UNIVERSAL DESIGN APPROACH TO A SMART, SUSTAINABLE, SAFE, AND ACCESSIBLE CITY FOR ALL

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ABSTRACT
Sustainable cities are one of the economic development elements in architecture and urban development, more than half of the world now resides in urban areas. Furthermore, the advancement of technologies such as artificial intelligence creates smart cities to improve urban integration. However, an essential aspect of sustainability that is absent is the inclusion of the elderly and the disabled in the community. It serves as one of the markers of modernity. Rather, it is a prerequisite for developing our cities, making them more sustainable, intelligent, safe, and accommodating to all society segments and achieving equality. Sustainability is not affected by persons, and environmental justice is as important as sustainable development. People with disabilities and the elderly constitute a large proportion of society and this is expected to rise in the upcoming years. Despite widespread support for the inclusion of people with disabilities in society, they were not considered during the design process. Society only sees the able-bodied; therefore, we must link technology and use universal design principles and integrate them with sustainability standards. As a result, the research aims to create an inclusive city and identify barriers to universal design through developing an objective approach framework and a new evaluation method, research was used to generate data by example analysis of various buildings, developing a new design approach of universal design, involving users, experts, people with disabilities, elders, designers, and stakeholders to solve problems with a focus on the city of Alexandria and evaluate it. The paper concludes by speculating about the part that designers can play in implementing a more inclusive design approach to be accessible for all. A society is not smart, sustainable, or secure if it is not accessible.
Keywords: Alexandria, smart, safe, sustainable, accessible city, sustainability, universal design, accessibility, disability, elderly.

1 INTRODUCTION

Alexandria has grown to be the largest city in the Mediterranean region, it covers an area of 2,679 km^2 of the total area of Egypt, 1,002,000 km^2, about 0.26% of the total area. Its population is 5,422,608 out of a total of 101,463,702, about 5.3% of the total population. Due to its prominent location, it is home to numerous attractive beaches, historic museums, and other tourist destinations that draw significant numbers of visitors. as well as an ancient street that stands witness to the history of the Mediterranean bride to paint a wonderful painting in one of the oldest streets in the world, it is Fouad Street, the most famous street of Alexandria, famous for the presence of many heritages' ancient buildings, theatres and cinemas in addition to museums such as The Greco-Roman Museum and Alexandria National Museum.

The Central Agency for Public Mobilization and Statistics revealed that the percentage of people with special needs represents 10.5% of the total population in Egypt, and indicated that the difficulty of walking or climbing stairs came first, followed by hearing difficulties, vision difficulties, and another type of disabilities, as well He revealed that the number of elderly people in Egypt between the ages of 60 and 70 has reached about 6% of the total population, and this percentage is expected to rise to 17.9% in 2052 [1].

So, the research focuses on how to make a sustainable accessible city for people with disabilities and elders and can be finding and presenting simple and small solutions to solve the potential problems that result from Architectural disability, exploration of elders and disabilities problems to explore design approaches that are suitable for all.

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1.1 Research problem

There is a missing part in sustainability which is the participation of people with disabilities and the elderly in the community, despite they constitute a large proportion of society So, one of the reasons for the major problem is architects' lack of deep understanding of the need of the elder and disabilities.

Table 1: Number of people with disabilities in Egypt and Alexandria in 2017 [1].

	Total population		People with a disability		% of disabilities
	Males	Females	Males	Females	
Egypt	42,297,930	42,297,930	4,596,601	4,039,929	
	81,897,253		8,636,530		10.5
Alexandria	2,337,155	2,200,652	308,485	266,527	
	4,537,807		575,012		12.6

Table 2: Number of elderly people over 60 according to gender and age in 2006 [1].

Age group	Males		Females		Total	
	Number	% of total pop.	Number	% of total pop.	Number	%
60	899,287	1.2	806,215	1.1	1,705,502	2.3
65	641,051	0.9	552,549	0.8	1,193,600	1.7
70	402,489	0.6	387,403	0.5	789,892	1.1
75+	376,730	0.5	362,034	0.5	738,764	1
Total	2,319,557	3.2	2,108,201	2.9	4,427,758	6.1

Table 3: Number of elderly people over 60 according to gender and age in 2017 [1].

Age group	Males		Females		Total	
	Number	% of total pop.	Number	% of total pop.	Number	%
60	1,416,589	1.5	1,232,771	1.3	2,649,360	2.8
65	942,610	1	777,591	0.8	1,720,201	1.8
70	531,050	0.6	484,900	0.5	1,015,950	1.1
75+	476,962	0.5	449,700	0.5	926,662	1
Total	3,367,211	3.6	2,944,962	3.1	6,312,173	6.7

1.2 Research aim

The Research aims to make a case for the sustainable development of Fouad Street, Alexandria, as the state aims to develop it by the inclusion of the elderly and the disabled in its Architectural Design by using the Universal Design Approach (UDA).

2 UNIVERSAL DESIGN DEFINITIONS AND PRINCIPLES

The mission of universal design is to create places and products that can be used by as many people as feasible without requiring specific adaptations or designs [2].

One strategy that encourages preserving social sustainability elements that ensure an equitable distribution of wealth and services both within and between generations is universal design [3].

Table 4: Universal design principles [4].

No.	Universal design principles
01	Equitable use: The design is useful and marketable to people with diverse abilities.
02	Flexibility in use: The design accommodates a wide range of individual preferences and abilities.
03	Simple and intuitive use: The use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
04	Perceptible information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
05	Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
06	Low physical effort: The design can be used efficiently and comfortably and with a minimum of fatigue.
07	Size and space for approach and use: Appropriate size and space are provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility.

3 SMART, SUSTAINABLE, SAFE, AND ACCESSIBLE CITY DEFINITIONS

A smart city is a locality that makes use of electronic and technological infrastructure, such as information and communication technology (ICT), to gather real-time data and insights, offer some crucial services, and address issues that affect the city's everyday operations, such as its public transportation, water and power supplies, and sanitation systems. The local government can then use this information to influence judgments about developing practical solutions to address these ongoing city issues, as shown in Fig. 1 [5].

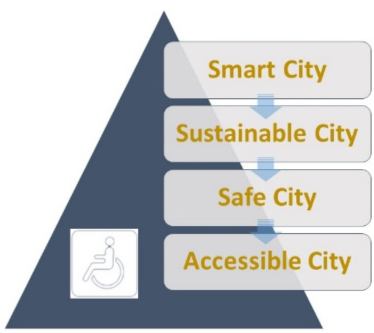

Figure 1: Smart, sustainable, safe, and accessible city.

A sustainable city is one that can withstand the effects of climate change while minimising population vulnerabilities. The ideal sustainable city would be self-sufficient in energy, manage waste to produce electricity, have more environmentally friendly transportation, preserve green spaces, and properly manage and utilise its natural resources.

It would be a city constructed around the ideas of equality, education, and ecology. We'll examine the traits of sustainable cities below, along with suggestions for how you may help create a pristine, environmentally friendly metropolis, as shown in Fig. 1 [6].

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The Safe City concept in Smart Cities offers a fresh approach for the government to create a city security system One strategy used to address the crime issue in metropolitan areas is the safe city concept, which is a component of the live concept of the city. In other words, Safe City is a concept for a community that makes use of technology to assist governments, communities, and companies in lowering the likelihood of crime and creating a setting where people feel secure and at home, as shown in Fig. 1 [7].

Accessibility is the idea of whether a good or service is usable by everyone, no matter how they come across it. Despite the fact that there are accessibility rules in place to help persons with disabilities, designers should nevertheless make every effort to include all prospective users in all use cases. Better designs for all are one of the clear advantages of doing so, as shown in Fig. 1 [8].

3.1 Development goals of sustainable cities

Making cities accessible, safe, resilient, and sustainable in ways that equally benefit people with disabilities is the focus of Sustainable Development Goal 11. Of the 6.25 billion people predicted to be living in urban areas by 2050, an estimated 15% will be persons with disabilities [9].

4 METHODOLOGY AND CASE STUDIES

4.1 Methodology

The main objective of this study is to provide a UD evaluation of building design. The Seven Principles of Universal Design are typically the foundation for several UD building feature evaluation methods. Concerns relating to the physical, senses, and cognition are addressed by these principles. literature review addressed societal issues and gave a general summary of several criteria, examples analysis, and comparison according to the standard codes.

4.2 Case studies

This study focuses on three buildings as case studies to be assessed in light of the UD concept. The chosen case studies were selected based on their significance for the users. The three case studies are Accessible beach of Alexandria (A), Alexandria National Museum (B), and Enabling Village by WOHA, Singapore (C), as shown in Tables 5 and 6.

Table 5: The code of the three buildings.

Building code	Building name
A	The accessible beach of Alexandria
B	Alexandria National Museum
C	Enabling Village by WOHA, Singapore

Table 6: The description of the score rating of the items.

Score rating	Description
4–5	Fully achieved Universal Design principles
2–3	Partially achieved Universal Design principles
0–1	Not achieved Universal Design principles

4.2.1 Universal Design buildings assessment

Table 7: Universal Design assessment of the buildings.

Criteria	Items		Item score /5 A	B	C
Size and space for approach and use	Entering				
	Entrance	Walking entrances	5	5	5
		Accessible entrances	0	2	5
		Sheltered accessible entrance	4	3	5
	Landing and boarding	Suitable seating	3	0	5
		Accessible sheltered	3	0	5
	Connection	Connections within the same structure	4	3	5
		Connection to the next-door building	0	0	5
		Connection between the building	3	0	5
		Linking of buildings and street	0	0	3
		Connecting a building to a park	0	3	5
	Parking	Parking space accessibility	0	0	5
		Accessible parking with a charging station for electric vehicles	0	0	5
	The score of UD for the entrance (out of 60)		22	16	58
Function and security	Circulation				
	Car parking	Car park paths	0	0	5
		Pedestrian crossings in the parking lot	0	0	4
	Circulation routes	A path connecting all areas and facilities	0	4	4
	Ramps	Warning surfaces	0	0	2
		Handrails on both sides	0	0	4
		Edge protection	0	0	5
		Ramp landings	2	0	5
	Stairs	Warning surfaces	0	4	2
		Handrails on both sides	0	1	4
		Edge protection	0	2	5
		Minimum tread width and maximum riser height	0	2	5
	Corridors	Minimum suitable width	0	5	5
	Lifts	Full achieved UD if it just ground floor	5	1	2
	Elevators	Full achieved UD if it just ground floor	5	0	2
	The score of UD for the circulation (out of 70)		12	19	54
Understanding	Wayfinding				
	Rest areas	Sufficient seats	4	3	5
		Seating layout	3	3	5
		Various heights of the adjacent seats	0	0	5
		Adjacent area with wheelchairs	4	2	5
	Location-searching				
	Signage	Maps at the main accessible entrance	1	4	4
		Signs with simple-to-understand pictograms with hearing systems	0	3	4
		Shapes, colours, patterns	0	5	5
	Front desk	Information counters located at a high enough location	0	2	5
	Services and toilets	A larger individual restroom	2	2	4
		Accessible sinks	1	0	2
		Restrooms with a mechanical hoist	0	0	3
		Accessible grab bars	0	0	2
		Accessible toilets	3	0	3
		Accessible circulation and suitable width	3	1	4
	The score of UD for the wayfinding (out of 70)		21	25	56

Table 7: Continued.

Criteria	Items		Item score /5		
			A	B	C
Social	Social and recreational	A mix of outdoor play and fitness facilities	0	3	4
		Multipurpose rooms	0	5	5
		Accessible drinking fountains and kitchenette	0	0	5
		Accessible table height	0	0	5
	The score of UD for social and recreational (out of 20)		0	8	19
The total score of UD for all items (out of 220)			55	68	187
Percentage %			25%	30%	85%

4.2.2 Over view and site analysis

1. The accessible beach of Alexandria is 230 m long, 90 m of which are for the disabled. walkway for the disabled has been developed, as it will be 12 m long and 2.5 m wide. Dedicate a special section for the blind, which includes specific paths within the water that allow the blind person to enjoy the sea without any problem, as shown in Fig. 2.

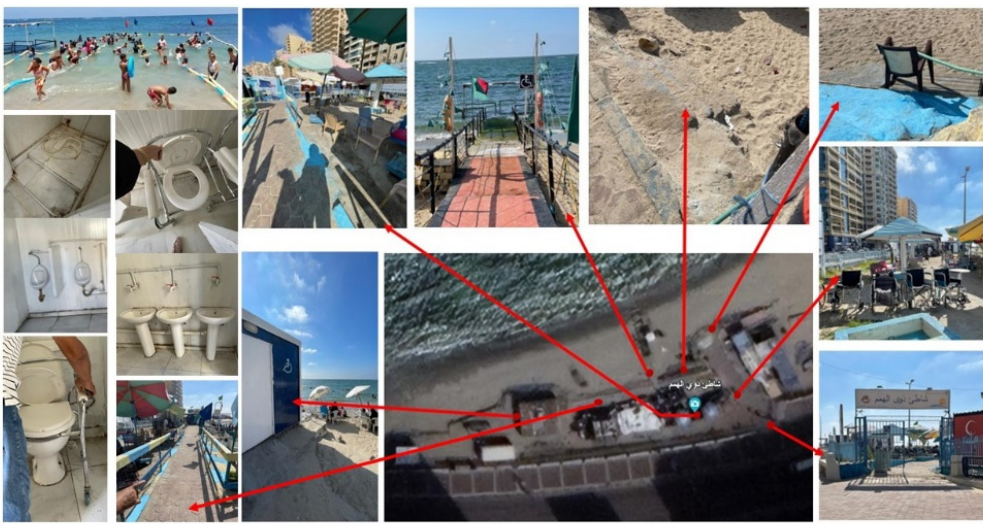

Figure 2: The condition of accessible beach analysis.

2. Alexandria National Museum is located in Foad Street and is the former residence of a prominent timber trading businessman, Asa'ad Basily. He constructed his villa in the Italian style. and it stretches over an area of 3,480 m. The palace was a popular gathering place for many of high-level people in the past century, particularly in the 1930s and 1940s, as shown in Fig. 3.

3. Enabling Village by WOHA, Singapore is known for being inclusive, The Enabling Village is a community centre, targeted to provide a better environment with the architecture. The new main building is anchored with the main pond that functions as a beacon to draw the pedestrian flow through improved linkages. The Enabling Village focuses on sustainability and sociability by promoting the learning, bonding, and healing of people with varying abilities [10], as shown in Fig. 4.

Figure 3: Alexandria National Museum analysis.

Figure 4: Enabling Village site [10].

4.2.3 Finding and results

1. Outdoor environment

Accessible routes: As shown in the figure the pavement width in building A and C is about 4.00 m and achieved the UD requirement according to national standard as the minimum clear width for a wheelchair user and a pedestrian to pass or walk beside each other is 1.80m.but pavement in building B is less than 1.00 m so that building doesn`t achieve the requirements, as shown in Fig. 5.

Crosswalks: As shown crosswalks' potholes and the subpar flooring put up obstacles and gave the disabled a bad feeling in building A. contrary to buildings B and C being clearly identifiable for all users, as shown in Fig. 5.

Curb ramps: There is no curb ramp at building A and just one curb ramp for car walking with a width of 3.00 m at building B reverse to building C shows Crossings and curb ramps be free of obstacles with more than 1.20 m width and landing space more than 1.20 m × 1.20 m and have a detectable warning surface on the sidewalk with a depth of 0.60 m, traffic light systems, and audio signals according to standard codes, as shown in Fig. 5.

Parking spaces: There is no parking in building A and B but providing of parking spaces in building C, providing 1 accessible parking space for every 25 spaces in reverse, the space is almost 4.00 m for accessible car parking and according to the standard, Car parking spaces must have a minimum width of 2.50 m in addition 1.5 m for accessible space, as shown in Fig. 5.

Figure 5: Entering and existing of the three buildings.

Shelters and seating: According to the standard codes all three buildings Providing with protection shelters, as shown in Fig. 6, including seats to rest and include floor space for wheelchair users directly adjacent to the seat, but just in building C provides benches both back and arm rests to give additional support, as shown in Fig. 7.

Figure 6: Shelters protection of the three buildings.

Figure 7: Seating area of the three buildings.

Handrails on ramps and stairs: According to the code building A doesn`t achieve the UD requirements, there is no handrail on both sides of stairs and ramps and no provision of edge protection, and lack of braille and tactile signage, and just 1.00 m width of the corridor. And building B lack ramps or lifts and 1.00 m width of scaping stairs, providing handrail in some stairs from just one side in comparing with building C providing ramps with width and landing space not less than 1.20 m, handrail on both side with a suitable high of 1.00 m, edge protection on the stairs with suitable landing space 1.20 m, as shown in Fig. 8.

Figure 8: Handrails on ramps and stairs of the buildings.

2. Indoor environment

Reach ranges: Just in building C you can easily reach things according to the standard code the high forward reach must be a maximum of 1.20 m above the floor and the low forward reach must be a minimum of 0.38 m above the floor, as shown in Fig. 9.

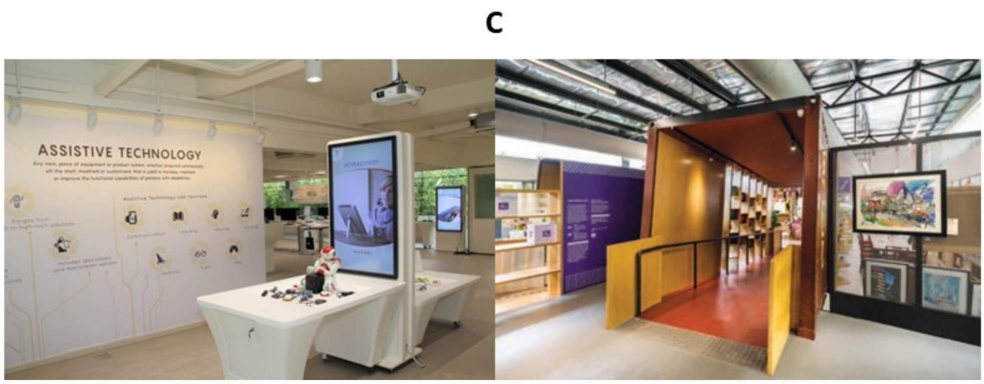

Figure 9: Reach ranges at building C.

Interior accessible routes: it has been achieved just in buildings B and C, according to the code to allow a wheelchair user to comfortably pass a pedestrian should be a minimum of 1.50 m wide.

Wayfinding and signage: Building A doesn`t achieve the UD requirements, building B providing with signage without brail but in building C, according to the standard code Sentence case characters be used as most people recognize a word by its shape when written in a sentence case capital first letter, providing raised signage text, providing braille for wall mounted signs, between 1.20 m and 1.50 m above. the floor, measured to the baseline of the braille cells, large signage pictograms be at least 150 mm tall.
Accessible toilets: The restroom didn't fully implement universal design principles according to the standard, The minimum area of a wheelchair-accessible toilet compartment must be 1.50 m and a minimum of 1.40 m in depth, Need providing with equipped with an alarm system, the door must open outwards. A horizontal grab bar with a minimum length of 1.07 m must be located a maximum of 0.30 m from the rear wall and extend a minimum of 1,370 mm from it. The length of a vertical grab bar must be a minimum of 0.45 m, The bottom of the vertical grab bar must be located at a minimum of 0.99 m and a maximum of 1.04 m above the floor. The fixed rear-wall grab bar must have a minimum length of 0.90 m, located a maximum of 0.17 m from the sidewall, and extend a minimum of 1.07 m from the sidewall, The washbasin or sink must be a maximum of 0.86 m above the floor, shower dimensions of 0.90 m wide, 0.90 m deep, there must have an entry at least 1,500 mm wide, as shown in Fig. 10.

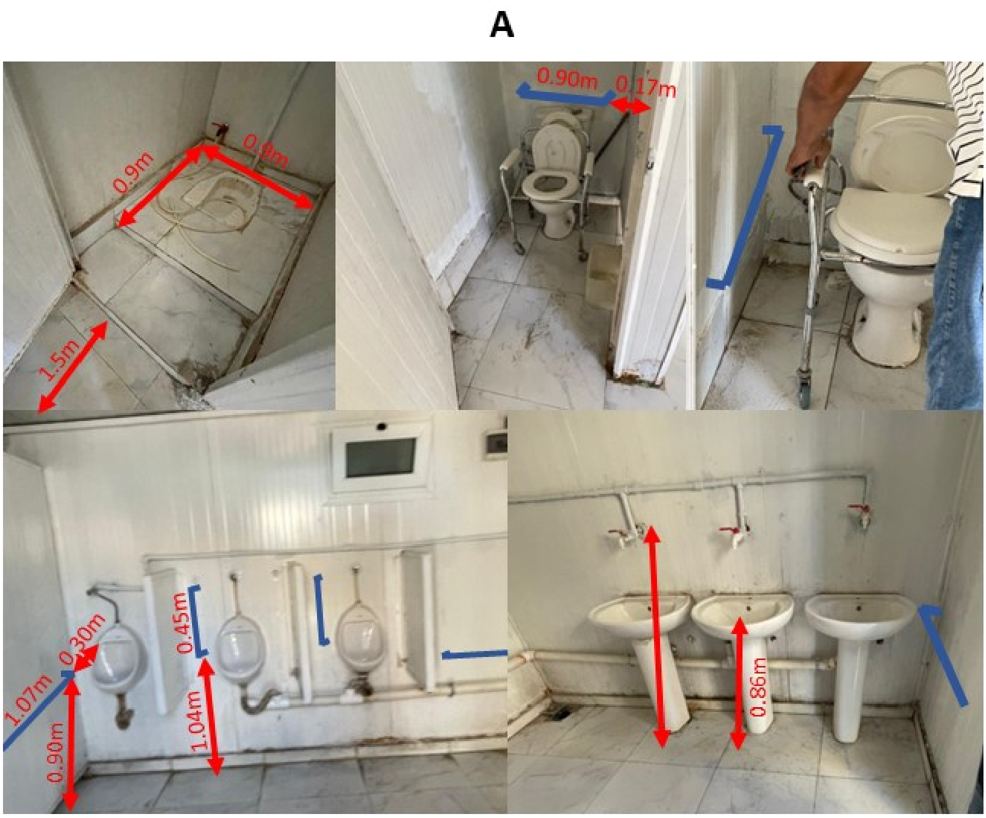

Figure 10: Accessible toilet suggestions at building A.

4.2.4 Discussion and recommendations
Here are some ideas for ensuring that people with disabilities can access, enjoy, and safely use the beach: Utilizing pavement that is climatically resistant will improve the quality of walk floors and roadway paving.

4.2.5 Conclusion
Both sustainability and universal design are crucial strategies for achieving a balance amongst individuals because there can be no social justice without any form of sustainability. The designer would be assisted by the integrated approach in creating buildings that are both universal and sustainable. While universal design concentrates on people, sustainable design is primarily focused on the environment. Universal Design can be seen as a key element for social sustainability in addition to fostering involvement and social engagement within a liveable community. Because it affects human behaviour and quality of life in so many different ways, the social component of sustainability should be highlighted in the general conversation about sustainability. In order to assist designers and prevent time and money waste, as well as to suggest a new future guideline with codes for mental disabilities, the current study describes the construction of an evaluation framework that may be used in the early stages of design when evaluating the performance of buildings using a rating system. Universities should teach universal design to raise early awareness of the need to make current built settings more accessible in order to provide a holistic socially sustainable environment for the benefit of future generations. Additionally, it is crucial to apply smart planning techniques while building homes to prevent unsustainable home modifications that result in pollution, the use of dangerous construction tools and materials, and the improper removal of waste.

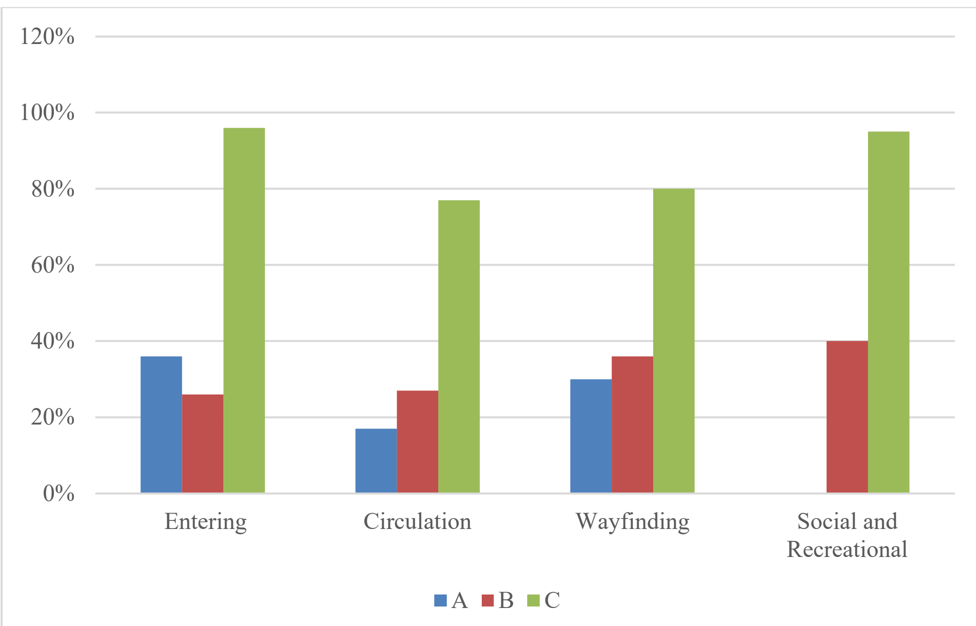

Figure 11: The score of achieving UD for each element in the three buildings.

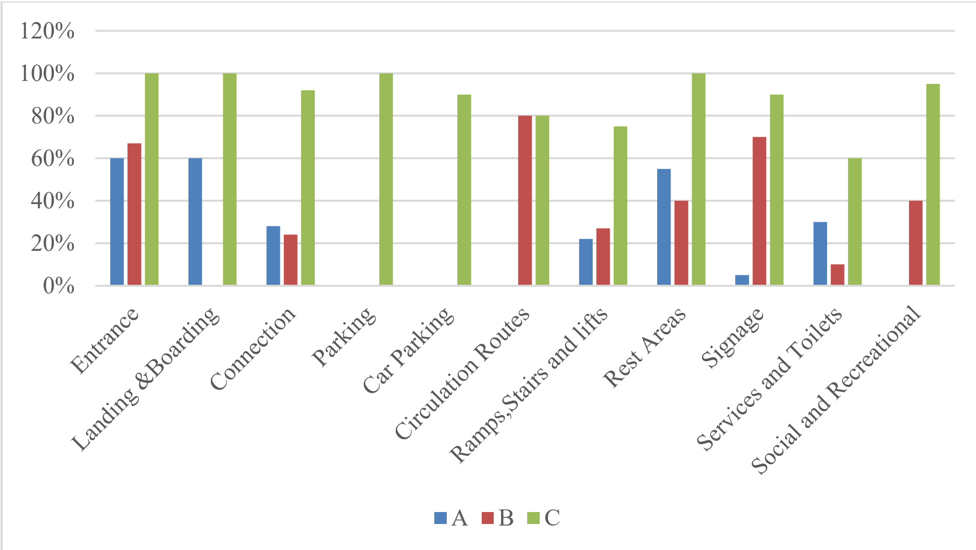

Figure 12: Percentage of achieving UD for the detailed items.

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