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Residential Architecture for people with Mobility Impairment: Case Study of Jeddah City

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ABSTRACT

Mobility impairment is a term which covers all kinds of movement disability which require the use of a wheelchair. Individuals who use a wheelchair have the right to live in homes designed according to their needs. Therefore, homes need special design considerations to allow people with mobility impairment to practice their daily activities independently. Developed countries are addressing this issue by implementing universal design standards, which are required by building codes. The research problem is that there is a gap in the knowledge in local and international research that has studied architectural design for rental flats used by people with a mobility impairment. This research aims to address this and also to study the implementation of universal design in rental flats. The research involved a site visit to 60 residential buildings in Jeddah. The 60 residential buildings were divided into three categories according to the district and flat size. The research concluded that universal design was not applied in the design of some architectural elements such as windows, doors, corridors, and toilets. Also, it was found that neither of the two main analysis elements, which were the size of the flat and the cost of rental, have a role in the implementing of universal design, with the exception of some elements such as size of doors and height of windows. The research recommends that the municipality should better monitor the extent to which universal design is applied by architects, even if such considerations are limited to one apartment within each residential building.

1. Introduction:

1.1. Universal Design

The term universal design has many definitions. Lid (2014) defines universal design as approaches that help in enhancing the accessibilities of an environment for disabled people. This is in agreement with Hamraie (2017) who defines universal design as creating good design and accessible environments for all people not only for people with mobility impairment. Similarly, the National Disability Authority in Ireland (NDA, 2014), classifies universal design as an accessible, and usable, environment which it is easy to circulate around. They go on to assert that to create this environment the designer should be knowledgeable about different disabilities including impairments related to being elderly. In some countries such as Nigeria, universal design has be studied in areas like education in terms of how it affects the accessibility of disabled students (Sholanke et al., 2019, Sholanke et al., 2018). Others have focused on disabilities experienced by this elderly in living spaces (Rowe and Kahn, 2015). In Egypt two recent studies discussed universal design implementation in Asyut university (Abu-Alsaud, 2019), and in a major governmental building that is used by all citizens in Asyut City (Abdulrahaman, 2019). Both studies found that universal design is not applied to architectural design for the studied buildings.

To create an accessible environment, there are many design elements that should be considered such as non-slip floor, ramps, entrances, grab bars, doors, corridors, furniture arrangements, kitchen cabinets, toilet elements, electricity switches and ramps (Adewale and Fasae, 2019). Universal design includes a more detailed description for most design elements. For instance, since handicapped people may use wheelchairs most of the time, flooring should be comfortable for the wheelchair to move around on without any obstacles. A soft floor material is mandatory for wheelchairs. For instance, ceramic or marble are preferable to carpet, but they should not be very soft to prevent wheelchairs from slipping especially in bathrooms. Ramp flooring should have a rough surface for safety (Kalaf, 2015, Pile, 2003). These special designs can be considered under the umbrella of universal design or Life-Span Home Design. In Canada, it is called Flex Housing and, in Europe, Design for All. The aim of universal design is to break down the barriers between disabled and non-disabled people with easy use solutions and safe designs. It allows disabled people to go about their daily business freely and independently (Schwab, 2011). Universal design can mainly be attributed to architect Ron Mace in North California State University, who introduced the idea in 1970 (CUD, 2008).

1.2. Disabilities

The term disability does not refer to a single issue alone. There are type of disability. Mobility impairment refers to people who are disabled to move. These people can work and have a normal social life if buildings are designed in line with universal design for disabled people since the term universal design is connected to human rights (Bickenbach, 2014). Mobility impairment people are not only those who have been born with special needs. People may be involved in a car accident, become disable to move. Claim that car accident cause the large number of death or different disabilities every day. According to Kalaf (2015), due to little attention being paid to mobility impairment people in domestic architecture in certain countries, these people are unable to be fully independent. They always need help from others in order to function in certain ways in interior spaces due to different disabilities.

1.3. Disabilities and Architecture

There are many studies that have discussed disabilities and architecture. For instance, Syakir Amir (2018) discussed if homes in Malaysia are suitable for its disabled community. The study of 800 occupants found that visually and physically disabled inhabitants are not satisfied with the design of interior spaces in comparison to exterior designs.

In Iraq, Kalaf (2015) did a study on special needs and residential interior design in Bakuba city. He did a survey of 30 residences in

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Bakuba with families who had either an adult or elderly member with special needs. The author claim that none of the residences were designed in a way that fulfilled the needs of the handicapped people. The interior space in terms of dimensions, furniture selection, doors, windows, and switch heights were not designed according to the standards laid out in universal design. Therefore, this affected the handicapped residents physically and psychologically Similarly, in Thailand, a qualitative study that conducted interviews with disabled elderly people in 30 homes investigated if bathroom designs suited their needs. The study found that the bathroom design in these 30 homes was inappropriate for being used by the elderly as it caused risks of accidents for them (Junprateep et al., 2020).

In Australia, a survey by Beer & Faulkner (2009) for 2698 households found that twenty percent of these households had one disabled member. The study found that if the design of the residence does not suit one member of the family, who is disabled, this will affect the lives of all family members. Therefore, the study suggests that architects should not focus only on the individuals but also think about the whole household (Beer and Faulkner, 2009).

On the other hand, in Japan the country has ruled that housing, healthcare and many other services must take account of universal design. As a result, universal design has become essential in residential design as it helps to reduce health and social services spending and help elderly people to live in their own homes (Kose, 2008). Also, Japan and the USA have placed universal design under the umbrella of sustainable design, which is essential in architecture (Fletcher, 2006).

Previous studies have investigated universal design implementation in residences and public buildings according to different disabilities in different countries such as, Egypt, Iraq, Japan, Australia, Thailand, and Malaysia as discussed in the introduction. However, it is important to highlight that there are differences in residence sizes and rental costs between these countries and Saudi Arabia, and that these factors affect home design. Therefore, this study will compare its findings with previous studies which have not considered residence size and rental cost. In Saudi Arabia, According to *The Guide book to Universal Design in the urban environment in the Kingdom of Saudi Arabia* (PSCDR, 2010), universal design standards must be applied to the exterior and interior design of most buildings such as private, public sector or residential and entertainment buildings. In reality, designs for people with special needs are considered in the public and private sectors. It is mandatory in interior and exterior places. For instance, most buildings have ramps for handicapped people to use in building entrances and elevators in interior spaces. However, there is a gap in the knowledge regarding whether universal design standards for people with mobility impairment is applied in residential design especially in rental blocks of flats in Jeddah which this paper will address as the main aim of the study.

2. Research Aim

The study aims to:

1. Investigate if universal design elements for people with mobility impairments are implemented in the rental blocks of flats in Jeddah.
2. Find out if the size of a flat, and cost of rent have any effect on applying universal design for people with mobility impairments as implemented in the rental blocks of flats in Jeddah.

3. Methodology

The current study involved site visit documentation in the form of photographs of the interior space of 6٠ blocks of flats in Jeddah divided into 3 groups. The sample of 60 blocks of flats for rent was divided into three groups. Each group contained 2 districts as shown in Fig.1. The reason for choosing these districts was the differences in rental cost as explained in Table.1.

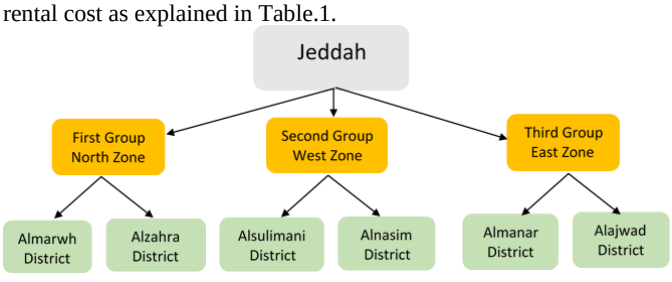

Figure: 1 Diagram shows the sample selection. Source: Author, 2019

Table 1: Rental cost for Type 1 and Type 2 flats in each group. Source: Author, 2019.

	Group 1		Group 2		Group 3	
	Type 1	Type 2	Type 1	Type 2	Type 1	Type 2
Rental cost of 20-25 thousand Riyal per year				×	×	×
Rental cost of 25-30 thousand Riyal per year		×	×		×	
Rental cost of 30-5 thousand Riyal per year	×					

The chosen buildings for all the groups were divided into two types. Type 1buildings had 2 flats per-floor (250 sqm per-flat). Type 2 buildings had 4 flats per-floor (150sqm per-flat). In each group of districts, 10 buildings from Type 1 and ten from Type two were analysed. Data were collected with the use of photographs of the interior spaces of 60 flats. The collected data were then analysed using quantitative methods under two categories to fulfil the research objectives:

- The first categories investigated the number of blocks of flats that had implemented universal design standards for people with mobility impairments in terms of certain architectural elements such as windows, doors, corridors and toilets. It is important to highlight that the study is limited to the architectural elements that should be included in the flats by landlords before residents rent the flat, which are doors, windows, flooring, toilets, switch locations and corridor design.
- The second category investigated if two major analysis points, rental cost and flat size, created any significant differences in terms of the implementation of universal design through the use of statistical analysis software.

Statistical analysis:

The SPSS software was used to run the statistical analysis (version 27). A Chi square test used to examine whether rental cost and flat size result in any significant differences in the implementation of universal design. Data present in result were frequency. A probability value below 0.05 was considered statistically significant.

4. Results & Discussion

4.1. Doors

Table 2: Number of blocks of flats in Type 1 and Type 2 that apply universal design standards for door design of each group. Source Author, 2019

Door Design Elements for Universal Design	Group 1		Group 2		Group 3		Total 60 flats
	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	
90 cm doors in interior space	10	4	10	4	10	5	43
Steel coverage on wall bottom	0	0	0	0	0	0	0
Non-rounded handles	10	10	10	10	9	10	59
Soft opening doors	10	10	10	10	10	10	60
Outer casement doors	0	0	0	0	0	0	0

Adewale and Fasae (2019) assert that large internal doors are essential for wheelchair users. In this study, Table 2 indicates how many blocks of flats apply door designs that are appropriate for people with mobility impairment according to universal design standards. It indicates that most flats have soft opening doors, and they do not have rounded door handles as shown in Fig.2. The width of door is 90 cm in 43 flats of Types 1 and 2, but 50% of doors are less than 90 cm in Type 2 for each group. This is due to the small size of such flats. The table also indicates that none of the 60 flats have outer casement doors or contain steel coverage on wall bottoms as shown in Fig.3.

Figure 2: Door handle design in all flats. Source: Author, 2019

Figure 3: Inner casement door opening. Source: Author, 2019.

Although, three of the necessary universal door designs for mobility impairment people were considered, they were not considered for the sake of mobility impairment people as they are basic designs for people with no special needs too. The other two designs that were not applied are only necessary for mobility impairment people, which shows that no attention has been paid to the needs of mobility impairment people in interior residential design. Indeed, the findings from Table 1 determine that the cost of rent does not play any role in whether universal design is applied except in terms of door width. It is found that flats with high and medium rent showed more implementation of door width with significant differences (P=0.001). Additionally, Type 1 flats showed more frequent implementation of appropriate door width sizes than Type 2 flats (P<0.0001).

4.2. Windows

Table 3 Number of blocks of flats in Type 1 and Type 2 that apply universal design standards for window design for each group. Source: Author, 2019.

Window Design Elements for Universal Design	Group 1		Group 2		Group 3		Total 60 flats
	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	
Numbers of blocks of flats with window opening handles not higher than 130 cm	3	0	0	0	1	0	4
Numbers of blocks of flats with window heights of 60-75 cm and less	3	4	1	0	1	3	12

Table 3 shows the number of blocks of flats that apply universal design in terms of window design. It indicates that the height of the opening handle for windows in all 60 blocks of flats is above 130 cm. It is found that it can be as high as 150 cm and more in some rooms. It can be as high as 170-190 cm in toilets as shown in Fig. 4. Also, it clarifies that the heights of windows start at 60-75 cm from the floor in 12 flats, which would allow handicapped people to see the view from the window as shown in Fig.5. In the rest, the windows started above 110 cm as shown in Fig.6. It is found that in Group 1, seven out of 20 blocks of flats consider window height. This could be due to the fact that in high cost flats, windows are big; therefore, their height starts at 60 cm. The findings clarify that Groups 2 and 3 contain small windows that do not suit people with a mobility impairment as the rental cost of these flat is less than for Group 1 flats. Indeed, rental cost indicated significant differences (P=0.01) for window handle height in high-cost blocks of flats. Also, the size of the flat influenced window handle height only (P=0.01) for type 2 flats.

Figure 4: Window opening height in toilet. Source: Author, 2019. Source: Author, 2019.

Figure 5: Window height in living room for Group 1 flats. Source: Author, 2019.

Figure 6; Window height in living room. Source: Author, 2019

4.3. Bathroom

The toilet is one of the most important spaces in a home. Toilets in either public or private places should be designed to make disabled users feel comfortable (Mamee and Sahachaisaeree, 2010, Adewale and Fasae, 2019). In order to provide mobility impairment people with a comfortable and functional toilet, the toilet size should be not less than 150 cm * 200 cm. Also, the arrangement of toilet seat, sink and shower should be big enough to allow a wheelchair to circulate inside it. For mobility impairment people, the toilet seat height should be 50-55 cm. The sink height must be 80-85 cm. A shower is preferred to a bath. There should be a supporting grab on the wall to support the movement of a mobility impairment person.

Table 4: Number of blocks of flats in Type 1 and Type 2 that apply universal design standards for toilet design for each group. Source: Author, 2019.

Bathroom Design Elements for Universal Design	Group 1		Group 2		Group 3		Total 60 flats
	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	
Numbers of blocks of flats with non-slippery flooring	10	10	10	10	10	10	60
Numbers of blocks of flats with stand-in showers	7	10	0	10	2	8	37
Numbers of blocks of flats with grab bars	0	0	0	0	0	0	0
Numbers of blocks of flats with a sink height not more than 80 cm	0	0	0	0	0	0	0
Numbers of blocks of flats with a toilet seat height of 50-55	2	0	5	2	1	1	11

Table 4 shows the number of blocks of flats that apply universal design in the five design rules for toilets in order to make them useful for people with a mobility impairment. It expresses that two rules, relating to grab bars and sink height, are not implemented in all 60 blocks of flats. This means that toilets in rental flats for three groups are not useful for people with a mobility impairment. On the other hand, it indicates, for instance, that a non-slippery floor was a feature of all 60 blocks of flats, but a stand-in shower was only available in 37 flats. It also shows that all the sinks were above 80 cm which would not allow people with a mobility impairment to reach the sink. The toilet seat heights ranged from 40 cm up to 50 cm. In comparison to Syakir Amir (2018), who has claimed that affordable home designs for low income people in Malaysia do suit people with visual and physical impairment, this study shows that neither rental cost nor size of flat were factors affecting whether a suitable toilet was provided for people with a mobility impairment.

As a result, this indicates that flats for higher income people are not suitable for people with a mobility impairment except those with stand-in showers. SPSS analysis shows that regarding rental cost, only stand-in showers in high and low rental cost flats showed a significant difference (P=0.001). For flat size, only Type 2 flats showed significant implementation of stand-in showers (P< 0.0001).

However, they did not suit wheelchair users as the toilet sizes were 1.90*1.30 cm in Type 2, which is smaller than the required toilet size. Also, the arrangements for the toilet seat, sink and shower did not allow wheelchairs to circulate as shown in Fig. 7. As a result, the findings indicate that toilets in rental blocks of flats in the city of Jeddah are not designed to suit people with a mobility impairment. This is in agreement with (kalaf, 2015) who found that 90% of toilet designs are not suitable for people with a mobility impairment people in Dyali city in in Iraq. Similarly, if toilets remain unsuitable, it can lead to accidents for disabled people, as found in Thailand through interviews with disabled elderly people (Junprateep et al., 2020).

Figure 7: Narrow circulation in toilet with stand-in shower. Source: Author, 2019.

4.4. Corridor

Table 5: Numbers of blocks of flats in Type 1 and Type 2 that apply universal design standards for toilet design for each group. Source: Author, 2019

Corridor Design Elements for Universal Design	Group 1		Group 2		Group 3		Total 60 flats
	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	Type 1 10 flats	Type 2 10 flats	
Numbers of blocks of flats with a grab bar at a height of 85-95 cm	0	0	0	0	0	0	0
Numbers of blocks of flats with a corridor width not less than 150 cm	3	0	8	1	2	0	14
Numbers of blocks of flats with steel coverage on wall bottoms to protect walls from wheelchair damage	0	0	0	0	0	0	0
Numbers of blocks of flats with witch heights not more than 45-120 cm	0	0	0	0	0	1	1

Handicapped people need enough space for wheelchair circulation in order to move their wheelchairs easily without any obstacles. Abdulrahaman (2019) classifies that 2m is the required width for a public building. However, in residential buildings, 150 cm is enough for wheelchairs to circulate. In this study, it was found that there were no grab bars at all and the corridor width was 150 cm in 14 flats only as shown above in Table 5. Corridors in the rest of the flats were 115 to 130 cm maximum. These 14 blocks of flats were in Group 2 with bigger interior space. On the other hand, corridor's width in type 2 is 100 cm as shown in Fig.8.

Finally, switches were at a height of 130 cm and above as shown in Fig. 9. Additionally, analysis from statistical software showed that a high rental cost for a flat significantly impacts on corridor width criteria only compared to low and medium rental costs (P=0.01) Also, as more flats are bigger in size, it helps in the implementation of corridor width criteria (0.0002).

Figure 8: Corridor width. Source: Author, 2019.

Figure 9: Switch heights. Source: Author, 2019.

5. Conclusion

The study investigated the implementation of universal design for mobility impairment in 60 blocks of flats in 6 different districts in Jeddah. From the data analysis in this study, it is found that basic needs for mobility impairment people are not considered in rental blocks of flats in the city of Jeddah. The major architecture elements which are put in place before a flat is rented, such as windows, doors, corridor, and toilet were not designed for mobility impairment people to use the space independently. The findings indicate that rental cost, and flat size have a major impact on the implementation of certain elements such as door and corridor width, window handle height and stand-in shower only.

The research recommends that the municipality should better monitor the extent to which universal design is applied by architects, even if consideration is limited to one flat within each residential building. To make this happen, building codes must require that each block of flats should contain a flat that has all the design elements for a mobility impairment person. Building codes should force landlords to do this since some landlords design blocks of flats for business reasons not in order to offer inhabitants the home they need. The study also recommends that further studies investigate if universal design for

different disabilities is applied in different types of residences, such as villas.

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