Criteria and Challenges of Inclusive Design in the Built Environment

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Abstract

Inclusive design is about designing accessible spaces for individuals with different needs. It beholds the ability to affect people's behaviour in the built environment, especially People With Disability (PWDs). Inclusive design aims to remove the barriers that hinder the accessibility and interaction of PWDs within their surroundings, enabling equal opportunities and expanding the scope of their activities. Ensuring an inclusive environment is the responsibility of architects, planners, engineers and facility managers. It is essential to ensure that buildings' design and operation align with inclusive principles through regular assessments. Many comprehensive assessment tools have been developed by scholars and used in the industry. Still, when issues arise like insufficient funding, the decision-makers should be able to prioritize inclusive design criteria in a defined assessment checklist. Addressing accessibility at the building level is particularly important to provide a suitable environment that facilitates users' interaction with the built environment. This study aims to identify prioritized accessibility assessment criteria for PWDs in higher education facilities through the lens of experts and to provide justifications for selecting the highest and lowest priorities. A targeted sampling methodology was adopted for the semi-structured interviews. Findings include a list of the highest and lowest prioritized criteria, identification of criteria with significant differences, justifications for selections and a close-up look into the influence of experts' experience on the criteria rankings. Furthermore, this paper provides insight into significant inclusive design criteria for improved FM decision-making processes and the strategy for managing the challenges of inclusive design in new and existing facilities.

Keywords: Persons with disability; Accessibility; Inclusiveness; Educational buildings; Facility management

1 Introduction

In 2022, the World Health Organization (WHO) estimated that a number of 1.3 billion people (16% of the population) have some form of significant disability. As an integral part of the natural human experience, disability results from several health conditions and personal and environmental factors. Persons With Disability (PWDs) have a shorter life span and less health and are faced with more functional limitations than others (WHO, 2022). Therefore, it is essential to integrate PWDs with society to offer them ample opportunities to improve their quality of life. It is necessary to show integration through different means, such as education, engagement in social activities and empowerment. As it is the right of both PWDs and People With No Disability (PWNDs), it is claimed by Simonson et al. (2013) that decision-makers must deliver high-quality, accessible educational environments. Accessing the built facility is the most challenging for PWDs compared to other features (Jacklin et al., 2007; Hopkins, 2011; Moriña and Morgado, 2018).

Ensuring an inclusive, accessible environment is the responsibility of architects, planners, engineers and facility managers. It is vital to ensure that buildings' design, construction and operations align with inclusive principles that respond to users' needs through regular assessments. Similar to requirements in engineering practices, building accessibility assessments need analysis and prioritization of the assessment criteria. Prioritization of accessibility assessment criteria is required to give attention to the most important ones and guide professionals in coping with challenges in some cases.

This study aims to identify prioritized accessibility assessment criteria for PWDs in higher education facilities through the lens of experts and to provide justifications for selecting the highest and lowest priorities. The study adopted a mixed-method research methodology; qualitative and quantitative data were acquired through the literature review and the semi-structured interviews with experts within a Facility Management (FM) team. Experts were selected based on targeted sampling. Findings include a list of the highest and lowest prioritized criteria, identification of criteria with significant differences, justifications for selections and a close-up look into the influence of experts' experience on the criteria rankings. Furthermore, challenges of PWDs, user requirements and environmental barriers are aligned with prioritized assessment criteria.

2 Literature review

2.1 Inclusive Design, Accessibility and Challenges in the Built Environment

The development of a universal design that prioritizes user requirements is known as inclusive design (Hadjri et al., 2016). It aims to provide building users with easy movement by removing all barriers in the built environment that hinder their activities and accessibility. Accessibility is derived from the word access, which means the ability to enter a space, giving the freedom of movement in complete safety despite age, gender, or disability, having no challenges or obstacles and providing full independence (Derese, 2020). Accessibility in the built environment, specifically, is the ability of the design of the environment to either support or restrict users' activities and movement, as defined by (Carlsson et al., 2022).

For example, challenges of physical disability in educational built environments include the lack of adequate furniture for PWDs in classes, auditoriums, eating areas, libraries, etc., entry obstacles and absence or inadequacy of design and surface material of ramps, handrails and doors. Moreover, it also includes inaccessible parking areas and insufficient maneuvering space externally and internally

(Mulazadeh and Alharbi (2018); Machado and Olivera (2021); Moriña and Morgado (2018); Muzemil (2018), Seshadhri and Paul (2017); Sholanke et al. (2019), Meyers et al. (2019)). According to Carlsson et al. (2022), steps and stairs are also considered environmental barriers, especially for people using a wheelchair. Movement on slippery or uneven floors, seeing from or reaching a certain height, and restless long travel distances are other challenges, as mentioned by Derese (2020).

The construction industry is essential for the country's development and is measured by improved infrastructure (Derese, 2020). It involves different participants, several phases like design, construction and operations, and different processes. Decision-makers are often faced with challenges within these stages when adopting inclusive design. These include non-complying to laws and policies, finance and complexity of design incorporating PWDs requirements, ignorance and lack of effective coordination and consultation with disability groups. It is beneficial for decision-makers and PWDs to understand information about accessibility and user needs; this reinforces the adoption of inclusive design in the built environment.

2.2 Inclusive Design Practices' Integration with Accessibility

To properly integrate inclusive design practices with accessibility, inclusive design focus should include operations' use, limitations and capabilities and PWDs preferences. According to Hadjri et al. (2016), decision-makers need to be able to select the right set of user requirements and consider the involvement of PWDs to meet their needs, prioritize, design accordingly and assess the final deliverable as per their requirements. Similarly, evaluating accessibility in facilities when faced with challenges requires analysis and prioritization of assessment criteria.

2.3 Accessibility Assessment Criteria

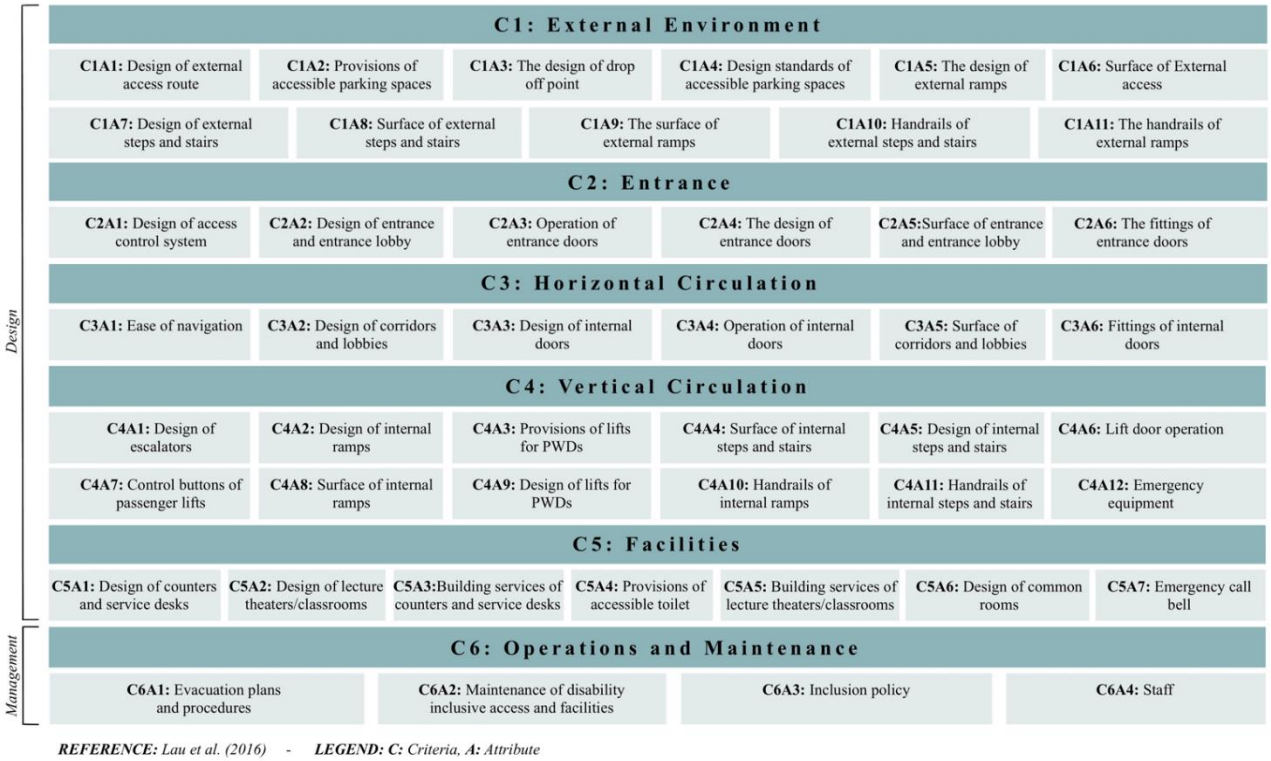

Fig. 1: Accessibility Assessment Criteria and Attributes

Ensuring an inclusive environment is the responsibility of architects, planners, engineers and facility managers. It is essential to ensure that buildings' design and operations align with inclusive design principles through regular assessments. Many comprehensive assessment tools have been developed by scholars and used in the industry. This paper adopted the accessibility assessment checklist developed by (Lau et al., 2016), as illustrated in Figure 1.

3 Methodology

To identify prioritized accessibility assessment criteria, the research methodology adopted a mixed-method approach; qualitative and quantitative data were acquired through a literature review and semi-structured interviews with experts. The study first explored the challenges of physical disability in educational built environments and the environmental barriers through a literature review to understand users' perceptions. Then, it explored experts' perceptions of challenges in the design, implementation and operations phases.

Furthermore, a checklist criteria developed by Lau et al. (2016) was adapted for the conducted interviews with selected industry experts. The sample included eight practitioners complying with the Americans with Disabilities Act (ADA), such as one facility manager, two architects, two interior designers, two implementation engineers and one landscape architects within an FM team between 1-25 years of experience. During the semi-structured interviews, experts were presented with assessment criteria to rank according to their importance and provide justifications for their highest and lowest selections. The session took 30 minutes.

The paper adopted two types of statistical analyses for the data; inferential and descriptive. The inferential analysis conducted a non-parametric test (Friedman's test) to test for the ranking significance of the attributes within each criterion. Furthermore, descriptive analysis was adopted for the overall ranking of the attributes within the six criteria and the ranking of criteria with significant differences according to experts' experience. Figure 2 illustrates the research methodology.

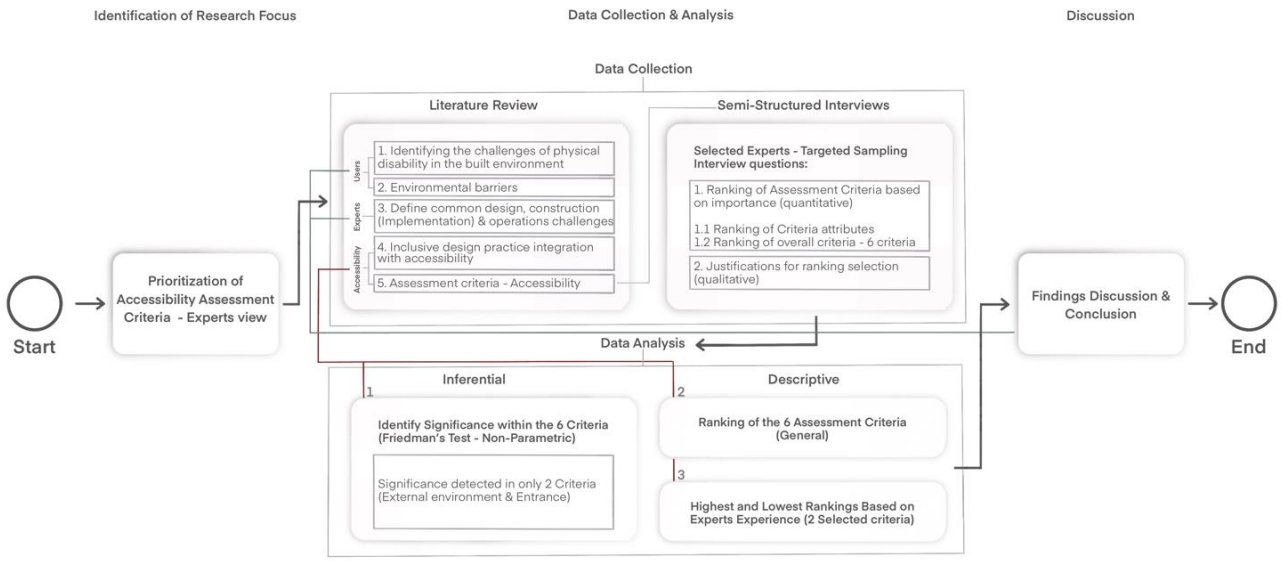

Fig. 2: Research methodology

4 Data Analysis

The data analysis for ranking of accessibility assessment criteria includes inferential analysis to identify significance among the criteria rankings, descriptive analysis for the overall ranking of criteria, and an in-depth analysis of experts' experience in relation to rankings of criteria with significant differences. Decsriptive analysis offers a summary of the data, while the inferential analysis creates a path to conclusions, predictions and estimations.

4.1 Inferential Analysis

As the criteria are ranked, a non-parametric test must be conducted. The test used is Friedman's test, which is the non-parametric equivalent to the two-way ANOVA. Each criterion is tested separately using an alpha (α) of 0.05 to identify significance in attribute rankings. Table 1 shows the test results.

$$H_0: There\ is\ no\ significant\ difference\ between\ the\ attributes$$

$$H_a: There\ is\ at\ least\ one\ difference\ between\ the\ attributes$$

Table 1: Inferential analysis

No.	Criteria	FT	Critical Value (χ^2)	P-Value	Significant/Not Signficant
1	External Environment	20.25	18.30	0.02	Significant
2	Entrance	11.28	11.07	0.04	Significant
3	Horizontal Circulation	7.57	11.07	0.18	Not Significant
4	Vertical Circulation	14.00	19.67	0.23	Not Significant
5	Facilities	0.53	12.59	0.99	Not Significant
6	Operations and Maintenance	2.25	7.81	0.52	Not Significant
Overall		11.67	12.59	0.06	Not Significant

The test results showed significance in ranking within two assessment criteria only; the external environment and the entrance. Furthermore, the test statistic in these two significant criteria is greater than the critical value. At the same time, the P-Value is less than (α). This indicates that the null hypothesis is rejected, and there is at least one difference among the attributes. On the other hand, the horizontal and vertical circulations, facilities and operations and management criteria failed to reject the null hypothesis; hence it is assumed that there is no difference among the attributes.

4.2 Descriptive Analysis

The descriptive analysis in Table 2 presents the rankings of all assessment criteria based on importance. The experts were presented with all criteria and their attributes and were asked to rank them (numerical order) in a 30 minutes long session. The attributes highlighted in green are the highest rankings, and the lowest rankings are highlighted in red.

Table 2: General ranking of all Accessibility Assessment Criteria (Legend: C-Criteria, A-Attribute, R-Ranking)

Accessibility Assessment Criteria Ranking						
C1: External Environment						
A-	C1A1 – *1*	C1A2 – *2*	C1A3 - *2*	C1A4 - *5*	C1A5 - *5*	C1A6 - *7*
R	C1A7 – *8*	C1A8 - *9*	C1A9 - *9*		C1A10 - *10*	C1A11 - *10*
C2: Entrance						
A-	C2A1 – *1*	C2A2 – *2*	C2A3 - *2*	C2A4 - *2*	C2A5 - *4*	C2A6 - *6*
R						
C3: Horizontal Circulation						
A-	C3A1 – *1*	C3A2 – *2*	C3A3 - *4*	C3A4 - *5*	C3A5 - *6*	C3A6 - *6*
R						
C4: Vertical Circulation						
A-	C4A1 – *2*	C4A2 – *4*	C4A3 - *5*	C4A4 - *6*	C4A5 - *7*	C4A6 - *8*
R	C4A7 – *8*	C4A8 – *9*	C4A9 - *10*	C4A10 - *11*	C4A11 - *12*	C4A12 - *N/A*
C5: Facilities						
A-	C5A1 – *1*	C5A2 - *2*	C5A3 - *2*	C5A4 - *3*	C5A5 – *4*	C5A6 - *5*	C5A7 - *6*
R							
C6: Operations and Maintenance						
A-	C6A1 – *1*	C6A2 - *2*	C6A3 – *3*	C6A4 - *4*		
R						

According to the inferential analysis, the external environment and the entrance are the only two criteria with significant differences. Based on the general ranking, the two highest attributes include; the design of the external access route (C1A1) within the external environment and the design of the access control system (C2A1) for the entrance. As for the lowest rankings, the external environment included two attributes with the same score; the handrails of external steps and stairs (C1A10) and the handrails of exterior ramps (C1A11). On the other hand, the entrance presented the fittings of entrance doors (C2A6) as the lowest ranking.

The analysis further investigated the influence of experts' years of experience on selecting the highest and lowest attributes. Figure 3 illustrates the detailed ranking of attributes within external environment criteria based on experts' experience.

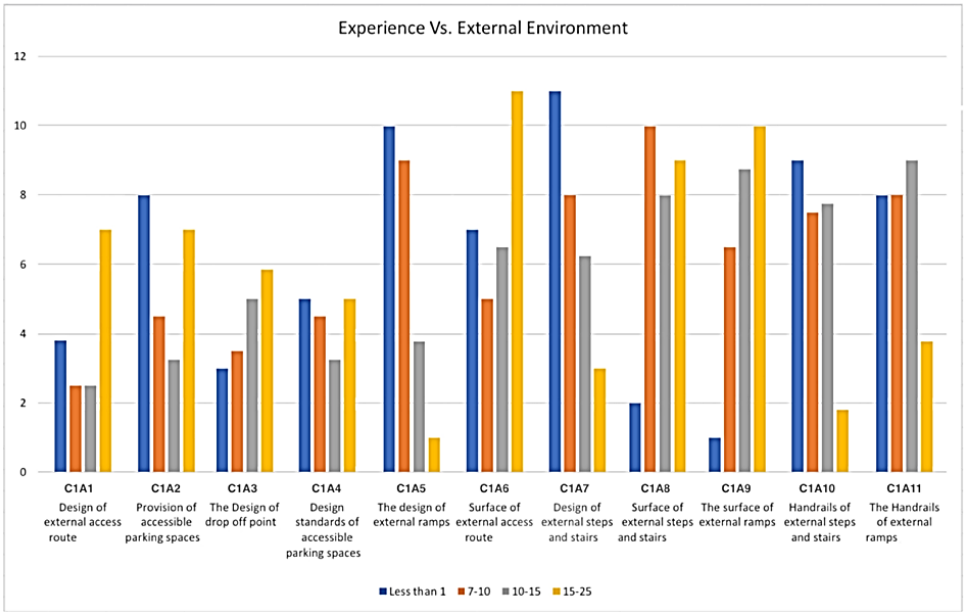

Fig. 3: External environment rankings based on experts' experience

According to Figure 3, the highest ranking was given to the design of external ramps (C1A5) by experts with experience of 15-25 years and the surface of exterior ramps (C1A9) by experts with experience of less than a year, making these two attributes the highest priority from the view of these experts. On the other hand, the lowest ranks are given to the surface of external access routes (C1A6) by experts with experience of 15-20 years and design of external steps and stairs (C1A7) by experts with experience of less than one year, making these two attributes the least priority.

Figure 4 illustrates the detailed ranking of attributes within entrance criteria based on experts' experience.

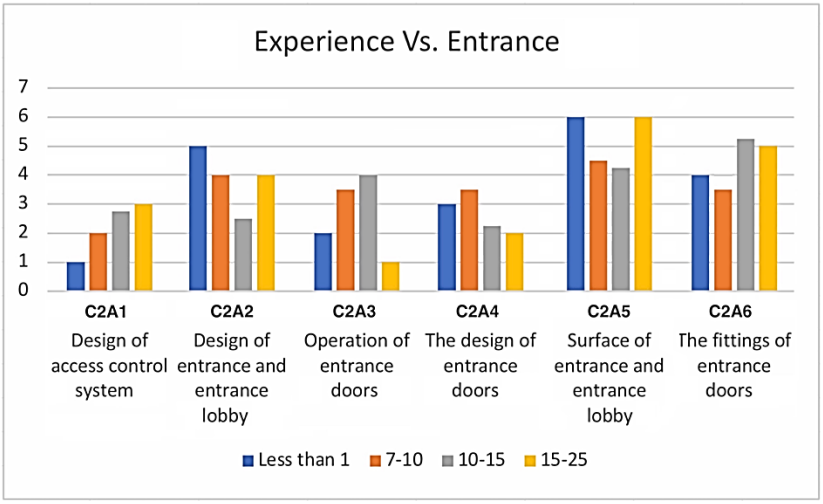

Fig. 4: Entrance based on Experts' Experience

Figure 4 presents that the highest ranking was given to the operation of entrance doors (C2A3) by experts with experience of 15-25 years and the design of access control system (C2A1) by experts with experience of less than a year, making these two attributes the highest priority. Furthermore, experts with experience of 15-20 and less than one year agree that the lowest rank is given to the surface of the entrance and entrance lobby (C2A5) as the least priority.

5 **Discussion**

This section explores the justifications for selecting the highest-ranking criteria attributes based on the view of experts with experiences of less than one year and 15-25 years. To integrate inclusive design practices with accessibility, it is essential to show how the highest-ranked criteria respond to vital challenges of physical disability in the built environment. Furthermore, the highest-ranked criteria should also be responding to decision-makers' challenges. Table 3 presents the physical challenges mentioned earlier, criteria and phases thematically. Also, according to Ahmad et al. (2022), the criteria can be categorized as general or essential requirements. The essential requirements would define the building as entirely inadequate if it failed to comply. On the other hand, the general requirements would cause the building to be partially inadequate.

Table 3: Challenges of physical disability and high ranked assessment criteria

(Legend: D-Design, C/I-Constriction/Implementation, O&M-Operation and Maintenance)

Users Focus	Experts Focus - Accessibility Assessment	Phase			Theme	Priority (General /Essential)
Challenges of physical disability	**Criteria (C) & Attributes (A)**	**D**	**C/I**	**O&M**		
	C1: External Environment					
Entry obstacles	C1A1: Design of external access route	X			Navigation	Essential
Inaccessible parking areas						
Insufficient maneuvering space						
Steps and stairs						
Seeing from or reaching a certain height						
Restless long travel distances						
Entry obstacles	C1A5: Design of external ramps	X			Entry	Essential
Insufficient maneuvering space						
Inadequacy of design and surface Materials of ramps	C1A9: Surface of external ramps		X	X	Movement	General
Slippery or uneven floors						
	C2: Entrance					
- Entry obstacles - Insufficient maneuvering space at the door	C2A1: Design of access control system		X	X	Restriction	General
	C2A3: Operation of entrance doors		X	X	Entry	Essential

The first criterion ranked as highest based on the general view of all experts collectively is C1A1: the design of external access route; it is an essential requirement that responds to vital challenges of physical disability, as displayed in Table 3. Experts ranked it as one of the highest for many reasons, such as; ease of circulation and access to PWDs, comfort and clarity in knowing the entries and exits from the drop-off points or parking. Failing to provide an adequate design for the external access route renders the facility entirely inadequate for PWDs. The second highest criteria attribute is C1A5: design of exterior ramps that is also an essential requirement. One crucial justification provided by the majority of experts with experience of 15-25 years is that PWDs must be provided with means of access to any buildings, lack of ramps imposes entry obstacles. Furthermore, C1A9: the surface of external ramps can affect the movement of PWDs, especially if the finishing material is slippery, as it may lead to accidents that can be avoided if proper rough materials are selected. However, it is considered a general requirement as it causes the building to be partially adequate.

Moreover, the first entrance criteria attribute ranked as highest is C2A1: design of access control system. This attribute leans more towards the facility management side; experts believe that access control systems should operate efficiently, or else it would cause obstruction and restrict movement. Furthermore, C2A3: operation of entrance doors is considered an essential requirement as it obstructs entry if not operating adequately, especially since PWDs would face difficulty trying to use them manually.

6 Conclusion

To sum up, it is an essential responsibility of decision-makers towards PWDs, to ensure that the buildings' design, construction and operations align with inclusive principles that respond to users' needs through regular assessments. There is a need to prioritize accessibility assessment criteria that would render the buildings either partially or fully inadequate to use by PWDs, to tackle physical and decision-makers challenges. This paper highlighted some assessment criteria ranked the highest by a targeted group of experts within an FM team. The general ranking showed a hierarchy of importance among all assessment criteria attributes. Furthermore, the ranking based on experts' experiences provided insight into how the years of experience influence the view of experts in ranking. Ultimately, the design of the external access route, the design and surface of exterior ramps, the design of access control and the operation of entrance doors are considered the highest-ranked accessibility assessment criteria.

Limitations

Project limitations include the small sample size that covered 70% of the ADA practitioners for the semi-structured interviews. In addition, the sample size was limited due to the extended session period and the availability of the practitioners.

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References

Ahmad, A.M. et al (2022), "Inclusiveness Assessment Tool for Disabled Persons in Higher Education Facilities," Journal of Facilities Management, vol. ahead-of-print no. ahead-of-print. https://doi.org/10.1108/JFM-08-2021-0086.

Carlsson, G. et al. (2022). A Scoping Review of Public Building Accessibility. Disability and Health Journal 15 (2022) 101227, pp. 1-11. DOI: https://doi.org/10.1016/j.dhjo.2021.101227

Derese, B. (2020). Assessing the Efficiency and Challenges with Implementing Accessible Building Facilities for Persons with Disabilities in Public Building of Addis Ababa. Addis Ababa Institute of Technology School of Civil and Environmental Engineering (Thesis). Addis Ababa, Ethiopia. Retrieved from: https://bit.ly/3VAmpnK [Accessed 27 November, 2022].

Hadjri, K., Afacan, Y. & Gadakari, T. (2016). Inclusive Design – Chapter 6. M. Noguchi (ed.), ZEMCH: Toward the Delivery of Zero Energy Mass Custom Homes, Springer Tracts in Civil Engineering, pp. 151-173. Springer International Publishing Switzerland 2016. DOI 10.1007/978-3-319-31967-4_6.

Hopkins, L. (2011). The Path of Least Resistance: A Voice-Relational Analysis of Disabled Students' Experiences of Discrimination in English Universities. International Journal of Inclusive Education, vol. 15 no. 7, pp. 711-727. DOI: 10.1080/13603110903317684.

Jacklin, A. et al. (2007). Improving the Experiences of Disabled Students in Higher Education. Available at: www.heacademy.ac.uk/assets/documents/research/jacklin.pdfJones [Accessed 10 December 2022].

Lau, W.K., Ho, W.D.C. and Yau, Y. (2016). Assessing the Disability Inclusiveness of University Buildings in Hong Kong. International Journal of Strategic Property Management, vol. 20 no. 2. pp. 184-197. DOI: 10.3846/1648715X.2015.1107653.

Machado, L. & Oliveira, U. (2021), "Analysis of Failures in the Accessibility of University Buildings", Journal of Building

Engineering, vol. 33 no. 2021, p. 101654, DOI: 10.1016/j.jobe.2020.101654.

Meyers, A. et al. (2002), "Barriers, Facilitators, and Access for Wheelchair Users: Substantive and Methodologic Lessons from a pilot Study of Environmental Effects", Social Science & Medicine, vol. 55 no. 8, pp. 1435-1446, DOI: 10.1016/S0277-9536(01)00269-6.

Moriña, A. & Morgado, B. (2018). University Surroundings and Infrastructures that are Accessible and Inclusive for all: Listening to Students with Disabilities. Journal of Further and Higher Education, vol. 42 no. 1, pp. 13-23. DOI: 10.1080/0309877X.2016.1188900.

Mulazadeh, M. & Alharbi, T. (2018), "Disability Policy and Wheelchair Users' Accessibility in Jordan", Review of Disability Studies: An International Journal, vol. 14 no. 4, pp. 1-2, available at: https://rdsjournal.org/index.php/journal/article/view/770/2078 [Accessed 19 December 2022].

Muzemil, A. (2018), "Campus Physical Environment Accessibility for Person with Disabilities in the Ethiopian Public Universities", International Journal of Multicultural and Multi-religious Understanding, vol. 5 no. 5, p. 286, DOI: 10.18415/ijmmu.v5i5.45.

Sholanke, A., Adeboye, A. and Alagbe, O. (2019), "Design Solutions Creating Barriers to Achieving Universal Design Compliance of Academic Buildings in Universities in Nigeria", International Journal of Civil Engineering and Technology (IJCIET), vol. 10 no. 1, pp. 671-690, available at: www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=10&IType=01, ISSN Print: 0976-6308 and ISSN Online: 0976-6316 [Accessed 19 December 2022].

Simonson, S., Glick, S. & Nobe, M. (2013). Accessibility at a Public University: Student's Perceptions. Journal of Facilities Management, vol. 11 no. 3, pp. 198-209. Iss Emerald Group Publishing Limited. DOI: 10.1108/JFM-06-2012-0025.

WHO (2022). Disability. [Online] available at: www.who.int/mediacentre/factsheets/fs352/en/ [Accessed 11 December 2022].

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