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Study of the Accessibility for Students with Disabilities to Faculty of Engineering Buildings at University of Tabuk

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Abstract

Modern facility design must prioritize inclusive design to ensure accessibility and usability of public spaces, regardless of physical abilities. The assessment of accessible facilities and services for students with disabilities at the University of Tabuk is the focus of this study. Its aim is to evaluate the planning and implementation of facilities specifically designed to meet their needs and to identify areas requiring improvement. A field assessment was conducted in selected buildings on the University of Tabuk's Faculty of Engineering campus (two academic buildings, a laboratory building, and a library building) using the King Salman Standard (KSS) for Inclusive Accessibility. The assessment encompassed external elements, internal elements, and communication and safety systems. Measurements were compared to standard benchmarks to identify gaps and propose improvements. The field assessment revealed key accessibility gaps in the studied Faculty of Engineering buildings, impacting students with disabilities. The results indicated varying levels of compliance with the King Salman Standard for external elements, internal features, and communication and safety systems. Addressing these issues through sound design and inclusive infrastructure will enhance safety and independence, aligning with the Vision 2030 goals of equal educational opportunities.

Keywords
Students with disabilities, Facility Planning and Layout, Accessibility.

1. Introduction
Providing opportunities for people with disabilities to actively participate in social life is a key indicator of a society's development and modernity. One of the most important factors enabling this group to live and participate in society on an equal footing with others is creating an accessible built environment that ensures ease of access and use for everyone. If accessibility requirements are not considered during the planning and implementation phases of urban development, people with disabilities will face obstacles that prevent them from accessing health and rehabilitation services, continuing their education, entering the workforce, and participating in cultural, artistic, and sporting activities, thus limiting their full and equal participation in social life. Furthermore, the difficulty of accessing or the lack of accessible educational and training facilities negatively impacts the educational journey of people with disabilities and their families, resulting in lower academic achievement and limited participation in higher education.

University education is a fundamental pillar in developing individuals' abilities, broadening their intellectual horizons, empowering them to shape their professional futures, and promoting their integration into society. In higher education institutions, Persons with disabilities, like everyone else, have the right to education in their chosen fields and to participate in the social and cultural activities offered by universities, thus enhancing their role in production and community participation without dependence on assistance.

The United Nations Convention on the Rights of Persons with Disabilities and Optional Protocol, affirms a set of principles and commitments aimed at inclusive empowerment, including equality and non-discrimination, accessibility, living independently and being included in the community, personal mobility, education, health, work and employment, participation in political and public life, awareness, education, participation in cultural life, recreation, leisure and sport (United Nations 2006).

Over the past two decades, awareness has grown regarding the need for effective measures to combat discrimination against people with disabilities. Therefore, it is crucial that higher education institutions lead the way in demonstrating how to overcome the accessibility barriers that have long prevented people with disabilities from enjoying the same rights and privileges as others. Literature studies have addressed the number and classification of people with disabilities, as well as their education in Saudi Arabia. Conceptual models for understanding disability have been examined, accessibility barriers faced by students with disabilities have been explored, and student-centred planning has been implemented to enhance accessibility. Improving accessibility at the University of Tabuk aligns with national and international trends. Furthermore, Saudi Vision 2030 emphasizes the importance of inclusive education as an effective tool for achieving social development and empowerment. Therefore, research into implementing comprehensive accessibility measures that address both physical and digital barriers is of paramount importance.

1.1 Objectives

1. Evaluate the planning and implementation of facilities in the Faculty of Engineering based on national accessibility standards
2. Identify gaps affecting students with disabilities
3. Identify areas needing improvement
4. Recommend improvements enhance safety and accessibility

2. Literature Review

In the literature some current state of international research in the area: Under the title of accessibility and universal design in educational institutions Gyamfi studied assessed the accessibility of the University of Ghana's campus for students with disabilities. It identified physical barriers, such as inadequate ramps and inaccessible buildings, and provided recommendations for improvements based on universal design principles (Gyamfi 2014).
In evaluation of university facilities for accessibility, Chiwandire and Vincent studied and evaluated the physical accessibility of university buildings at the University of Cape Town. It utilized surveys and site inspections to identify accessibility barriers and proposed a set of guidelines to make the campus more accessible to students with disabilities (Chiwandire and Vincent 2017).

Under the title of inclusive design in educational spaces, Morgan and Houghton explored the implementation of inclusive design principles in UK universities. It analysed the effectiveness of current accessibility measures and provided recommendations for improving the design of educational spaces to accommodate students with various disabilities (Morgan and Houghton 2011).

Lima and Barbosa investigated the accessibility barriers faced by students with disabilities in Brazilian universities. The research highlighted the need for comprehensive accessibility audits and the implementation of design practices (Lima and Barbosa 2020).

In the literature some current state Saudi Arabia research in the area: In the field of inclusive education in Saudi Arabia, Alquraini reviewed the policies related to inclusive education in Saudi Arabia by particularly focusing on the implementation of these policies in higher education institutions. While it is not a direct case study of facility design, it provides an overview of the challenges and opportunities in making Saudi universities more inclusive for students with disabilities (Alquraini 2013).

Alnahdi from King Saud University studied and evaluated the accessibility of King Saud University’s campus for students with disabilities. It examined the physical infrastructure, including ramps, elevators, and classroom layouts, and assessed the adequacy of these facilities in meeting the needs of students with disabilities (Alnahdi 2020).
Alothman studied the promoting accessibility in Saudi universities faces challenges like weak digital platforms, inadequate teacher training in inclusive practices, negative attitudes, and physical barriers, while recommendations

focus on strengthening laws, improving teacher prep, enhancing tech support, fostering collaboration, and adapting curricula, with a goal to create inclusive environments for students with disabilities (Alothman and Alghadeer 2021).

3. Methods

This study aims to assess the accessibility of the Faculty of Engineering buildings at the University of Tabuk. It focuses on identifying the needs of students with disabilities by examining the current situation within the faculty. A checklist based on national accessibility standards, King Salman Centre for Disability Research principles: Build Environment Guidelines for the Kingdom of Saudi Arabia, (King Salman Centre for Disability Research 2010) will be used to systematically evaluate physical elements, including classrooms, libraries, lecture halls, corridors, entrances and walkways, restrooms, doorways, ramps, and signage, among others. Measurements and visual documentation will be the assessment tools. The study explores ways to improve services for students with disabilities by identifying current shortcomings and proposing practical solutions to address them, with the goal of providing a safe and stimulating learning environment. This will be achieved within a framework of balancing comfort requirements with the quality of facilities, thus supporting the educational process and enhancing the learning experience for people with disabilities.

In this article the checklist forms to be applied and the parts of the relevant standards are arranged as follows:

1. Exterior Elements: The exterior surfaces, roads, streets and crossings, sidewalks and paths, ramps, exterior stairs, curb stones, pedestrian paths and parking
2. Interior Elements: Building entrances, Entrances, aisles, paths and walkways, elevators, interior doors, window, bathrooms, classrooms, library, activities, signs, emergency doors, emergency routes, fire evacuation plan and information systems
3. Communications and safety systems: Talking signs, visual alarms, emergency exits, assistive technology, digital contents, security, warning surfaces and listening devices

The buildings at the University of Tabuk are generally constructed according to specific architectural styles. The older buildings were used as single-story classrooms, then this style changed to multi-story buildings as numbers of students increased. These multi-story buildings were used for classrooms and laboratories. A newer building styles are also present; for example, the library building is more modern than its predecessors and considers the needs of all students, including those with disabilities.
In this study, four buildings from the Faculty of Engineering were selected as model buildings of the above styles for conducting the study:

1. Singl-story classroom Building #6
2. Multi-story classroom Building #4
3. Laboratories Building #11
4. Library Building.

Tables 1, 2, and 3 show the check list forms used in this study to access the Exterior elements, Interior elements, and the Communication and safety systems in the above four buildings.

Table 1. Checklist form of Exterior elements

No	Element	Guideline	Standard	Building 4	Building 6	Building 11	Library
1	Sidewalks	Width	Minimum 1200 (mm)	1300	3700	1200	1250
2	Ramps	Width	Minimum 1200 (mm)	1320 mm	1060mm	1400mm	1400 mm
		Start and end	1500*1500 mm	1360*1300	1500*1500	1500*1500	1500*1500
		Width	Minimum 1500 (mm)	4400	3700	1500	1600
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3	Pedestrian crossings	Ground brands	width of 300 mm, with a 70% color contrast with the road	None	None	None	None
		Traffic lights	must be set based on slow walking speed, while providing audiovisual signals	None	None	None	None
4	Parking	Width	Minimum 2400 (mm)	2500	2400	2000	2100
		Canopy	Canopy	None	None	None	None
5	Street Furniture	External seats specifications	The seats must be with supportive and back supporters	Available	None	None	None
		Garbage boxes	the height of the opening should not exceed 1060 (mm)	870	870	870	870
6	Public Areas	External Squares	Minimum 2100 mm, and in the case of restrictions it can be reduced to 1500 (mm)	5800	More than 2100	More than 2100	More than 2100
7	Ground & Floor Surfaces	The outer surfaces should be stable, solid, non-slippery, and free		Stable, solid, non-slippery	Stable, solid, non-slippery	Stable, solid, non-slippery	Stable, solid, non-slippery
8	Exterior Stairs	Height	between 125-180 (mm)	150	None	150	150
		Tread Depth	between 280-350 (mm)	320	None	325	320

9	Handrails	Double handrails (two levels) should be installed on both sides		Available	None	Available	Available
		Handrails height	Between 875-925 (mm) above the front of the stairs	None	None	990	840

Shortcomings of Exterior Elements:

- Sidewalks need to monitor Building 11 for crowding issues.
- Ramps in Building 4 of insufficient landing space and too narrow in Building 6.
- Pedestrian crossings with good width in all buildings but lack of ground brands and Traffic lights.
- Parking missing shelters.
- Garbage boxes are available, and very few externally accessible seatings.
- Public areas are not enough compared with the number of students.
- Some external floor surfaces are slippery.
- Exterior Stairs are non-compliant, unsafe for mobility-impaired
- Handrails height in-accessible in some buildings

Table 2. Checklist form of Interior elements

No	**Element**	**Guideline**	**Standard**	**Building 4**	**Building 6**	**Building 11**	**Library**
1	Building Entrance	Clear width of entrance doors	Minimum 900 (mm)	1730	1900	1010	900
		Automatic door opener	Required at main entrances	None	None	None	None
		Color contrast at doors	Doors should contrast with surrounding surfaces	Done	Done	Done	Done
2	Roads and Corridors	Clear width of accessible routes	Minimum 1200 (mm)	2655	4000	2860	1252
		Edge protection	Kerb at least 75 mm high if elevation difference is 200–600 (mm)	None	90	100	None
		Clear width of elevator doors	Minimum 900 (mm)	915	None	910	910
		Interior dimensions of elevator cab	Minimum 1725 wide * 1525 (mm) deep	1400 * 1340	None	1400 * 1600	1400 * 1600
		Handrails inside elevator	Mounted 800–900	830	None	880	880

3	Elevators		(mm) above floor				
		Floor designation buttons	Height 900 –1200 (mm), tactile Braille labels	994	None	1030	1170
		Door reopening device	Activates without contact between 100–150 (mm) and 700 –760 (mm) above floor	None	None	Available	Available
4	Windows	Windowsill height	Maximum 750 (mm) above floor	1170	840	950	920
		Operable mechanisms	Within reach range (maximum 1200 mm above floor)	1910	1560	1420	1470
		Glazing markings	Markings on fully glazed windows	Done	Done	Done	Done
5	Toilets	Clear floor space in front of fixtures	Minimum 800 * 400 (mm)	1520 *1065	1800 *2000	2170 *1670	1866 *1130
		Toilet stall dimensions	Minimum 1500 *1500 mm	2135 *1570	1660 *1820	1660 *2110	2220 *1680
		Grab bars	Mounted 800–900 (mm) above floor	None	None	None	None
		Washbasin height	Maximum 850 (mm)	810	850	830	830
6	Offices	Clear floor space for wheelchair turning	Minimum 1500 (mm) diameter	960	960	968	–
		Desk height	Maximum 850 (mm)	745	720	750	–
		Controls and switches	Height 900–1200 (mm)	1750	1170	1190	–
		Knee clearance under desks	Minimum 750 high*600 (mm) deep	1110 *670	720*530	670 *710	–
		Accessible seating	Minimum 1 seat per 25 seats	None	None	None	–

7	Classrooms	Clear floor space for wheelchair users	Minimum 800 *1400 (mm)	None	None	1270 *690	–
		Writing boards	Lower edge maximum 900 (mm) above floor	1010	910	920	–
		Acoustics	Background noise minimized, even illumination	None	None	None	–
8	Bookshelves and Returns stations	Maximum height of accessible shelves	Not more than 1350 (mm)	–	–	–	1860
		Book return boxes (dual height: seated/standing)	Must be available	–	–	–	None
		Turning space in front of return boxes	1500*1500 (or 2100*2100 (mm) in renovation cases)	–	–	–	None

Shortcomings of Interior Elements:

- The building entrances lack automatic doors, hindering the movement of wheelchair users with mobility impairments.
- The pathways and corridors in Building 4 are unsafe, and the library lacks edge guards.
- The size of elevators cabin is small, lack accessible door reopening devices, and lack of audio announcement of the floor number for visually impaired users.
- The window height is unsuitable for wheelchair users.
- Grab bars are not available in most of the accessible Toilets
- The turning space in the offices is insufficient for wheelchair users
- The classroom seating does not meet accessibility standards, and the lack of soundproofing.
- The bookshelves and return areas are inaccessible, but the library has a section for students with disabilities.

Table 3. Checklist form of Communication and safety systems

No	Element	Guideline	Standard	Building 4	Building 6	Building 11	Library
1	Signage	Text language (Arabic, English, Braille)	Must be available	Not Compliant	Not Compliant	Not Compliant	Compliant
		Color contrast	Adequate contrast required	Compliant	Compliant	:	Compliant
		Mounting height	(approx. 1700 (mm)	1708	1710	1702	1700

2		Directional signage at corridor turns	must be available	Compliant	Not Compliant	Compliant	Compliant
		Powered exit signs	must be available	Compliant	Compliant	Compliant	Compliant
2	Alarm system	Alarm Types	Manual and automatic systems must be installed	Compliant	Compliant	Compliant	Compliant
		Audible & Visual Alarms	Must be present and operational	Compliant	Compliant	Compliant	Compliant
		Manual Call Point Spacing	Max 30 meters (m) between call points	26	18	25	15
		Manual Alarm Height	100 cm - 140 (cm)	130	120	120	150
		Smoke Detector Spacing	Max 9 meters (m) between detectors	6	3	6	5
3	Emergency Exits	Door Swing Direction	Doors must open outward	Compliant	Not Compliant	Compliant	Compliant
		Number of Exits	At least 4 exits per floor	Compliant	Compliant	Compliant	Compliant
		Door Width	Minimum 81 (cm)	90	100	95	91
		Door Height	Standard: 200 (cm)	200	200	200	200
		Corridor Width	Minimum 110 (cm)	111	130	120	140
		Handle Accessibility	Must be easy to operate	Compliant	Not Compliant	Compliant	Compliant
		Handle Height	85–120 (cm)	100	110	100	85
		Emergency Lighting	Present and functional	Compliant	Compliant	Compliant	Compliant

Shortcomings of Communication and Safety Systems:

- Lack of Braille signage, more directional signs are required in Building 6.
- In library, the alarm systems call points are very high.
- The doors and emergency exit in Building 6 do not open correctly, the handles are unavailable, and there is no emergency lighting.

4. Results and Discussion

As a result of the investigation, suggestions for solutions to the identified problems are as follows:

4.1 Exterior Elements

Sidewalks for all buildings exceed the standard dimension of 1200 mm, except sidewalks of Building 11 that need to be monitored always for crowding issues. Ramps must be modified urgently in Building 4 and Building 6, so in Building 4, the start and end are less than the standard of 1500*1500 mm, and Ramp width of Building 6 is too narrow. Pedestrian crossings in all buildings are very wide but lack ground brands that should be with a width of 300 mm and color contrast with the road, Traffic lights, paving of concrete floors, while providing audiovisual signals. All Vehicle parking spaces need to be redesigned to the special dimensions of Persons with disabilities and canopy installation. The outdoor courtyard of the Faculty of Engineering lacks seating that should comply with street furniture, especially for people with disabilities, and adds some public gathering areas. The outer surfaces of the floors need to be modified to be stable, solid, and non-slip. Garbage boxes are available in all buildings and well distributed. Finally, Exterior Stairs are non-compliant, unsafe for mobility-impaired and handrails either not available or their heights less than the standard dimensions.

4.2 Interior Elements

All main internal entrances are in contrast with surrounding surfaces, and this is required, but lack of automatic doors in all buildings, this barrier for wheelchair and mobility-impaired, installation of these automatic doors is urgent for accessibility for Persons with disabilities. Roads and Corridors are wide enough and exceeds the standard of 1200 mm, but corridors in Building 4 & Library are unsafe and without edge protection this problem can be solve by install kerb where elevation differences exist, this Kerb must be at least 75 mm high if elevation difference is 200–600 mm. The dimensions of Clear width of doors of the Elevators is acceptable, Handrails inside elevator and door reopening device that activates without contact, of suitable height above floor but the priority have to give to upgrade elevators by replace the existing cabins with wider ones equipped with an audio announcement of the floor number to serve the Persons disabilities. All windows in all buildings have Glazing markings, but Operable mechanisms are higher than the standard and the priority must be given to lower window heights to less than 750 mm above floor to accommodate wheelchair users. Toilet stall dimensions and Washbasin height in all buildings are in accepted dimensions, but Grab bars are and need to be installed in all accessible toilets. Sufficient floor space must be provided for wheelchairs with a diameter exceeding 1500 mm to maneuver, and offices should be redesigned to provide adequate space and ease of access. Desks, control panels, and switches at acceptable heights. It has been observed that knee space under desks is below standard in some buildings and this needs to be rectified. Referring to the standard, it must provide accessible seating for people with disabilities with the rate of minimum one seat per twenty-five seats in classrooms, this is not available. Classrooms also must provide floor space for wheelchair users, not less than 800 *1400 mm. Lower writing boards in all buildings by low-profile whiteboards and improve acoustics. The library shelves, which are 1860 mm high, are higher than the standard height of 1860 mm, making them unsuitable for people with disabilities, they also lack book return boxes (dual height: seated/standing) and turning space in front of return boxes

4.3 Communication and Safety Systems

Text language (Arabic, English, Braille) is one of the requirements of signage in all buildings. No comment about the mounting height, directional signage at corridor turns and Powered exit signs except in Building 6. Regarding the Alarm system in buildings, different alarm types of manual and automatic systems were installed, Audible & Visual Alarms are present and operational. Manual Call Point Spacing and Smoke Detector are within the maximum distance between them. The only issue is in alarm call points are too high than the standard in the library. Generally, there is no comment about the Emergency Exits, except some Handles do not operate easy in Building 6. Otherwise, door swing opens outward, at least 4 exits per floor, door width More than 810 mm, Door's height exceeds the limit of 2000 mm, wide Corridor width, accessible Handle Height and Emergency Lighting are present and functional in all buildings.

5. Conclusion

Based on the findings and discussions, several conclusions were drawn. People with disabilities encounter significant challenges within the Faculty of Engineering due to inadequate accessibility in the physical environment. Failure to remove accessibility barriers can negatively affect the academic success of students with disabilities, while ease of mobility is essential to ensure their full participation in educational and extracurricular activities. Students with disabilities have trouble moving freely in outdoor areas because of ramps with insufficient landing space, the absence of tactile ground indicators, traffic signals, and accessible outdoor seating. In addition, slippery floor surfaces and inadequate handrail heights further restrict their mobility. Inside the buildings, major physical barriers include the lack of automatic doors, edge guards, and audio floor announcements in elevators. From a communication perspective, Braille signage is rarely available, and classroom seating does not adequately meet the accessibility requirements of students with disabilities.

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Biography

Ahmed Hassan is an Assistant Professor of Industrial Engineering at the University of Tabuk, Saudi Arabia. He received a BS in Industrial Engineering from Sudan University of Science and Technology, Sudan, an MS in Manufacturing Engineering from Shanghai Jiao Tong University, China, and a Ph.D. in Manufacturing and Automation Engineering from Shanghai Jiao Tong University, China. He brings industry experience as a Production Engineer at Saeed Food Factory, Sudan. His teaching expertise spans Facilities Planning, Manufacturing Processes, Industrial Automation and Production Planning and Control. Hassan's research focus encompasses Facilities Planning, Manufacturing Processes, and healthcare systems.