

Design Requirement of Bathroom and Toilet for the Elderly in Malaysia

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ABSTRACT

According to previous research, the toilet and bathroom are the most common locations where injuries and accidents involving elderly people occur. Thus, the purpose of this paper is to investigate the issues and challenges of existing toilets and bathrooms among the Malaysian elderly and to identify appropriate solutions for them. The Focus Group Discussion (FGD) and Quality Function Deployment (QFD) sessions were implemented in this study, which involved a total of nineteen respondents, including elderly aged 60

years and above, their caregivers/family members, and agencies/authorities related to housing planning/development and technologies as well as researchers/experts. The recorded data were transcribed into text and organized systematically in the House of Quality (HoQ) for technical analysis. The focus group findings revealed that the four categorized issues raised by respondents in this study were quality, design, cost, and function. Furthermore, based on the HoQ analysis, it indicated that the top five highest ranks of customer requirements (CRs) for a

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new bathroom and toilet design requirement were comfortable (Rank 1), safety (Rank 2), affordable price (Rank 3), easy to enter bathroom/toilet (Rank 4) and anti-slippery floor (Rank 5). Meanwhile, the top five highest rank of technical requirements (TRs) refer to the existing OKU toilet design (Rank 1), anti-slip ramp & small drain under toilet door (Ranks 2 and 3), relocating existing toilet accessories, e.g., sink bow (Rank 4) and categories the cost according to the minor, major or new design (Rank 5). The information gathered could be used to develop appropriate bathrooms and toilets for the elderly in Malaysia.

Keywords: Bathroom, design requirement, elderly, focus group discussion, Malaysia, quality function deployment, toilet

INTRODUCTION

Elderly people are defined in a variety of ways. The chronological age of 65 has been accepted as a definition of "elderly" or older person in most developed countries worldwide (Kowal & Dowd, 2001). In Japan, "elderly" has traditionally been defined as being 65 years old or older, with those 65 to 74 years old referred to as "early elderly" and those over 75 years old referred to as "late elderly" (Orimo et al., 2006). The National Policy on Older Persons in India, on the other hand, defines "senior citizen" or "elderly" as a person 60 years of age or older (Amarya et al., 2015). At the moment, the United Nations does not have a standard numerical criterion for 'elderly'. However, when referring to the elderly, the UN-agreed-upon cut-off is 60 or older (Swaminathan & Audisio, 2012). In Malaysia, elderly people are defined as those aged 60 and above. This definition is based on the definitions made at the 1982 World Aging Conference in Vienna (DOSM, 2019). The elderly is one of the fastest-growing segments of the population, and the world's population is aging. The number of people aged 60 and up is expected to more than double by 2050 and triple by 2100, rising from 962 million in 2017 to 2.1 billion in 2050 and 3.1 billion in 2100, up from 962 million in 2017 (United Nations, 2017).

According to Jacob (2005), increasing longevity as well as declining fertility and mortality rates (Rashid et al., 2014) result in a higher proportion of elderly people in the population over time as well as more advanced healthcare and treatment facilities, improved infectious disease prevention and a significant improvement in nutritional status have all contributed to this situation. Malaysia also has a rapidly growing elderly population. According to the Department of Statistics Malaysia's 2018 census, approximately 3.23 million (9.97 percent) of the total population of 32.38 million are elderly people aged 60 and over, with men and women having life expectancies at birth 72.7 and 77.4 years, respectively. By 2034, the number of elderly is expected to exceed 5.1 million, accounting for 15% of the total population, with Malaysia expected to achieve aged nation status at that time (Tyng & Hamid, 2015).

Physiological changes are associated with decreased muscular strength, movement, and postural balance (Haus et al., 2007; Trappe, 2009). It is due to changes in joints and muscles that reduce mobility and strength. Muscle mass and strength usually decline as individuals age (Hasegawa et al., 2008). The aging process causes a loss of muscle mass and strength, where muscle strength declines between 16.6 percent and 40.9 percent between people aged 40 and those over 40 (Keller & Engelhardt, 2013). Furthermore, reduced muscle mass and strength contribute to a higher risk of fractures, fatigue, lower quality of life, and a loss of independence (Faulkner et al., 2007). Besides muscle, aging also influences some body postures, particularly those in the upper and lower body, because it is a key indicator for assessing health and quality of life, especially for the elderly (Gong et al., 2019). Furthermore, poor posture leads to decreased movement and a reduced ability to respond appropriately to external and internal stimuli (Bellomo et al., 2009). According to previous studies, good posture alignment and muscle quality are critical for elderly people's balance control (Hsu et al., 2014). As people get old, their vision and hearing abilities also deteriorate. Thus, physiological changes associated with aging reduce elderly people's autonomy and functional independence, which can lead to falls, either directly or indirectly (Terroso et al., 2014). At the same time, psychological issues such as dementia, agitation, anxiety, loneliness, and social exclusion have a negative impact on the health of elderly people due to the aging process (Kourkouta et al., 2015). People will experience physiological and psychological changes as they age, resulting in challenges in interacting with their environment due to functional decreases or declines in these aspects.

Elderly people frequently spend more time at home (Krantz-Kent & Stewart, 2007; Reinhardt et al., 2021). The environment is an important factor in an older person's self-sufficiency (Illario et al., 2016). Environmental hazards were as prevalent in the elderly homes, where the bathroom reported had the most home environmental hazards except for the lack of grab bars in the tub/shower (Gill et al., 1999), no slip-resistant mats, and a toilet that was not close to the bedroom (Zuniga et al., 2011). For the elderly, bathing is the most difficult daily activity (Guay et al., 2019). Home hazards are significant predictors of falls among elderly people (Sophonratanapokin et al., 2012), where most falls occur in the bathroom/toilet (Carling et al., 2018; D'souza et al., 2008; Rose et al., 2020). According to Hanba et al. (2017), a significant proportion of elderly traumatic injuries are caused by bathroom falls. Home injuries are a significant public health issue resulting in frequent hospitalizations and high fatalities (Camilloni et al., 2011). Furthermore, the rates of injury and hospitalization both increased with age. A study by Stevens et al. (2011) estimated that 234,094 non-fatal bathroom injuries were treated in EDs in 2008, and which majority of injuries were caused by falls and occurred while bathing, showering, or getting out of the tub or shower. While during the period 2002–2010, 13,175 toilet-related injuries were reported to ERs, which most common mechanism involved a crush caused by an accidental

fall of the toilet seat (Glass et al., 2013). In terms of toilet usage, according to Panek et al. (2017), standard toilets frequently fail to meet the needs of a significant number of elderly and disabled people. Besides, toileting difficulties were three times more common among the elderly who used assistive devices. Furthermore, non-flush toilet users in rural areas were almost two times more likely to have difficulty toileting than flush toilet users (Fong & Feng, 2021). Musculoskeletal problems caused by aging and lifestyle changes make it difficult for the elderly to defecate in a squatting or semi-squatting posture (Hari Krishnan, 2019).

Therefore, modifications to products, systems, and environments for daily use and use should be considered to accommodate these age-related changes in functional capabilities (Pennathur et al., 2003). It is because the built environment influences people's ability to live healthy lives, and elderly people require high-quality built environments that meet their needs throughout their lives—a building stock and infrastructure that supports independent living and improves the quality of life for the elderly (Tobi et al., 2017). This study examined the issues and challenges that the elderly face in their current bathroom and toilet, as well as identified potential solutions for improvements. However, several previous studies have been conducted on similar issues (Lim et al., 2014; Rosnah et al., 2008; Zaid et al., 2019); this study is seen as an additional finding but highlighted in a technical solution using QFD and HoQ. The findings are expected to enable the development of suitable bathrooms and toilets that are tailored to the needs of the elderly.

METHODOLOGY

In the social sciences, Focus Group Discussion (FGD) is a common qualitative research technique typically carried out in person to generate research insights through group discussion and interaction (Chen & Neo, 2019). FGD is simple, inexpensive, requires a small number of participants, and can be completed in a short amount of time (Zacharia et al., 2021). Thus, the purposive sampling method, such as FGD, was used in this study to obtain information involving six older persons aged 60 years old and above from the Association for Lifelong Learning of Older Persons (U3A) Kuala Lumpur and Selangor, Malaysia members and living in community-dwelling, one of their carer/family members and three agencies/authorities person related to housing planning and development. They were divided into groups of 2–5 people each. Participants were given written information about the purpose of the study prior to the session, and they signed an agreement form to ensure the confidentiality of the entries. This study has also received ethical approval from the UPM Ethics Committee for Human Subjects Research (reference no: JKEUPM-2018-123). FGD sessions were led by trained moderators assisted by rapporteurs (note-taker). The moderator begins the discussion session by greeting participants and explaining the purpose of the research. Participants/respondents were asked to introduce

themselves before being asked questions about the research topic. The moderator guides the discussion, encouraging all participants to share and ensuring everyone has enough time to express their opinions. Each session was recorded with a digital voice recorder, and the notes were later reviewed, analyzed, and transcribed into text form. The focus group lasted between one and a half or two hours. The information gained was structured systematically and categorized into a particular classification based on issues and challenges, ways to solve issues, as well as important criteria for consideration in developing friendly bathrooms and toilets for the elderly in the future.

Then, the Quality Function Deployment (QFD) session was conducted in the second stage involving two carers/family members for the elderly and seven researchers/experts to generate a new design solution for bathrooms and toilets that considers the needs of the elderly people. QFD is an effective and powerful tool in product design, development, and planning, where the primary function is to convert the voice of the customer (VoC) to technical characteristics or the designer's voice (Iranmanesh et al., 2014). According to Leppänen et al. (2000), QFD has features similar to participatory ergonomics and can be used to improve the ergonomics and usability of products. Both methods and approaches tend to include the end user in the design process. Starting with the initial matrix, commonly known as the House of Quality (HoQ) (Figure 1), the QFD methodology focuses on the most important product or service attributes or qualities. However, the correlation matrix (Roof of the HoQ or interrelationship between technical descriptors) was not considered or applied for this project. VoC or Customer Requirements (CRs) or WHATs are data collected from respondents during the FGD relating to their needs and requirements.

These are given a weighted priority rating. The information was then converted into technical descriptors or Technical Requirements (TRs) or HOWs, which are engineering considerations and specifications (product characteristics). This step was challenging because it required specific people, such as researchers/experts, elderly caregivers, and industry persons involved in the marketing and sale of walking frames/walkers, to work in teams to identify the variables that may have the greatest impact on the customer requirements. Furthermore, variables must be meaningful and measurable, and TRs must be synchronized with CRs. Based on Cudney and Elrod (2011), the correlation or strength of CRs and TRs can be represented on a value scale using the relationship matrix; 0 (no correlation), 1 (weak correlation), 3 (moderate correlation), and 9 (strong correlation). Data was then technically analyzed using specific Equations 1, 2 and 3 to determine importance value, Design Priority (DP), and Percent Priority (PP). This matrix identifies the technical requirements that satisfy most customer consequences. The obtained values are then displayed in order of rank. The design process should prioritize the technical requirements that address the most customer consequences to ensure that a product or service meets customer expectations.

$$\begin{aligned} & \text{Average CRs importance value} && [1] \\ & = \underline{\Sigma \text{ of all points from each CR given by the respondent}} \end{aligned}$$

Σ of maximum point value for each CR

$$\text{Design Priority (DP)} = \Sigma (\text{Correlation Value} \times \text{CRs Importance Value}) \quad [2]$$

$$\text{Percent Priority (PP)} = \underline{\Sigma (\text{Correlation Value} \times \text{CRs Importance Value})} \times 100 \quad [3]$$

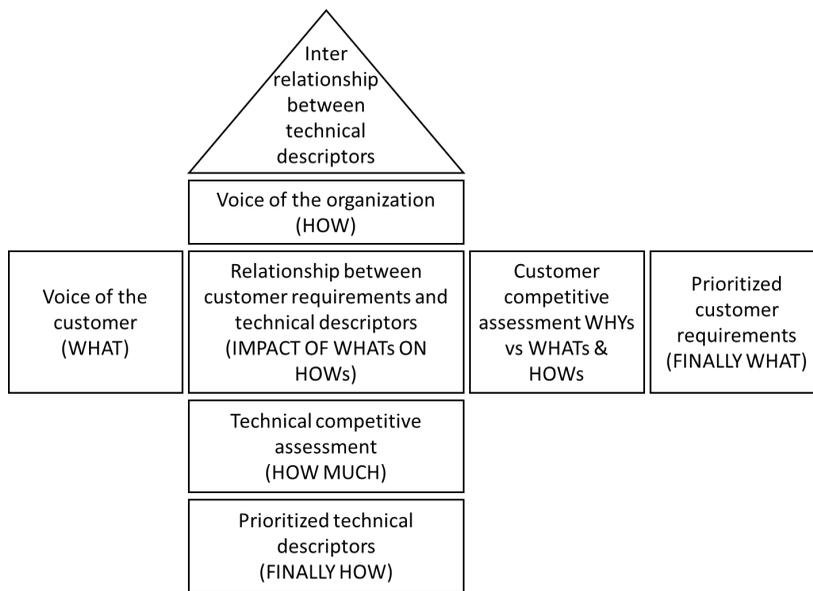


Figure 1. QFD house of quality (Kiran, 2017)

RESULTS AND DISCUSSION

Focus Group Discussion (FGD)

Some issues were reported by respondents regarding the current design of bathrooms and toilets in the home based on discussions conducted. Hence, researchers have categorized them into four issues: quality, design, cost, and function.

Quality. On the quality aspect, some of the issues and challenges highlighted by respondents were slippery bathtub base and floor when wet as well as slippery steel bar holder when covered with soap. The information shared by the respondents during the discussion was summarized in the statements below.

Elderly (M): Most people put a slippery tile style, right? Very dangerous. Sometimes bring water; a little spill can fall.

Elderly (M): I think the practice is in this bathroom. Our people like to use a lot of soap. Wet is ok. But if there is soap, it is slippery. So, it is very dangerous when you slip. It is a problem.

Elderly (F): Grab bar also has to be selected. If it is stainless steel, it is slippery, especially when covered by soap.

The feedback of respondents in this FGD was found to be supportive of some findings from previous studies regarding quality aspects such as slippery/wet floors in bathrooms or toilets (Hignett et al., 2010; Rosnah, Norazizan, Aizan & Rizal, 2008; Vaccari, Lenardt, Willi, Betioli & de Oliveira, 2014). Because aging is associated with a decline in several body systems' strength and senses, slippery floors may contribute to the elderly's loss of balance (Sophonratanapokin et al., 2012). As a suggestion by Mazloomy Mahmoodabad et al. (2018), promoting a culture of non-slippery flooring, as well as using public media and education, can help prevent elderly people from falling. Furthermore, separating dry and wet spaces can help the elderly avoid slipping, prevent splashing, and maintain heat (Han et al., 2020).

Design. The finding discovered the issues on design were bathroom size bigger/smaller, toilet door width too small for wheelchair access, toilet/bathroom far from bedroom, squat toilet/toilet seat too low, water pipe too low, and non-lever type water tap. The statements below summarize the information shared by the respondents during the discussion.

Elderly (M): Some bathrooms are large, while others are small. My wife has a little bit of bathroom experience. She could fall if the area is too large for her to grasp.

Agency/authorities person (M): Because of the narrowness of the door, it is difficult for the current wheelchair to enter the toilet.

Elderly (F): In some village houses, the bathroom is far from the bed. It is not located in the bedroom but occasionally in the kitchen. Then there are stairs that you must descend.

Elderly (F): There is one location where all the toilets are squat. If I sit down, I won't be able to get up. I need to cling to something.

Elderly (F): For me, the water pipe I am currently using needs to be slightly bent. However, neither is it very high nor very low.

Elderly (M): As I previously stated, the floor was covered in vinyl. Most people use a slick tile style. It is extremely dangerous. Bring water on occasion, as a small spill can cause a fall or slip. Slips are hazardous because falling is extremely dangerous.

Some previous research findings were also found to be similar to the issues and challenges of design that have been raised in this study. As mentioned by Nagananda et al. (2010), the lack of a bidirectional door and insufficient door width made the bathroom entrance unsafe for the elderly and difficult for those who needed ambulatory or mobility aids. Besides, inadequate bathroom size is also viewed as a potential hazard and discomfort to users (Joshi & Dsouza, 2015). A previous study also shows that the elderly who had outside bathrooms or toilets were likelier to fall than those who did not, possibly due to inadequate lighting, uneven floors, and the path to the toilet (Sophonratanapokin et al., 2012). Thus, the bathroom should be reserved enough from the start of the design process so that the elderly can stay as long as they want (Ju & Lee, 2017). Creating a new approach to designing and optimizing the layout of bathroom facilities is also recommended (Wang et al., 2018). Toilets are typically located at the back or outside the house, whereas squatting toilets are common in traditional houses. Some are typically not well-maintained, with unpaved outdoor areas and improvised kitchens, which may contribute to hazards and risk of falls (Romli et al., 2018). Therefore, changing the sole position in a squatting-type toilet and its sloping design can effectively make users more comfortable (Mououdi et al., 2020). It also discovered that the low water faucet height from the lowest floor level makes it difficult for wheelchair users with permanent or temporary back injuries to operate (Dawal et al., 2016). Thus, using anthropometric data to design products and living facilities is critical for increasing the comfort, safety, and health of the elderly (Kaewdok et al., 2020).

Cost. According to feedback from respondents on cost, some of them stated that if an item's price or cost is relatively high, they are unlikely to purchase it. The following are some of the respondents' responses to the cost-related discussion.

Elderly (M): For the safety and well-being of the elderly. That is valuable. That is what developers have to think about. It involves cost. So, we have to find a way that does not cost that much.

Elderly (F): We sometimes buy because it is beautiful. But we do not know its safety. Sometimes when we buy something, we do not even think about it. Then look at the price, right? If it is too expensive, do not buy it either.

According to the study, most elderly did not have enough money in their later years (Yin-Fah et al., 2010). As a result, it will indirectly affect their purchasing power and represent a significant economic and social issue (Jakimovski, 2010). This study's findings in terms of cost and price were found to support the previous study. In terms of functionality, there have been previous studies that show similar results. Most respondents did not have

bathub grab bars installed in their homes (Sveistrup et al., 2006), and toilets always had no handrails or other supporters (Yuan et al., 2021). Therefore, related issues should be given full attention to ensure this environment is safe and comfortable for the elderly.

Function. The respondents' feedback on the functionality issue revealed that several related issues were highlighted, such as no safety railing in the toilet, a grab bar to enter the bathtub, and a two-way door lock. Some of the issues raised by respondents are listed below.

Elderly (F): Handrails are only found in public restrooms. There are not in any homes yet.

Elderly (F): At home, I also have a bathtub. It is a bit hassle when you want to go in and out because you have to step up one level to get inside. There is no rail/handrail to grab. I am concerned because it is slick.

Elderly (F): When it comes to doors, I always tell them. If someone needs to use the restroom, do not lock the door from the inside. Because if it is locked and something unexpected happens inside, it takes time to save or assist someone inside.

Some previous studies were similar to the issues and challenges raised in this study regarding functionality. As Chacko et al. (2017) mentioned, handrails were absent in most of the toilets in rural houses of elders. Past researchers have also voiced issues related to grab bars. The basic function of the grab bar is to maintain balance during transfers and allow safe movement in the bathtub (Morales et al., 2017). However, the study also shows that most respondents did not have bathtub grab bars installed in their homes (Edwards et al., 2006; Sveistrup et al., 2006).

QFD House of Quality

Based on the FGD session, CRs were classified into three categories: quality, design, cost, and function, as shown in Figure 2. Under Quality, the CRs' list was anti-slippery bathtub base, floor and hand bar/railing, higher safety, and comfort. For Design, the CRs identified were suitable size for the bathroom, easy to enter toilet/bathroom, location of the toilet near bedroom, enough lighting lux, toilet flush level at both hand sides, and suitable color. Under Cost, affordable price is the CRs' list. While for Function, two-way door lock, emergency button's switch, and fall/movement detector were CRs' list suggested by respondents.

Thus, some of the previous study's findings are consistent with respondents' suggestions or Customer Requirements (CRs) for improvements. On the quality aspect, floor tiles may be treated with an anti-slip coating to prevent slips and fall. If the floor cannot be treated, use a rubber or anti-slip mat (Salam & Shams El-din, 2019; Lago et al., 2018; Mulliner et

al., 2020), handrail or grab handle (Blanchet & Edwards, 2018; Rousseau, 2018). While in the design aspect, recommendations for the distance between the rooms that support the activities of daily living for elderly residents should be shortened to improve the QoL of the elderly in the home, including locating bedrooms near bathrooms/toilets (Yu et al., 2017). Furthermore, as mentioned by Leung et al. (2016), the route between the bedroom and the toilet should be short and free of obstacles, there should be adequate artificial lighting, and doors should be wide enough to allow elders in wheelchairs to pass through to ensure the elderly's safety.

Therefore, appropriate support features/facilities are required to create a safe and comfortable environment, which is critical for meeting the psychological and social needs of the elderly (Ma et al., 2016) as well as one of the most important fall prevention interventions used to reduce the risk of falling in the home setting (Hamm et al., 2019). For the cost aspect, the higher-priced product should be carefully considered based on scientific support or user feedback before being produced or marketed. In terms of functionality, as suggested by Kam and Chan (2015), the locked door must be easily opened from the outside if there may have collapsed or fallen incident inside the bathroom or toilet. Besides, a qualified emergency calling device or emergency button in the bedroom and bathroom is also recommended (Huang & Ho, 2012). At the same time, some researchers emphasize using devices/sensors to detect emergencies such as falls and injuries involving the elderly in the home (Meng et al., 2017; Rachuy et al., 2013; Thapliyal et al., 2017; Tsuchiyama & Kajiwara, 2019).

The requirement obtained for TRs according to the CRs list. Some of the TRs that were discovered included using anti-slip tiles for the floor, a good air ventilation system, relocating the location of the toilet and bathroom, a sitting toilet bowl, suitable height water tab level, and use of lightweight sliding/folding door. Table 1 shows the example detailed calculation for TR16. Finally, the rank for the TRs was determined accordingly based on the value of PP, starting from the highest (Rank No.1) to the lowest (Rank No. 33).

The Technical Requirements (TRs) analysis findings were also compared to previous research recommendations. Several studies have suggested that the toilet and bathroom should be installed with a non-slip mat or floor (Afifi et al., 2015; Kamei et al., 2015; Mahmoodabad et al., 2018), air ventilation system (Leung et al., 2017; Savchenko et al., 2017), relocation of toilet or bathroom (Granbom et al., 2019), sitting toilet bowl type (Dawal et al., 2015; Zaid et al., 2019), the suitable height of water tab/faucet (Sukadarin et al., 2021) and use sliding/folding door (Lee et al., 2007).

Table 1

The detailed calculation for TR 16

(CR)	TR16: Refer to Existing OKU Toilet	CRs Importance Value (IV)
CR 4	Strong correlation = 9	0.59
CR 5	Strong correlation = 9	2.16
CR 6	Strong correlation = 9	2.60
CR 9	Strong correlation = 9	0.74
CR 10	Strong correlation = 9	1.37
CR 21	Strong correlation = 9	0.49
DP	$= (9 \times 0.59) + (9 \times 2.16) + (9 \times 2.60) + (9 \times 0.74) + (9 \times 1.37) + (9 \times 0.49)$ $= 71.47$	
PP	$= \frac{\text{Design Priority}}{\Sigma \text{ Design Priority}} \times 100 \frac{\text{Design Priority}}{\Sigma \text{ Design Priority}} \times 100$ $= \frac{71.47}{1093} \times 100 \frac{71.47}{1093} \times 100$ $= 6.54$	

Note. CR = Customer's Requirement, TR = Technical Requirement, IV = Importance Value, DP = Design Priority and PP = Percent Priority

CONCLUSION

In conclusion, it has been discovered that there are issues and challenges with the existing bathroom and toilet facilities among Malaysia's elderly, which have been classified into three categories: quality, design, cost, and function. Based on the findings, the authors created a House of Quality (HoQ) for bathroom and toilet design requirements. Using the results of the Design Priority (DP) and Percent Priority (PP) of the technical requirements in HoQ (Figure 2), the design team can prioritize the TRs for an appropriate bathroom and toilet design recommendation, which may meet the CRs as the elderly user. It shows that the highest rank of CRs for a bathroom and toilet design requirements are comfortable (Rank 1), higher safety (Rank 2), affordable price (Rank 3), easy to enter bathroom/toilet (Rank 4), and anti-slippery bathroom floor when wet (Rank 5). Meanwhile, the highest rank of TRs refers to the existing OKU toilet design (Rank 1), the design anti-slip ramp for toilet access and drain under the toilet door (Ranks 2 & 3), relocating existing toilet accessories, e.g., sink bowl (Rank 4) and categories the cost according to the minor, major and new design (Rank 5). Thus, this information is hoped to be useful in designing bathrooms and toilets that may provide more safety features, stability, and user-friendliness for the elderly.

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