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Original Article

Wudu' Workstation Design for Elderly and Disabled People in Malaysia's Mosques

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Abstract

Background: Ablution area is one of the facilities used by most Muslims in all categories. There are numbers of design guidelines for praying facilities but lack on ablution area specification. Therefore, this study was conducted to design an ergonomic ablution area for the Muslim's disabled and elderly based on their preferences and anthropometric dimension.

Methods: Kano questionnaires and user evaluation form, was used to investigate the preferences of elderly and disabled in ablution area to 20 respondents at Masjid Bulat, Petaling Jaya and Masjid Kampung Kerinchi,Pantai Dalam, Kuala Lumpur in 2015. Anthropometric dimension of elderly and disabled people was measured. Besides, dimensions of two existing ablution units at selected mosques were evaluated using 'Ablution Unit Dimension Evaluation' form.

Results: New ablution area design was developed based on elderly and disabled people anthropometric dimension and user preferences as well as user satisfaction survey. This study can be considered as preliminary study for the development of ergonomic ablution unit design.

Conclusion: It is hoped that the findings and recommendations from this research will be referred by the stakeholders to determine the best solution to increase the level of comfort and accessibility for elderly and disabled at mosques in Malaysia.

Keywords: Wudu', Ablution, Workstation, Elderly, Disabled, Design, Mosque

Introduction

Malaysia population is facing a high rate of demographic rate as in 2014; the population reached 30 million compared to 29 million in 2013 according to Malaysia Department of Statistic Quick Info. High demographic rate not occurs only in Malaysia but this aging issue actually had become a global problem (1). Malaysian population is projected to increase by 35% in 2040 but the annual growth rate is projected to decrease to 0.6% in 2014 expected to occur due to decrease in fertility rate and active international migration based on Department of Statistic at 2013. Elderly people commonly referred as population having one or more illnesses other than having movement or functional problem (2). Improvement in healthcare services results in existence of active elderly people which prefer to live independently (3), demands development of facilities which able to

adapt to their capabilities and abilities also increasing to conduct their daily activity, including praying facilities. As for the Muslim, praying and ablution are considered as part of the daily activity that has to be conducted wherever they are.

Disability is defined as a physical or mental impairment experienced by an individual that substantially limits one or more major life activities (3). A physical impairment is any disability which limits the physical function of limbs or fine or gross motor ability. The Persons with Disabilities Act (2008) defines persons with disabilities as "Those who have long term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society." (4). Malaysia has a total population of 29.9 million in May, 2014 and the number of persons with disabilities who are registered with the Malaysian Social Welfare Department is 301,346 (5).

World Muslim population in the world is estimated to be around 20-25% of total world population. Majority of the Muslim residents is approximately in 40 countries including Malaysia and almost every country has small Muslim population (6). In Malaysia, Selangor, Kuala Lumpur and Putrajaya themselves already had 645 and 144 mosques and musolla, registered with the government bodies. Prior to obligate five times praying every day, Muslims are required to perform ablution as a cleaning procedure for the Muslim (7). In Malaysia, praying facilities equipped with ablution area can be easily found around public places including shopping complex and highway rest area for the Muslim to pray.

Most of the existing praying facilities design guideline developed by some countries focus solely on the appearance of the praying facilities while ignoring proper design of supporting spaces such as toilet and ablution area (6). In Malaysia, set of Malaysia Standard has been developed as a guideline for the developer and designer to build public facilities which can be accessible by the vulnerable group such as elderly and disabled population to provide design specification such as height of ramp and handrail, slope of ramp and finishing material. Therefore, it is necessary for praying facilities designer to promote an adequate environment for the elderly and disabled, considering their needs, capabilities, abilities and limitations.

Even though ablutions space is considered as one of the important public facilities especially in country with high Muslim population, there are numbers of design guideline for mosque but still lacking in guideline, research or document specifically on ablution area (8). Most designer will neglect design of supporting area such as toilets and ablution space since most of them emphasized on aesthetic appearance of their design. As elderly population is increasing, their requirement should be taken into design consideration so that they will function with limited assistance from other people. Ergonomic aspect also should be taken into the consideration for safe and low risk environment. In Malaysia, research on anthropometric data is expanding which can be used to design an ergonomic ablution area at mosques for public use.

Therefore, this study focused on designing wudu' workstation for elderly and disabled people in mosque.

Materials and Methods

Development of ergonomic ablution unit was done in two stages. In stage 1 which is the evaluation stage, the dimensions and supporting facilities were being measured and recorded in the Ablution Area Evaluation Form. After that, problems or dissatisfaction they met at those units were determined using user satisfaction form. In final stage, Kano questionnaire form were distributed to evaluate user preferences to 20 respondents focusing on the elderly in 2015 at Kuala Lumpur and Selangor. By the results of Kano questionnaires and user evaluation form, the preferences of elderly people in ablution area and opinion on current ablution area performance were determined. Kano questionnaire form is one of the validated questionnaire forms which can be used to identify user preferences (9).

Elderly Participants and Wheelchair Users

As for this study, ablution unit at two selected mosques, i.e. Masjid Bulat, Petaling Jaya, Selangor and Masjid Kampung Kerinchi, Pantai Dalam, Kuala Lumpur were evaluated. 20 elderly at aged 50 years old and above involved in the survey. A randomly selected disabled wheelchair user was interviewed for this particular case study to gather information on the accessibility of the ablution areas.

Analysis

Evaluation form on ablution unit dimension, user satisfaction survey form and Kano questionnaire form were used in this research. Results from respective evaluation will be used to design the ablution workstation.

Ablution Unit Dimension Evaluation

In order to provide ergonomic dimensions for new ablution unit, relevant anthropometry dimension were selected from previous study for user friendly design of domestic furniture and appliances (10). For example, arm reach forward dimension is useful to determine distance between users to the water tap of the ablution unit while popliteal height can be used for the seat height. Comparison between existing ablution unit and design unit is established to point out deficiencies of existing unit and corrected or improved in new ergonomic design unit.

Ablution Unit User Satisfaction Evaluation

Kano model approach is used to investigate user's perception and level of satisfaction towards current ablution area. The evaluation form was distributed to 20 elderly individuals on voluntary basis and they were informed about the purpose of the study. From the survey, problems upon usage of existing ablution unit can be determined and components or requirement that needs to be added and improved from the existing design were identified.

Ethical approval for the study was obtained from the Medical Ethics Committee, University Malaya Medical Centre.

Results

Ablution Unit Dimension Evaluation

Dimensions of two existing ablution units at two mosques selected i.e.: Petaling Jaya, Selangor and Pantai Dalam, Kuala Lumpur, respectively, were evaluated using 'Ablution Unit Dimension Evaluation' form which consists of several dimensions such as seat height and width, tap height, distance in between water tap and user and distance between ablution points. Fig. 1 show the evaluation of ablution unit dimension. Table 1 illustrated the evaluation of an ablution unit dimension.

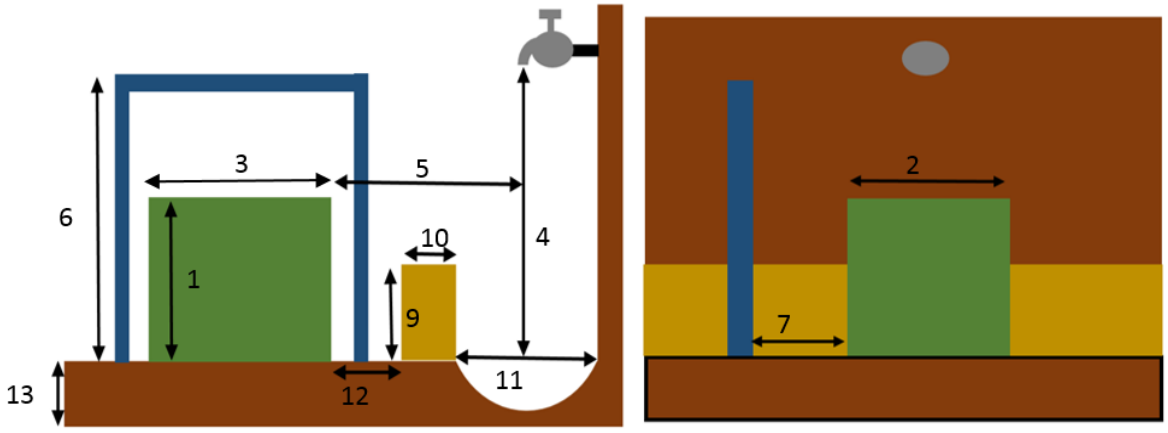

Fig.1 : Ablution Unit Dimension Evaluation

Table 1: Ablution Unit Dimension Evaluation

n	Dimension	Masjid Bulat, Petaling Jaya	Masjid Kg Kerinchi, Pantai Dalam, Kuala Lumpur
1	Seat height	-	-
2	Seat width	-	-
3	Seat length	-	-
4	Tap height	90.0	80.0
5	Tap-to-user distance	30.0	25.0
6	Handrail height	-	-
7	Handrail-to-seat distance	-	-
8	Ablution point-to-point distance	85.0	50.0
9	Barrier height	-	-
10	Barrier width	-	-
11	Drain width	35.0	30.0
12	Barrier-to-user distance	-	-
13	Floor elevation	15.0	15.0
14	Foot step width (if seat not available)	50.0	35.0

Note: All dimensions are in cm.

Kano Evaluation Model

Analysis of the Kano Questionnaire Form were done based on the Kano evaluation model as indicated in Table 2.

Elements marked with (visual) indicate that product requirement in terms of visual aspect. Subsequently, each product requirement or element customer satisfaction (CS) and dissatisfaction (CD) were calculated using customer satisfaction and dissatisfaction equations. The results showed that the elderly select three elements as 'Must-be(M)' quality, two elements as 'Attractive (A)' and nine elements as 'Indifferent(I)' quality.

Table 2: Kano Category Classification

Product Requirement	Customer Satisfaction, CS	Customer Dissatisfaction CD	Category
Seat provision	0.4705	0.2941	A
Seat height	0.2353	0.2941	I
Legroom	0.2353	0.2941	I
Tap height	0.4118	0.5294	M
Tap distance	0.5294	0.3529	I
Tap type	0.2353	0	I
Handrail provision	0.2353	0	I
Handrail height	0.2353	0.0588	I
Handrail distance	0.4705	0.2941	A
Water tap (visual)	0.1764	0.2941	I
Wet seat (visual)	0.2941	0.4117	M
Wet floor (visual)	0.1765	0.4706	M
Splash barrier (visual)	0.1765	0	I
Floor elevation (visual)	0.2353	0.2353	I

Anthropometry Dimension Data

There are five main components of the ablution unit design which are seat, water tap and visual recognition as well as accessories including handrail and water barrier as show in the qualities classification table below. It should not restrict standing and sitting around the ablution unit. The ablution unit dimension will be designed based on respective anthopometric dimension with specific requirement as indicated in Table 3.

Table 3 : Kano Qualities Classification (8)

Factor	Qualities	Description
Seat	Seat provision	Support physical condition of the elderly
	Seat height	Suitable to used with fixed tap and handrail height.
	Legroom	Enough space for leg position and proper feet rest.
Water tap	Tap height	Suitable for various body size.
	Tap distance	Easy to be reach at fixed seat distance.
	Tap type	Water saving, durable and easy to be used.
Handrail	Handrail provision	Support physical condition of the elderly
	Handrail height	Suitable for various body size
	Handrail distance	Easy to be reach at fixed seat distance.
Splash barrier	Barrier height	Able to protect user from get wet
Visual recognition	Water tap	Easy to recognize and reach
	Wet seat	Easy to recognize and prevent
	Wet floor	Easy to recognize, prevent or being extra careful
	Floor elevation	Easy to recognize to step up and step down

Discussion

Sample Demographic Data

Survey form was distributed at two selected mosques at Pantai Dalam and Petaling Jaya each to 20 elderly. Out of 20 responders, 17 completed forms were returned. The results indicates that 64.7% of the elderly participated in the survey were female.

It can be seen that most of the respondents were aged 55 yr and above (82.4%) and others aged below 55 yr old. Even though elderly in Malaysia was defined as the person which aged 60 years old and above, for this study, person aged from 50 years old was included as human body deterioration starts at 50 yr and also elderly anthropometric data that will be used to design ablution unit taken from previous study by (9) considered person aged 55 yr old and above as elderly. The youngest respondent aged 50 yr old while the eldest respondent aged 68 years old. Thus, most of the respondents were female, 82.4% aged 55 yr old and above with the eldest respondent aged 68 years old.

User Satisfaction Survey

The survey form distribution mainly focusing on 5 components of ablution unit to be considered in the new design of the ablution unit which are seat, water tap, handrail, splash barrier and visual as provided in the ablution unit model (8). Questions asked were related to user individual aptitudes and experience on corresponding ablution unit and to identify user potential abilities and limitation to function within widest possible range of situations (11). In addition, considering multiple user opinion and identifying optimum level of user condition such as body allows researchers or designer to merge different properties to function as one and fit with them and also increase product engagement level (12).

Seat provision

Most of the elderly (53%) prefer to have seat at the ablution unit while others (47%) does not need seat at the ablution unit. However, based on the conversation throughout the study, most of them would be glad if seat is provided so that they did not have to stand during ablution. Moreover, 6 out of 9 respondents which need seat to be provided at the ablution unit were aged 60 yr old and

above. This shows that seat can act as their physical supporting component correspond to their physical condition of the elderly which unable to stand or bending forward for a long time.

Most of the elderly (59%) had experienced using seat and some of them never experienced using seat and 6% of them not sure or does not remember whether they ever experienced it or not. 53% user which need seat at the ablution unit as in pie chart above might be affected by their experience utilizing seat at the ablution unit. They probably thought that provision of seat able to support their limited physical abilities. From the analysis on seat provision as above, it can be concluded that most of the elderly need seat to be provided at the ablution unit and the decision was strongly associated to their experience of using seat at the ablution unit where majority of the respondent had experienced on utilizing seat at the ablution unit.

Water Tap

Water tap is one of the most important components at the ablution unit. It must supply clean, fresh and unused water for the ablution activity (13). Regarding the suitability of the water tap height at selected ablution unit, 82% of the elderly user thought that the height of the water tap was suitable and easy to use while 18% of them experienced opposite situation. Heights of water tap measured at the studied ablution unit were 90.0 cm and 80.0 cm, for Masjid Bulat and Masjid Kg Kerinchi, respectively. The water tap must be either too high or too low for them to reach which made them experienced arm pain or back pain. As most of the respondents thought that the water tap height was suitable, therefore, the existing water tap height was acceptable and does not need further improvement. From the result, 65% elderly user thought that the distance of water tap from the user acceptable while 29% of them thought that the water tap was too far, which might be experienced by short hand dimension or small sized person. Another 6% elderly were not sure on suitability of the distance as some of them rarely performing ablution at respective ablution unit.

Distance of water tap from user also another matter which should be taken into consideration, i.e. if the water tap is too far, it will makes the user have to bend forward which may cause back pain or user have to move closer to the tap which would make user's cloth to get wet. Wet condition also may occur if the water tap is close to the user especially if there is no splash barrier. Distance of water tap from the user measured from the studied ablution unit was considered corresponds to the drain width as there was no seat provided at the ablution unit which were 35.0 cm and 30.0 cm for Masjid Bulat and Masjid Kg Kerinchi, respectively.

Handrail

The third component being evaluated in this survey was handrail. Handrail was recognized as assistive component for toilet transfer (14) and the concept can also be applied at the ablution unit as assistive component for standing and sitting from and to the seat at the ablution unit. From the result, it can be seen that, majority of the elderly (41%) does not need handrail to sit or stand from the seat while 35% agreed that they need handrail to sit and stand from the seat. Another 24% of the users were not sure whether they needed handrail or not to move at the ablution unit. From the 35% user which needed handrail provision, 50% were elderly aged 60 yr old and above. Fifty three percent of the user does not have any difficulty to move around without handrail which might be one of the factor 41% of them does not need handrail to sit or stand. Only 18% of the user have difficulty to move without handrail. As most of the respondents does not have difficulties to move without handrail, this may affect percentage of respondent which does not need provision fo handrail at the ablution unit.

Most of the elderly (65%) never experienced using handrail at the elderly, contributing to the reason why there was some elderly which not sure whether they need handrail at the ablution unit to sit and stand and if they have difficulty to move around without handrail.

Splash Barrier

The survey indicates that 65% of the user were recorded enquiring for splash barrier to be installed at the ablution unit as without the splash barrier all of them experiencing wet condition when performing ablution without any barrier. Both studied ablution unit does not provided with splash barrier. Therefore, splash barrier is reliable and important to be included in the design. Other than to prevent user from getting wet, safe and comfortable condition are two factors that needed to be included in ergonomic design of ablution unit (1, 6).

Visual

For visual evaluation, 88% of the elderly user stated that they can see and identify position of water tap, existence of wet seat and floor elevation. However, when it comes to identifying wet floor, there was one user does not sure whether he or she able to identify wet floor while majority of the other user (82%) able to easily identify and differentiate existence of wet floor. From the study, it can be concluded, existing ablution units were provided with adequate lighting and suitable selection of material and color as majority of the user does not having difficulty to recognize water tap position, wet seat and wet floor as well as floor elevation.

Anthropometry Dimension Data

The require dimensions were accomodated in the new design as in Table 4. As male and female anthropometric dimension were slightly different, only male anthropometric data will be used as measurement reference as it will fit into most of the target population for both gender. 5th percentile measurement was used for seat height, tap height, tap-to-user distance, handrail height, handrail-to-seat distance, barrier height, barrier width and drain width while 95th percentile measurement was used for seat width, seat length, barrier-to-user distance and foot step width. 5th percentile measurement was used to represent smallest person of the target group to avoid extended reach easily while 95th percentile measurement was used to represent largest or highest person of the target group for sufficient clearance to avoid unwanted contact. Mean value represent 50th percentile of the data set.

Considering the nature of the ablution activity, new design of ablution unit should be equipped with suitable dimension of seat, water tap and handrail, other than physical appearance of the ablution unit also should be able to adapt to the elderly visual performance to avoid unnecessary functional and environmental problem.

Proposed New Ablution Area Design for Elderly

Ablution Unit Dimension

Based on the Kano Questionnaire Model, main elements which highly preferred by user were seat provision and handrail distance which falls under 'Must-be(M)' category, tap height and clear visual of wet floor which falls under 'Attractive(A)' category and tap distance even though it falls under 'Indifferent(I)' category. Therefore, new design also includes clear visual of wet seat which falls under 'Must-be(M)' category. As mentioned earlier, five main components for the ablution unit design were seat, water tap, clear visual and accessories which are handrail and splash barrier. Dimensions of the ablution unit were tabulated in the Table 4. It shows the illustration of ablution unit designed for both male and female elderly based on the elderly anthropometric data by (9). Seat height and length provided in the design were 45.00 cm. Seat height took the approximate of mean value of the sitting popliteal height in the anthropometric data (Male: 44.27 cm, Female: 42.18 cm) as it should be able to accommodate fixed water tap and handrail height as well as easily reached by the smallest person. Seat length took approximate value of buttock-popliteal height (Male: 43.24 cm, Female: 41.90 cm) to provide adequate sitting area. For the seat width, measurement was taken at 40.00 cm in reference to sitting hip breadth mean value with 37.15 cm for male and 36.59 cm for female.

Water tap was designed with 100.00 cm height allowing tallest person to reach to avoid them to bend their trunk too much to reach the water tap, in reference with 95th percentile female and male

sitting shoulder height (78.85 cm and 94.23 cm, respectively). Distance of water tap from the user should be within arm reach forward which is 80.00 cm and 75.00 cm for male and female, respectively as arm reach forward dimension mean for male is 78.59 cm and 73.44 cm for female. Leg clearance room, splash barrier width and drain width should be within arm reach forward distance. For the design, width of the drain was 15.00 cm, based on existing ablution unit.

Table 4: Proposed new ablution unit dimension

No	Component	Dimension(M)	Dimension (F)	Reference
1	Seat height	45.0 cm	45.0 cm	Mean
2	Seat length	45.0 cm	45.0 cm	Mean
3	Seat width	40.0 cm	40.0 cm	Mean
4	Foot clearance	30.0 cm	30.0 cm	95th percentile
5	Water tap height	100.0 cm	100.0 cm	95th percentile
6	Distance water tap – user	<80.0 cm	<75.0 cm	Mean
7	Handrail height	100.0 cm	100.0 cm	95th percentile
8	Handrail distance	30.0 cm	30.0 cm	95th percentile
9	Splash barrier height	30.0 cm	30.0 cm	5th percentile
10	Splash barrier width	10.0 cm		Within arm reach forward range
11	Floor elevation	15.0 cm		Existing ablution unit measurement
12	Drain width	15.0 cm		Existing ablution unit measurement

Handrail height was designed to be similar to the water tap height with 100.00 cm height for both male and female ablution unit with the same purpose, i.e. to avoid them to bend their body too much. Distance of handrail from the seat should close enough to allow elderly to reach the grab bar. 30.00 cm distance was fixed based on foot length dimension. Height of the splash barrier was 30.00 cm to prevent water splashed out to the user. Distance between seat and splash barrier was designed at 30.00 cm to provide enough foot clearance for the user to move around with 95th percentile male foot length (25.80 cm) as reference. Floor elevation was designed with 15.00 cm height, similar with both existing ablution unit which able to provide clear visualization of elevation during stepping on and down, to and from the ablution unit. Ablution point-to-point distance should be fixed according to the ablution space available as if the space is limited, the distance can be closer to 50.00 cm and vice versa with 85.00 cm as the studied ablution unit.

Figure 4 shows view of ablution unit consists of floor elevation, foot step, seat, foot clearance, splash barrier, drain and water tap from right side. Both and female sketches bent their body with user arm almost completely outstretched at several degrees to reach the water tap.

Ablution Area for Disable / Wheelchair User

There are number of studies being conducted on the building accessibility for wheelchair used by PwDs. Mostly, studies on the accessibility for wheelchair used have been done on office building comparatively to mosque. Nowadays, the problem of mosque's accessibility becomes viral and being spread to the diverse group of Malaysian people through social media. Because of this reason, more studies need to be conducted in order to highlight the problem faced by the PwDs in the mosque especially at ablution area. For this study, the mosques that participated are Masjid Negara, Jalan Perdana, Kuala Lumpur and Masjid Tuanku Mizan Zainal Abidin, Jalan Tuanku Abdul Rahman, Presint 3, Putrajaya.

In reality, the ablution areas in Masjid Negara were constructed either by using guidelines from Middle East countries such as UAE, (15) or maybe through educated assumptions. In addition, the involvement of anthropometric measurements in the development of these guidelines is questionable as there is no study being conducted in this specific subject.

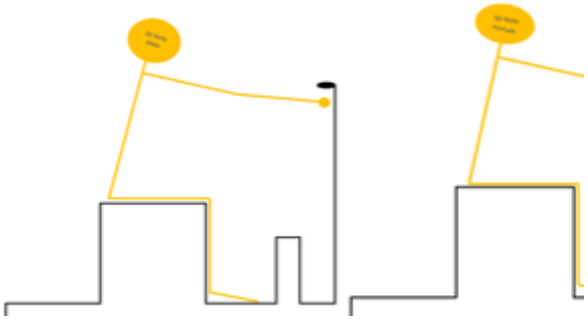

Fig. 4: Sketch of Proposed Ergonomic Ablution Unit for 50th Percentile Male (left) and Female (right) (Right side view)

These crucial facts are yet to be proven and one of the ways to validate these statements is through investigation on the mismatch of mosque facilities measurement with the PwDs anthropometric measurement.

The placement of the faucet within this standard length will improve reachable factor. Hence, the risk of accidental upper limb injuries experienced by PwDs might be reduced as this specified length requires less effort for wheelchair user to reach the faucet.Practically, the faucet position should be determined by referring to the anthropometric dimensions that represent the wheelchair user population. This is necessary to ensure the high degree of safety and accessibility for wheelchair user to facilitate the facility is acceptable. Anthropometric dimensions such as sitting popliteal height (SPH), sitting shoulder height (SSH) and arm reach forward (ARF) of a population need to be collected to determine the faucet position. Based on previous conducted studies, wheelchair user's population measurement of related anthropometric dimensions in USA (16) and Poland (17) were gathered to design workstation. Unfortunately, there is no data of anthropometric dimension for wheelchair users in Malaysia, so, data comparison is impossible in this matter.

Summary of Investigation on the Mismatch between Ablution Area Facilities Measurements and Pwds Anthropometric Data

Based on the investigation on the ablution areas at both Mosques which are Masjid Negara and Masjid Tuanku Mizan Zainal Abidin, it is found that the faucet height from the lowest floor level is too low making it impossible to be operated by wheelchair user who has permanent or temporary back injuries. Thus, the existing height of faucet is mismatching the anthropometric measurements as the wheelchair user had to initiate bend down motions when performing ablution steps. As a recommendation, the faucet should be placed at higher position with at least 1200 mm from ground level as suggested in Model 2 of Mokhtar (7, 15) guideline. In addition, design of faucet tap and water outlet at ablution area of Masjid Tuanku Mizan Zainal Abidin should be customized and remake so that it can be reached by wheelchair user. Other than that, specialised ablution area for wheelchair user should be constructed at mosques as other alternative so that the user can perform ablution.

Conclusion

Number of mosques and musolla built up to 2014 reached almost 6,000 in Malaysia which will kept

on increasing every year as well as number of elderly and disabled population especially in Muslim community. Advancement of healthcare sector and awareness of healthy daily lifestyle and diet were some of the factor contributed to the increase of elderly and disabled population. Therefore, it is important for the new mosques and musolla to provide with ergonomic ablution unit to prevent health problem to the elderly and disabled.

Ethical Considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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