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EVALUATION OF HEALTH, RELIGIOUS FACTORS, AND MODERN TECHNOLOGIES IN PUBLIC TOILETS DURING HAJJ

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ABSTRACT: *Hajj pilgrims encounter a great deal of tough physical and mental stress. Overcrowding, extreme temperatures and electrolytes imbalance are common among pilgrims. Approximately more than 2.5 million people from different parts of the world gathered in the holy sites Makka. These factors trigger the increased risk for communicable and non-communicable diseases. This study discusses health and religious factors in an attempt to assess the mandatory health requirements for public toilets in the holy places at Makkah city, that can be translated into toilet design for Hajj pilgrimage at Mecca with the purposes of integration of modern technologies. Articles related to toilet problems faced by the pilgrims published between 2013 to 2018 in some selected data bases were considered in this study. Only 20 studies were included, encompassing 12,000 respondents out of 300 articles. An evaluation requirement checklist was made to evaluate whether the toilet facilities conform to the local and international public toilet standards. Randomly, about 242 toilets were selected and assessed for the availability of essential hygienic items from Mina (54%), followed by Arafat (26%) and Muzdalifah (20%). The proposed conceptual toilets design for Arafat, Muzdalifah, and Mina in the Kingdom of Saudi Arabia is not only applied for Hajj purposes but also as a model to the development of toilet design in all Muslim countries. Sustainable design proposal with safety provisions, accessibility, hygiene, ventilated, lighted and cleaned public toilets during Hajj rituals would more likely protect pilgrims against adverse health effects. However, a definitive conclusion could not be drawn due to lack of existing studies related to this area. The contribution of this study is that the health and religious factors are very crucial in the consideration of toilet design whilst not forgetting modern technologies of the future.*

KEYWORDS: Arafat, health and safety, Mina crowd, Muzdalifah crowd, Public toilets.

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INTRODUCTION

Public discussion on toilet design and its issues may seem impolite, but it is one of the most important spaces in any building of anthropogenic character or otherwise. Its non-existence in a building is unacceptable, without which a building may not function effectively for its users. Taboo as it may seem, modern civilization depends on it for the comfort and ease in answering the call of nature, for maintaining the physical health from illnesses and diseases, for maintaining the religious need of privacy while carrying out the day-to-day activity one cannot escape from, and for fulfilling the values and requirements of the society, its culture and most importantly its religious obligations in the case of Islam and the Muslims. Nature calls are unavoidable. Humans naturally eat and drink, the digestive systems continue to be in operation, necessitating the provisions of efficient space and technology to cater for the excretion needs at any time required. It is also a compulsion for Muslims to be free of "najis" (an Arabic word meaning excretion or filth) when performing their obligatory rituals or else the rituals are deemed a waste of time and energy since it will be considered void and unacceptable by Allah's law. In view of this, the design of toilets for Hajj purposes needs careful thought especially with the increasing numbers involving millions of Muslims performing the Hajj yearly. Hajj is the largest annual Muslim mass gathering in Mecca, Kingdom of Saudi Arabia, for religious and ritual performances (KSA). Every year, over 2.5 million Muslims from all over the world perform Hajj (Ebrahim et al., 2009). For example, the total number of pilgrims in 2011 was 2,927,717, a 5% increase over the previous year 2010. According to reports, at least 1,828,195 pilgrims were foreign visitors, with 1,099,522 pilgrims coming from Saudi Arabia, (Royal Embassy of Saudi Arabia (RESA), 2011).

In 2016 (1437H), over 8.75 million pilgrims entered Makkah for Hajj and Umrah, the vast majority of whom are from outside the KSA, Figure 1. The total number of visitors to Saudi Arabia is expected to reach 30 million by 2030, including an increasing number of business travelers. Every year, an increasing number of Hajj pilgrims from various countries arrive in Saudi Arabia (RESA, 2011; Khan et al., 2010). The Hajj congregations are obviously overcrowded, posing significant public health challenges (Asghar, 2006).

Figure 1: The Holy Masjid in Mecca

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The goal of this research is to discuss toilet design criteria from an Islamic perspective. This discussion is later translated into a conceptual toilet design for Hajj purposes, with the goal of incorporating modern technologies into future toilet design. The significance of toilet design, particularly for Hajj purposes, is to ensure that clean, healthy, and comfortable practices are performed to support and sustain the hujjaj's day-to-day religious activities while performing their obligatory rituals. The emphasis on toilet design for Hajj purposes is critical for proposed model design in all Muslim countries, including Nigeria. Toilet design that incorporates references to Makkah and Madinah is critical, as these two cities are considered the holiest places in Islam. The study proposes toilet design based on health and safety requirements, as well as Islamic requirements, with the use of modern technology to ease and facilitate the call of nature for both able and disabled users.

The study first discusses the issues and problems encountered in toilets in general, and then highlights specific challenges in toilet usage during the Hajj season. It discusses the general design criteria, the health criteria, and the criteria based on Islamic requirements in the design of toilets, as well as the research methodology used. Finally, based on the criteria discussed, the study proposes a conceptual toilet design at a micro scale that focuses on the design and space requirements of the toilet cubicle. The fixtures, gadgets, and the room in which they are housed are all part of the design. The internal plumbing fixture and waste disposal systems are not discussed in this study because they require engineering expertise to address.

Background Problem in Toilet Design

Toilet literature generally divides concerns about the condition of public or private toilets into three categories: functionality and aesthetics, health and safety, social, cultural, and religious. To effectively serve users, toilets must address issues beyond basic functionality and aesthetics. The health and safety issue concerns cleanliness, hygiene standards, and functionality effect on physical health caused by illnesses and diseases spread through the use of toilets. Value fulfillment is influenced by social, cultural, and religious issues. The United Nations General Assembly declared November 19th as World Toilet Day in 2013. World Toilet Day is a day to raise awareness and motivate people to take action to address the global sanitation crisis (UNICEF, 2013). Globally, 2.5 billion people (36% of the global population) do not use improved sanitation facilities (safe, clean toilets), and 1 billion people (15% of the global population) still defecate in the open, with the majority of these (934 million) living in rural areas (WHO & UNICEF, 2013).

According to Water and Sanitation for the Urban Poor, a public toilet is distinguished by its location in a public place and its accessibility and it remains a serious public challenge (Peprah et al., 2015; Belay et al., 2022). Therefore, it is a room or booth for the public to use for urination and defecation. More research on public toilets have been conducted in recent years, with a focus on their provision, governance, and implementation policies in governmental, professional, organizational, and cultural contexts (Afacan, 2015). The adequacy and cleanliness of the toilet facilities are used to judge the success of events. It has been demonstrated that public restrooms can cause health and safety issues, particularly for women, children, the elderly, and the disabled (Anthony & Dufresne, 2017). However, residual organisms from an infected person can survive in significant populations if not regularly decontaminated. Toilets can be an ideal environment for pathogens to spread from one person to another via hands and surfaces from the gut, respiratory tract, and skin (Gerhardt et al, 2012).

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Contamination of toilet doorknobs is one of the most common ways organisms are picked up through surface contact as observed by Ahmed and Seraj (2016).

Hajj is a 5-day event that is one of the world's largest annual gatherings. Approximately more than 2.5 million people from all over the world gathered in the holy sites at Makkah. The toilets should be sufficient in number, conveniently located, suitable for the Hajj event, and kept clean and tidy. Local governments play an important role in providing safe and accessible public restrooms. Saudi authorities place a high priority on providing accessible public toilets, as evidenced by adequately well-designed public toilet facilities in holy places as seen in Figure 2.

Figure 2: The Eastern Toilet: A Hajj Reflection

Part of public toilets are accessible to people with special needs, Figure 4, such as the layout of new improved clearly labeled toilets and the separate approach for each gender, Figure 5. The use of bright balloons to identify toilets, the water supply being serviced 24 hours a day during the Hajj event, the large number of labor, supervisors, engineers, and housekeepers to keep toilets clean and ready for use during the Hajj event, but despite these efforts, not all pilgrims' needs are met (Ascoura, 2013). Despite the guidance of the Health and Safety Executive the Event Safety Guide (1999) (Sanitary facilities), the number and facilities are insufficient in comparison to the number of pilgrims. There should be an adequate number of handicapped-accessible toilets, as well as the provision of portable toilets whenever and wherever possible (Jones & Reed, 2005).

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Notwithstanding, from scientific and environmental considerations, the fundamental principles of public toilet design should adhere to Islamic jurisprudence. It is preferable to refer to and emphasize Islamic teaching on the topic of cleanliness and the philosophy of toilet design (Abdul Rahim, 2005). For example, plenty of water, preferably running water, should be available at all times for cleaning the body and the environment. Furthermore, all toilets should be installed in the opposite direction of the qiblah (the direction of the Kaaba in Makkah's holy Mosque) (Abdul Rahim, 2005). The study evaluates the mandatory health requirements for public toilets in Makkah's holy sites during Hajj season for a proposed sustainable model in the Sustainable Development Goal (SDG). Every year, an increasing number of Hajj pilgrims from various countries arrive in Saudi Arabia (WHO & UNICEF, 2013; Ahmed & Seraj, 2016). The Hajj congregations are obviously overcrowded and pose significant public health challenges (Ascoura, 2013). The recorded temperatures ranged from 37°C to 45°C during Hajj (Mimesh, Al-Khenaizan & Memish, 2009). The leading causes of health problems among hajjis were overcrowding and the hot climate. Pilgrims performing the Hajj face significant physical and mental strain. Extreme temperatures, intravascular volume, and electrolyte disturbances all increase the risk of communicable and no communicable diseases in Hajjis (Mandourah, Al-Radi & Ocheltree, 2012).

The Functionality and Aesthetic Issues

Man has been answering the call of nature in differing ways according to the geographic locations, eras and cultures where they reside. The water closet was invented as early as 2,500 BC in the form of stone benches containing holes with running water underneath. The civilization of Greece, Egypt, India, South America and China graced their people with toilets that were connected to the underground drainage systems in areas where water was abundant. The Romans' public latrines were functionally designed with fine finishing of marble seats, coloured floor tiles, wall frescoes with windows and planting under the ceiling to improve the air quality and the aesthetic values. All these finesse and functionality were surrounded with soft and hard landscape to heighten the experiences of the users. It is incomparable to our contemporary drab-like public toilets. Nik (2017) in her initial research on the condition of toilets in Makkah, Arafah, Mudzdalifah and Mina found that the toilets lack enclosure in Arafah, Muzdalifah, and Mina, besides being inconvenient. There is no provision for the elderly and disabled, and further urgent upgrading in terms of numbers and physical condition. Through observation, the earlier researcher found that although the toilet facilities in these areas were equipped with taps, showers and ablution areas, they, inconveniently, function with limited cubicle space to maneuver; extremely lacking in privacy; inaccessible for the elderly and disabled; and aesthetically unpleasant.

The authors similarly found the toilet cubicles in Muzdalifah open directly to the public route and lack privacy. The female toilets are directly behind with open ablution areas for both the male and female. Urinals are still provided for men and are exposed to public view. Cubicles are narrow and difficult to maneuver for washing and cleaning purposes as seen in Figures 1-4. Additionally, the toilet facilities are surrounded by gravel and inaccessible for the disabled. Similar conditions are also found in Mina and Arafah (Al-Tawfiq & Memish, 2014). However, in Makkah better and improved condition of toilets is provided for the *hujjaj* and the general public (Ahmed & Seraj, 2016).

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The Health and Safety Issue

Reviews show that during the Middle Age, public toilets were non-existent. People used chamber pots and closed stools in their private homes with manual disposal systems. There were calls for public toilets but the open fields and the back streets remained as popular places for them to fulfill their needs. The unhealthy habits caused diseases, and epidemics spread rapidly. In the mid 19^{lh} century in France, many of her people, among them her own Prime Minister, died due to the spread of diseases caused by human excretion. The tragedy brought about a large-scale development of the underground drainage systems (Katsumata & Sakamoto, 2018). Since then, the importance of cleanliness in toilets has become a serious concern among the public. Modern day issues linked toilets with the spread of SARS. The outbreak of SARS panicked Hong Kong's public to the extent of making them question whether the disease could be spread by contact with public facilities, specifically the toilet. They avoided touching doorknobs and handles without protection, using tissues and plastic to cover surfaces before contact (Cheng, 2016). Toilets have always been associated with filth and bad odor. These conditions reflect the presence of germs, bacteria and viruses.

Apart from fulfilling its function as a disposal chamber for feces and urines, toilets are also places for powdering, resting, interactions and diaper changing for mothers and infants. Cleanliness and the prevention of the spread of diseases, sicknesses and ill health are supporting means for their activities to be safely and pleasantly carried out (Adler, 2019). Hygiene standards are important for all, especially during Hajj. As observed during the Hajj season, the conditions of the toilets were in a poor state of hygiene due to millions of users. Preventive measures from the spread of diseases, sicknesses and ill health are important for the preservation of the Hajj community's health and safety. The consideration of proper materials used together with ergonomically designed fittings is highly recommended for easy cleaning and maintenance.

The Social, Cultural and Religious Issues

Public toilets are places where one can see social expression and behavior in action Greed, (2018). They are places used by people from all walks of life from different ages, gender, cultures and religions. It is a microcosm of society at large. Unfortunately, these social expressions and behaviors are mostly negative actions in the form of graffiti, vandalism, substance abuse, thefts, etc. Different cultures have different sets of norms in which they perform their call of nature. These norms in the usage of toilets, like it or not, are part of the culture and everyday activity of any society. The Japanese, for example, treat toilets as pure and sacred places. However, certain third world cultures pay little attention to the public facilities, easing themselves at street corners and public precincts.

However, Islam regards toilets as less distinguished and respectable spaces because they are places for discharging human wastes and dirt from the human body. However, it is regarded as a very important space in any building and environment. It is where Muslims obtained physical cleanliness, a compulsion before performing their religious obligations. Focus is more on the religious requirement rather than social or cultural (Afacan, 2015).

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LITERATURE REVIEW

The toilet is a very important support space for any building although they are regarded as less distinguished and respectable. Specifically, during Hajj, millions of Muslims from all walks of life use the toilet facilities. These toilets allow Muslims and the *hujjaj* to obtain physical cleanliness, a compulsion before performing their religious obligations. It is critical to consider the special needs, according to the Islamic perspective, in the design of toilets to enable Muslims achieve acceptable and effective religious performance (Cheng, 2016). Toilets provide a place for humans to carry out their most private day-to-day needs of urination and defecation. In the Arabic language, the acts of urination and defecation are called *qada hajat,* an Arabic word meaning the acts of urination and defecation. No building can function effectively without toilet spaces, as it cannot support and facilitate *qada hajat.* Islamic perspective in toilet design, whether for homes, hotels or for public usage requires actors understanding on elements that constitutes *najis* and how *najis* can be strictly avoided according to Katsumata and Sakamoto (2018)

Definition Of *Najis*

Based on the *sharia* laws, the definition of *najis* denotes a dirt such as menstrual blood, urine and excreta that if left unclean, the act of prayer, reciting of the Quran, *tawaf,* and reciting the *khatbah* are regarded as illegal (Info Anis, 2017). Fathy (1990) argued that *suci* based on Islamic perspective is clean from small and heavy *hadas* and *najis.* There are physically two types of *najis* which are:

1. *Najis Aini* is the type of *najis* which can be seen, felt and smelt, such as blood, menstrual blood, urine and excreta.

2. *Najis Hukmi* is the type of *najis* which has no smell nor color. For example, the house floor which has urine on its surface. The area of this floor is considered not clean from a *najis.*

***Najis* can be further divided into 3 types as follows:**

a. *Najis Miikhajfafali* (light category of *najis)* is a male's baby urine less than 2 years old, with condition that the baby does not eat any foods like biscuit, bread, rice and fruits, and does not drink any beverage like dairy milks, glucose and fruit juices except only breast milk of his mother.

b. *Najis Mughallazah* (heavy category of *najis)* is part of or the excreta from dogs and pigs and the generation or hybrid associated with any of these two animals.

c. *Najis Mutawassitah* (middle category of *najis)* is all types of *najis* other than *najis mughallazah* and *najis mukhqffafah* such as blood, pus, urine, liquid from itches, vomit, and carcasses/remains of animal.

In this context, the types of *najis* associated with the use of toilets are *najis mukhajfafah* and *najis mutawassitah* (Wenz-Gahler, 2015b).

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Toilet Requirement in Islam

Islam requires Muslims to follow certain basic acts when dealing with *qada hajat* and cleansing in the toilet and bathroom respectively.

i. Privacy: Muslims when using toilet facilities should have privacy as noted by Jabir ibnu Abdullah in a translation of one *hadith* (An Arabic word meaning narration about the act and statement from Prophet Muhamad (peace be upon him)) by Rasulullah s.a.w., "When there are two men who want to urinate, each of them must border themselves from each other, and no discussion should be made as Allah s.w.t hates those who do not follow His laws." (*Hadith* narrated by Ibnu Sakan and Ibnu Qattan

As discussed earlier, toilets should be located at the rearmost of the building to ensure privacy status and prevent users being viewed from outside, more so between men and women. The use of urinals within the toilet spaces invades the privacy of men while urinating. The best solution is to avoid the use of urinals in public toilets. The use of individual toilet cubicles with a water closet and supportive washing facilities is recommended as it maintains cleanliness as well as privacy of the users.

ii. Toilet Orientation: Performing *qada hajat* in a direction or rear direction of *qihlat* (An Arabic word meaning the direction to Kaabah at Makkah by the Muslim when performing their prayers) is *haram* (An Arabic word meaning disobedience in fulfilling basic requirements in Islam which are wrongdoings or neglecting responsibilities. It is considered as sinful). In a translation of *hadith* of Rasulullah s.a.w., "When doing urination, you must not do it in a direction of *qibla*, and you must also not do it at a rear direction to the *qibla* but you can do it at a direction either west or east." (*Hadith* narrated by Bukhari, Muslim dan Ahmad). *Qada hajat* is permissible in the direction to the *qibla* if the area has a border with a wall perpendicular to the direction of the *qibla.* The size of the wall must be at least *2A hasta* high and *2'A hasta* wide as regarded by Imam Syafie. However, if *qada hajat* is intentionally done by a Muslim at the direction of the *qiblat* whilst making a joke of the Islamic laws, the act of the *qada hajat* is haram and if this act of *qada hajat* by a Muslim is purposely to humiliate the religion of Islam, his/her status will be considered as *kafir* (An Arabic term meaning infidelity). Actors must understand these religious requirements in providing spaces and facilities for users in performing *qada hajat.* It is the *sitnnah* (An Arabic word meaning an obedience which is not compulsory to follow the act of Prophet Muhamad (peace be upon him) by the Muslim in their daily life. There will be a reward for this obedience) of Rasulullah s.a.w. that states any Muslim who follows his *sunnah* by not performing *qada hajat* at either the direction or rear direction of the *qiblat* will get rewards from Allah s.w.a. Adler, (2019)

iii. Design of Toilet Bowls: It is also the *Sunnah* of Rasulullah s.a.w. to perform *qada* "Whoever says that Rasulullah s.a.w. perform *qada hajat* in standing position, this is not *hajat* in sitting position. Translation of one *hadith* from Siti Aisyah r.a. stated that, true. Rasulullah s.a.w. never performs *qada hajat* in standing position. He performs *qada hajat* in sitting position. (*Hadith* narrated by Ahmad, Nasai and Tarmizi). Another translation by Ibnu Malik r.a., quoted that, "Rasulullah s.a.w. teaches us a lesson for us to use sitting position while performing *qada hajat,* and to focus on sitting position more on the left foot with a right foot in the straight position." (*Hadith* narrated by Baihaqi).

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iv. Toilet Design with the Use of Left Hand for *Qada Hajat*: Based on the *hadith* translated by Qatadah r.a., Rasulullah s.a.w. said, "Please do not hold your genitals with your right hand when you urinate, and please do not use your right hand when you clean your private parts of your body, and please do not breath into the water while drinking." (*Hadith* narrated by Bukhari and Muslim). Based on the translation of the *hadith* from Salman Al-Farisi, "Rasulullah s.a.w. forbids us to use the *qiblat* direction while performing *qada hajat*, and *istinjak* (An Arabic word meaning using at least three stones (gravels size) to clean excretion or filth from a body after urination and defecation as an alternative way when there is no clean water available) with our right hand using less than three gravels/stones and using soil and bones." (*Hadith* narrated by Muslim, Abu Daud and Tarmizi).

v. Toilet Design Compromising Cleansing Requirements: Cleansing means to clean *najis* on our body, clothes and place. Cleansing is compulsory to all the Muslim believers. Islam requires it so that it is possible to perform *solat* (prayer) and to keep our body healthy (Yahya, Muaz & Pilus, 2018). *A hadith* translated by Muaz r.a. from Aisyah r.a. said, "You need to ask your husband to clean his filth and urine with water. We are ashamed of them whereas Rasulullah s.a.w. performs *istinjak* with water.' (*Hadith* narrated by Ahmad, Nasai & Tarmizi, n.d.). The toilet should have a good piping and water system with sufficient water supply adjacent to the cleansing process for *qada hajat.* It should also allow the users to easily use their left hand to clean their private parts of the body and it should employ an efficient use of water. The toilet should also have a good sewage system to discharge the dirt thus ensuring the cleanliness of the toilet (UNICEF, 2013).

vi. Toilet Design with Left Foot's Entrance: Toilet must have a door opening and its knob and the direction of opening should allow the user to use left foot entrance and right foot exit. A *hadith* translated by Abu Hurairah r.a. quoted Rasulullah s.a.w. as saying, "When you use a sandal/terompah, you need to use your left foot to enter a toilet. When you want to wear a sandal, you need to use your right foot first and when you want to take off your feet from the sandal, you need to use your left foot first."

vii. Cleansing with *Mutlak* Water: All toilets must have *mutlak* (An Arabic word meaning clean water, which is never used before for cleansing) water supply to clean *najis.* Types of *mutlak* water are water from conventional modern pipe water systems, well, river, rainwater, sea, spring water, dew and snow (UN Children's Fund, 2019). On the other hand, non-*mutlak* water is not categorized under *najis* water. The example of non-*mutlak* water is water from washes of the hand, body and feet. This non-*mutlak* water is possible for other non-cleansing usage such as to flush water in a water closet to discharge *najis* from a toilet bowl (WHO, 2013; UNICEF, 2013).

The requirements described above are positive additions to the existing set of criteria developed by the different world organizations. Adopting these requirements in the design of future toilets in public and private areas will cater for the needs of all communities regardless of culture and religion. This initial information could be a starting point for the authorities, toilet management groups, architects and designers to consider and use in the decision making involving the design of toilets for *Hajj* purposes. It is intended to solve the toilet issues holistically thus ensuring the well-being of the users (Abdul Rahim, 2005).

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RESEARCH METHODOLOGY

The study was conducted during Hajj 1438 H (2017) to assess the sanitary requirements of public toilets in Makkah, Saudi Arabia's Holy sites. The chosen toilets were located approximately 100 meters from each of the three mosques in a holy place (Figure 4). An evaluation was created to assess whether these requirements were met and whether they met local and international public toilet standards (Figure 5). The availability of essential hygienic items in 242 randomly selected toilets was evaluated. All outcomes were analyzed and evaluated using the IBM Corp. Released 2012 Statistical Package for Social Sciences Version 21.0 of IBM SPSS Statistics for Windows IBM Corporation, Armonk, New York."

Table 5: Requirement's checklist used in the study

No Date Time		GIS	
STUDENT NAME:-			
Holy place: 1-Arafat 2-Muzdalifah 3-Mina			☐
		Toilet No	
1	People crowd into toilets.	Yes ① No ②	☐
2	Separation of female toilets.	Yes ① No ②	☐
3	Availability of water supply.	Yes ① No ②	☐
4	Free of Waste overflow.	Yes ① No ②	☐
5	Availability of Locked-designed doors.	Yes ① No ②	☐
6	Presence of taps and flushing tanks	Yes ① No ②	☐
7	Adequacy of Lighting and ventilation.	Yes ① No ②	☐
8	Presence of exhaust fan.	Yes ① No ②	☐
9	Presence of handwashing station.	Yes ① No ②	☐
10	Presence of hand-drying methods.	Yes ① No ②	☐
11	Presence of poster or sign for handwashing procedure.	Yes ① No ②	☐
12	Availability of hand washing soap.	Yes ① No ②	☐
13	Availability of sanitizer or disinfectant.	Yes ① No ②	☐
14	Presence of cleaning services.	Yes ① No ②	☐
15	The walls and floors constructed of durable and cleanable materials	Yes ① No ②	☐

Evaluation of Health Requirements of Public Toilets During Hajj.

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RESULTS

A total of 242 toilets were visited. As shown in Figure 6, 188 of the toilets (43.8%) were from Mina, 71 (27.3%) from Arafat, and 65 (27.3%) from Muzdalifah (Gerhardt et al., 2012). Overall, there was a lack of hand washing soap (99%), hand drying methods (97%), posters or signs for hand washing (89%), exhaust fan (86%), sanitizers or disinfectants (81%), lighting and ventilation (63%) (Figures 7). The toilets were (52%) crowded (Figure 7). There is a statistically significant difference in toilet location (holy site) across hand washing stations, washing soap, sanitizers (disinfectants), and hand-drying procedure (p value = (0.00). There were no significant differences in the location of the toilet (holy site) across crowds into toilets (p value =0.48).

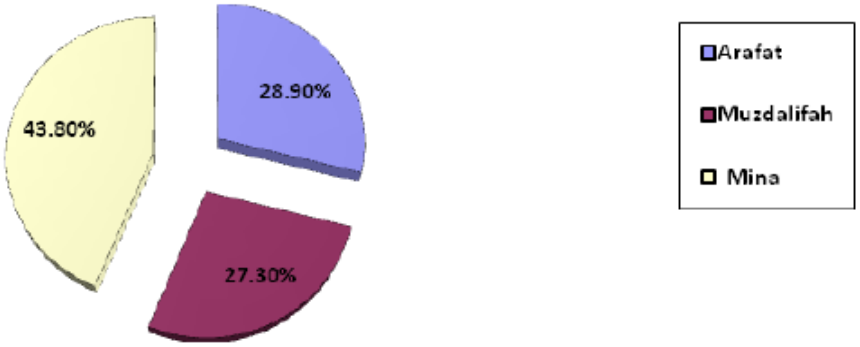

Figure 6: The Toilets Tested from the Three Holy Places

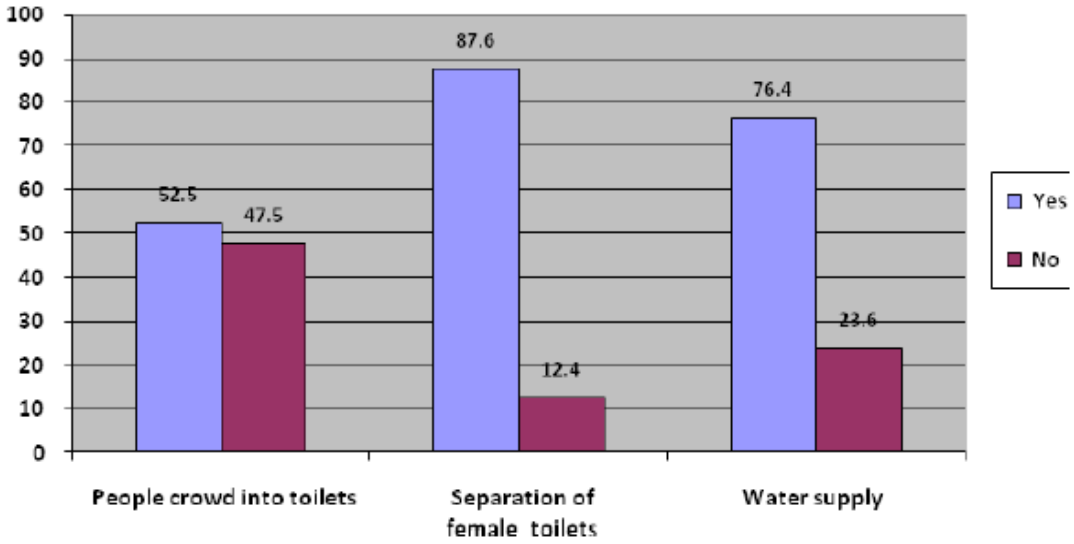

Figure 7. Toilets crowd, separation according to gender and availability of water supply.

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DESIGN AND RECOMMENDATIONS

Filth, dirt, smell, graffiti, vandalism, lack of privacy and hindrance to religious obligations in toilets are associated among others to poor toilet hygiene and etiquette; poor maintenance and poor design. It is not the authority of the writers to discuss toilet hygiene and etiquette. The study focuses on the design of toilets in overcoming the health and religious issues, two of the most important factors in ensuring pilgrims are secured from ill health and filth in carrying out their obligatory rituals.

Toilet Design Criteria in General

According to various literatures, the principles of good toilet design should incorporate good ventilation to extract bad odor, good lighting, bright interior space, safety features, such as grab-bars, vandal proof exterior, recesses under urinal bowl and wash fittings to prevent urinal dripping and water splashes on the floor and a bidet. The criteria developed by the world toilet organization addresses the cultural differences, the technological, ecological and legal aspects of toilet construction. The formulation of its requirements is based on contemporary toilet design that includes:

1 Aesthetically designed and architecturally unmistakable.

2 Spacious and sufficiently high rooms with abundant natural and artificial lights.

3 Additional ventilation to provide fresh, circulating air.

4 Materials used should be easy to maintain.

5 Accessible to the special needs of the disabled, mothers-to-be and infants.

6 Sufficient provision for rubbish and hygiene bins, mirrors and seats.

As such, toilets are to be functional, clean, hygienic, accessible and beautiful for all. Any toilet design should incorporate these basic requirements.

Health Factors

Apart from the cleanliness issue, the methods of excretion of bodily waste are found to be a health issue for the majority. Research revealed that squatting, not sitting, is a more natural and comfortable position to empty the bowels. When comparing between the two, much evidence points to the sitting toilet ritual as the cause of many ailments. Evidence also shows the advantages of squatting position as being superior compared to sitting. Clinical researches found that squatting have advantages as follows:

1. Makes elimination faster, easier and more complete. This helps prevent “fecal stagnation,” a prime factor in colon cancer, appendicitis and inflammatory bowel disease.

2. Protects the nerves that control the prostate, bladder and uterus from becoming stretched and damaged.

3. Securely seals the ileocecal valve, betweenthe colon and the small intestine. In the conventional sitting position, this valve is unsupported and often leak during evacuation, contaminating the small intestine.

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4. Relaxes the puborectalis muscle which normally chokes the rectum in order to maintain continence.

5. Uses the thighs to support the colon and prevent straining. Chronic straining on the toilet can cause hernias, diverticulosis and pelvic organ prolapse (Rad, 2016b).

6 Highly effective, non-invasive treatment for hemorrhoids, as shown by published clinical research

7. For pregnant women, squatting avoids pressure on the uterus when using the toilet Daily squatting helps prepare the mother-to-be for a more natural delivery.

Doctors have recognized the connection between sitting toilets and constipation (Hornobrook, 2019; Aaron, 1938). According to Hornobrook (2019), man's natural attitude during excretion is squatting. The ordinary sitting position forbids emptying of the lower bowel in the way nature intended and great strains are imposed on all the internal organs during excretion. The adoption of the squatting position helps to remedy constipation. Aaron (1938) claimed that the squatting position helps complete excretion in a way that when the thighs are pressed against the abdominal muscles, the pressure within the abdomen is greatly increased, thus allowing the rectum to be completely emptied. Our toilets are not constructed according to physiological requirements and he suggested that toilet designers study physiology and construct seats intended for proper excretion. This serves a good significance for people and in our case the pilgrims since *najis are* 'fully' disposed of. Rad (2016b) compares the effectiveness of sitting versus squatting for excretion. He relates sitting to hernia known as "rectocele," which is a bulge of the front wall of the rectum into the vagina. He further studied and measured the angle where the end of the rectum joins the anal canal. At this junction, the puborectalis muscle creates a kink to prevent incontinence. He found that when the subjects used sitting toilets the average angle of this bend was 92 degrees, forcing the subjects to strain. When they used squat toilets, the angle opened to an average of 132 degrees. At times it reached 180 degrees, making the pathway perfectly straight. All the subjects reported "complete" excretion when using squat toilets and reported that excretion felt "incomplete" in the sitting position. He concluded that the use of the squat toilet is a more comfortable and efficient method of bowel excretion than the sitting toilet.

Many residents in cities of Asia have abandoned their traditional customs, believing the West is more progressive and somehow "superior." By adopting western toilets, they have unwittingly introduced new diseases into their society. Evidence shows that the Asian technique of squatting can maintain better pelvic health than the Western sitting technique (Kira, 1976). Hong Kong city-dwelling women had more urinary incontinence and bowel problems than country dwelling women. Their basic differences were their toilet habits. Women in urban areas use the sitting method while the rural women use the squatting method. Squatting causes the angle of the pelvis to relax much better and give better pressure. Sitting prohibits the right relaxation of the muscles and the angle of the pelvis. It is believed that the squatting technique has tremendous beneficial effects on the pelvis and urinary incontinence. Sitting toilets force the users to strain for excretion, repeatedly subjecting the pelvic floor to unnatural stress. The downward pressure stretches and weakens the pudendal nerve, responsible for bladder control. The modem toilet has made women incapable of prolonged squatting, the position designed by nature to protect the pelvic floor during delivery.

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Virtually every physician and physiologist agrees that squatting is the most natural and physiologically sound posture to use for excretion. The sitting posture is associated with the cause of the following diseases which are almost exclusively confined to the western world: appendicitis, colon cancer, prostate disorders, diverticulosis, bladder incontinence, hemorrhoids, and inflammatory bowel disease. As such the method of excretion can help in preventing these diseases. In conclusion, the "porcelain throne" has caused enormous amounts of needless suffering, and the annual waste of billions of dollars in health-care costs. We are ignoring squatting at our peril. The best posture for passing stools is the natural squatting position. In all other positions, especially sitting, the colon does not have the natural support to perform its role effectively.

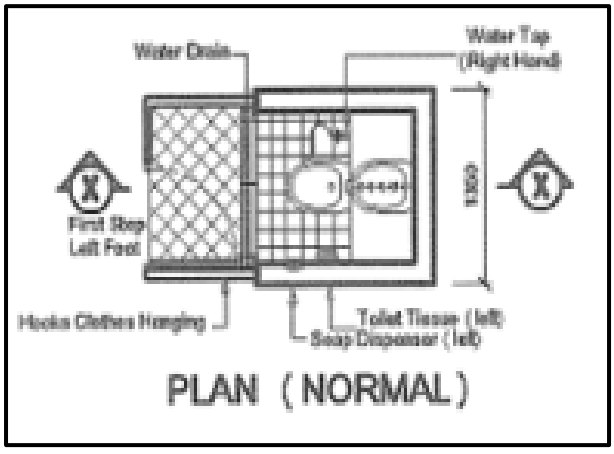
The sitting toilet is no longer confined to the Western world. It is fast becoming the toilet of choice in many Asian, African and Middle-Eastern societies, whose people have traditionally been squatting populations. The unintended consequence of this change has been tragic as indicated by the high incidence of serious ailments and diseases previously unheard of in squatting populations. There is no guarantee that those who squat will not suffer from these health problems. However, adopting the sitting posture for waste excretion is a dangerous habit. The tragedy of it all is that the discomfort, pain and suffering associated with the porcelain throne are unnecessary. The sitting toilet, for what it is, is a health threat that has largely been ignored for more than 150 years.

A Conceptual Proposal

Based on the literature reviews on toilet design criteria, the following shows and describes typical conceptual toilet design proposals for normal, squatting, aging and disabled users which adopt modern toilet technology as tools in ensuring a hygienic and friendly toilet environment. Although the squatting toilet is most recommended, choices are given especially for the aged and the disabled. The proposals are based on the health and religious requirements as described above.

General Characteristics of the Conceptual Design of Toilets

The common features introduced generally and in sitting toilets are shown in Figure 7.



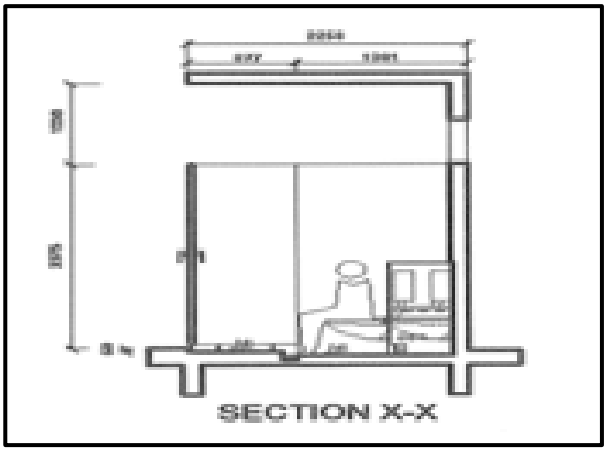


Figure 7: Normal Sitting Toilet **Section X-X**

Minimum size: 2258mm x 1350mm x 2375mm allowing open ceiling space for light and air flow above.

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Walls use both solid and light partitions to increase aural privacy and stable fittings. Solid walls could be finished with odor absorb tiles. Doors that unconsciously allow left foot entry and right foot exit. Rear top for user belongings. Wall hung self-cleaning/auto clean closet bowl for easy maintenance and hygiene. Automatic sensor flushing: reduce bodily contact with surfaces. 1.5-liter Vacuum Assist Flushing Pan: for water saving. Water drain with gratings/pebbles etc. with floor lay to fall to keep the toilet dry. Auto sensor heat coil fans for fast drying of toilets. Right hand placement of water taps for comfortable washing purposes. Tissue and soap dispenser on the left for easy and effective reach using the left hand. Features for squatting toilets include (Figure 8).

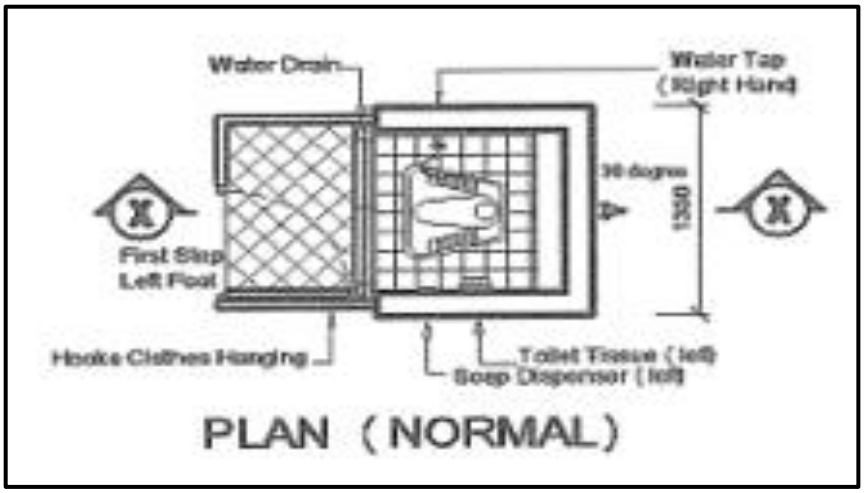
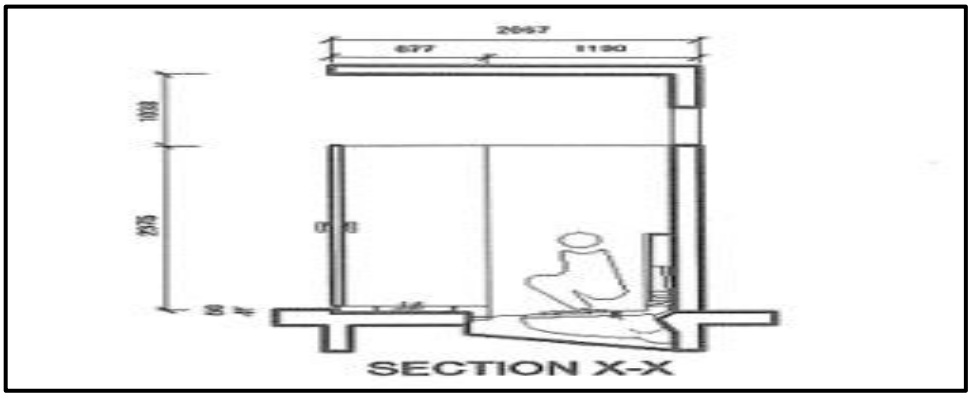


Figure 8: Squatting Toilet



Section X-X

Minimum size: 2067mm x 1350mm x 2375mm with the same characteristic as above apart from the toilet bowl design.

The toilet bowl is place tilted horizontally (5° inclination) and shaped at an angle of

30° on plan (trapezoidal shape) for natural squatting position.

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Toilet Features for Aging and Disabled Users

The provision of barrier free toilets enables the aged and disabled persons to reach the facilities provided without hindrance. It is believed that these categories of users are large in numbers during the *Hajj* season. The features include (Figure 9).

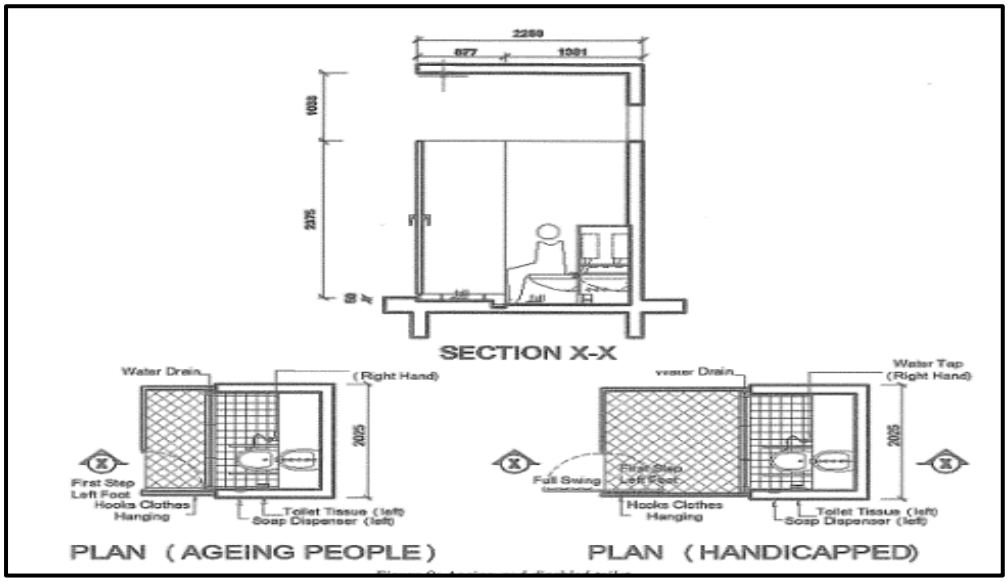

Figure 9: Aging and Disabled Toilet

Wider space for aging users and wider and deeper space for handicapped as shown above. Extra/sufficient space for wheelchair to maneuver all mounted grab bars.

1. Upward folding grab bar, which will be lowered when needed, to help save space.
2. All fixtures to be installed at ergonomically right height.
3. Provision for emergency buttons.
4. Locks to the door that enable the door to be opened from outside in case of Emergency.

DISCUSSION

A mass gathering is defined as a congregation or assembly of more than 5,000 people taking place in an open space or open air for more than 24 hours (Al-Tawfiq & Memish, 2014). Facilities should be sufficient in number, healthy, safe, conveniently located, appropriate for the event, and kept clean and tidy to avoid insanitary conditions. This study sought to assess the mandatory health requirements for public toilets in Makkah's holy sites. The availability of essential hygienic items was assessed in 242 randomly selected toilets, the majority of which were from Mina (44%), followed by Arafat and Muzdalifah. During Hajj, pilgrims spend the majority of their time in Mina (three to four days). Our findings revealed a lack of hand washing

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soap toilets (99%), hand drying methods (97%), hand washing posters or signs (89%), exhaust fan (86%), sanitizers and disinfectants (81%), and lighting and ventilation (63%). The location of the toilets (holy site) differed statistically across hand washing stations, washing soap, sanitizers (disinfectants), and hand-drying methods. The effectiveness of hygiene promotion and good hygiene behavior during Hajj are critical. Although it is uncommon, handwashing with soap may be one of the most cost-effective methods of infection prevention in mass gatherings. Inadequate sanitary conditions and poor hygiene practices contribute significantly to the increased burden of communicable disease among mass gatherings.

Soap-washed hands have been shown to reduce diarrheal morbidity by 44% and respiratory infections by 23% (Curtis, Danquah & Aunger, 2009; United Nations Children's Fund Soap, 2017). However, globally, the proportion of people who wash their hands with soap ranges from 0 to 34% (Global Handwashing Day, 2017). The addition of soaps or detergents to water improves the removal of microorganisms from skin. Hand drying should be an important component of effective hand hygiene procedures (Boyce & Pittet, 2002; World Health Organization, 2009). Hand washing with soap and water or water alone, followed by drying on paper towels, has been shown to effectively remove bacteria from the hands. However, bacteria are likely to remain if hands are only shaken dry after washing (Huang, Ma & Stack, 2012). Hand-drying effectiveness includes drying speed, degree of dryness, effective bacteria removal, and cross-contamination prevention (Huang, Ma & Stack, 2012). The directional signage reduces the number of inquiries made by pilgrims prior to reaching the toilets, as well as the average time taken by pilgrims to reach the toilets. Posters assist in teaching pilgrims how to use effective hand washing procedures. According to a Kansas State University study, posters can help with hand hygiene in a health care setting (Filion et al., 2019).

Ventilation and lighting are two important factors in the success of a public restroom. In fact, these two factors have direct and immediate effects on pilgrims' feelings when they enter and use the restroom. Toilet rooms are expected to have high concentrations of contaminants due to their function: A local exhaust system that removes contaminants before they can migrate away from the source is best suited for these "wet rooms" (Sherman, 2004). Our findings revealed that 52% of the study toilets were overcrowded. There was no statistically significant difference in the location of the toilet (holy site) across the crowd into toilets. Many studies on public toilet provision show that access and equality of public toilets is a sanitary, political, and social issue (Afacan, 2015; Kwarteng, 2015; Greed, 2009). When pilgrims do not have access to toilets during Hajj rituals, it has a negative impact on their health. Medical evidence also shows that delaying defecation can cause health problems, such as constipation, abdominal pain, diverticuli, and hemorrhoids (Curtis, Danquah & Aunger, 2009). Regular urination is important for women, according to medical studies. People who need to go frequently (every hour or so) and those who need to go suddenly and urgently use public restrooms (restroom challenges).

The "restroom challenged" constitutes a sizable proportion of pilgrims. Voluntary urinary retention can cause an increase in the frequency of urinary tract infections, which can lead to more serious infections and, in rare cases, renal damage (Nielsen & Waite, 1994). In the current study, 12.5% of the toilets examined were not gender separated. This could be due to some pilgrims' lack of commitment when using restrooms, particularly the elderly. Finally, all of the toilets in the study had a place for ablution, which is one of the features that must be considered when designing a toilet from an Islamic perspective. Furthermore, the direction of qibla was established during the location and design of all the toilets studied (AbdulRahim, 2005).

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Finally, providing safe, accessible, sanitary, well-ventilated, well-lit, and clean public toilets during Hajj rituals would be more likely to protect pilgrims from adverse health effects.

CONCLUSION

This paper argues for the health and religious approach of designing toilets for *Hajj* best practices to satisfy the needs of the pilgrims. Modern technology, such as automating sensors, cleaning and drying, and vacuum assist flushing, helps to maintain the health and safety of the pilgrims and at the same time fulfilling the sustainability aspects of the design (Wenz-Gahler, 2015b). Architectural design features, such as the size of toilets, the walls and openings, the materials and type of fixtures and finishes, are top priority in the design of the toilets to ensure that the health and religious requirement of cleanliness and privacy of pilgrims are catered for. The general design criteria adopted in contemporary toilets should be implemented as long as it does not hinder or forsake the health and religious requirement. However, it needs to be pointed out that this study serves as initial ideas and more detailed studies are required to accurately determine the actual needs of pilgrims during *Hajj* and how the toilet cubicles can be successfully laid and integrated with the washing, powdering and ablution areas. It is crucial for all Muslims to focus further studies on toilet design for *Hajj* as a major reference to the development of the toilet design because it could lead a way towards holistic toilet design for all Muslim nations including Nigeria.

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