns for stature, sitting height and

limbs length in Croatian children and youth (3 to 18 years of age). *Collegium Antropologicum*, *27*(1), 321–334.

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



Shahrin Azuan bin Nazeer D received his BSc in Computer Science from Clarkson University, Potsdam, New York, United States, in 1990; MSc in Information System Engineering from University of Manchester Institute of Science and Technology, Manchester, United Kingdom, in 1997; and PhD in electrical engineering (control system) from Universiti Teknologi Malaysia, Skudai, Johor,

Malaysia in 2008. He has been with Northern Border University, Arar, Saudi Arabia as associate professor since 2017. His research interest includes intelligent systems, information security, artificial intelligence, image processing, software engineering, and web development. ORCID: https://orcid.org/0000-0002-3401-1459



Mohammad Akram Randhawa graduated from King Edward Medical College, Lahore, Pakistan in 1973. He obtained his MPhil in pharmacology from Post Graduate Medical Institute, Lahore (1977) and did Fellowship in Clinical Pharmacology at St. Bartholomew's Hospital, London, United Kingdom (1985– 1986). He completed his PhD from Quaid-

e-Azam University, Islamabad in 2002. Has been teaching Pharmacology at King Edward Medical College (1974–1983), Rawalpindi Medical College (1983–2000), University of Dammam (2000–2014), and Northern Border University, Saudi Arabia (2014– 2018). He has 58 research publications and 33 presentations at scientific conferences to his credit.



Maher Sayel Alshammari graduated from the Department of Urban and Regional Planning, College of Architecture and Planning, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia in 1994. He obtained a master's degree in urban and regional planning from the University of Texas at Arlington, Texas, United States in 1999. He completed his PhD in urban plan-

ning and public policy from the University of Texas at Arlington,

Texas, United States in 2007. He has been teaching urban and regional planning at Imam Abdulrahman Bin Faisal University (2007–2020). Has has worked on several funded projects and research related to urban and regional planning.



Abdulhakim Bawadekji graduated from the Faculty of Agriculture, University of Aleppo (Aleppo, Syria) in 1980. He obtained his master's in experimental ecology from IBEAS (Pau, France) in 1988. He completed his PhD in agriculture sciences from ENSA_M (Montpellier, France) in 1993. He has been teaching botany, biology and applied mycology at the University of Aleppo

(1994–2005), Arar Teachers' College (2006–2008), and Northern Border University (2009–2020). He has 64 publications and several presentations at scientific conferences to his credit. ORCID: https://orcid.org/0000-0001-6148-5441

The authors are grateful to the Deanship of Scientific Research, Northern Border University, Arar, Saudi Arabia for financial support (Project No. 7321-SCI-2017-1-8-F). The authors also thank all persons who assisted in the research, particularly, the Department of Mosques in Arar, for accepting to implement the suggestions in other mosques.

eid

Copyright 2021 by Human Factors and Ergonomics Society. All rights reserved. DOI: 10.1177/1064804620984940 Article reuse guidelines: sagepub.com/journals-permissions