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Applying Post-Occupancy Evaluation (POE) to investigate Inclusive Design in library spaces.

Case studies: Kharazmi, main library and documentation centre, and the Art and Architecture libraries.

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Abstract: Inclusive architecture aims to create spaces that cater to everyone, regardless of their abilities or disabilities. Public libraries play a pivotal role in this endeavour by providing accessible environments for diverse communities. This study conducts a post-occupancy evaluation (POE) of the inclusivity of three libraries in Shiraz, examining how effectively these libraries cater to the needs of all users through an inclusive design approach. The POE process comprised three steps: planning, implementation, and application. During the planning phase, a checklist of 180 items was compiled and adjusted based on theoretical foundations. These items fell into four general categories: 1-Spatial Design (including spatial design requirements, flooring, ceilings, and walls), 2-Accessibility and Circulation (covering movement paths, ramps, lifts, elevators, and staircases), 3-Amenities and Equipment (such as parking, toilet services, entrances, furniture, and guide signs), 4-Sensory and Atmosphere (addressing lighting, colour, texture, materials, shape, scent, sound, and temperature). In the implementation phase, the evaluation was conducted over three days at the indicator level by a two-person evaluation team. They utilised observation, photography, and metric measurement tools. In the subsequent step, field observations to complete the checklist were carried out, and data entry and analysis were performed using IBM SPSS Statistics 26.0 software. The results indicated that all three libraries (MLDC, Art and Architecture, and Khwarizmi libraries) exhibit several weaknesses in terms of inclusive design. The average inclusiveness scores assigned to them were 37.50%, 35.10%, and 34.35%, respectively. As the achievements of the application phase, it can be summarised that the findings of this study provide a practical example for POE research on inclusive design, offering insights for enhancing inclusivity in architectural environments.

Keywords: Inclusive Design, Post Occupancy Evaluation, POE, library, accessibility, disability.

1. Introduction

The need for inclusivity is far more common than usually perceived. Indeed, nearly all individuals encounter some form of disability or impairment at some point in their lives due to a variety of factors such as accidents, illnesses, aging, or even during childhood. This requires the inclusion of design provisions in the products and spaces around them. According to statistics provided by the World Health Organisation, approximately 15% of the global population have some form of disability, with between 2% and 4% experiencing severe disabilities (WHO, 2011). Similarly, in Iran, statistics related to individuals with disabilities are around 11%, with severe disability statistics cited as 4% of the total population (Aslefallah & Hashemi, 2019). These statistics underscore the need for a greater emphasis on inclusive design.

Indeed, a design approach that emphasises inclusive design principles is essential, considering the widespread presence of individuals with physical and mobility disabilities in all societies. Neglecting the needs and desires of these individuals can be seen as a form of discrimination in design, effectively excluding these groups from the user range of spaces and products (Aslefallah & Hashemi, 2019). This highlights the importance of inclusive design in creating a more equitable and accessible environment for all. These limitations ought not to be viewed as a barrier to individuals' access to their preferred spaces; instead, they should be able to live with utmost independence, devoid of limitations and without the burden of restrictions that ordinary members of society are free from. Adapting spaces for individuals with disability is a demonstration of social justice and safety in access, which, in addition to creating physical and health security, will have remarkable psychological effects (Noroziyan Maleki & Hosseini, 2008).

One of the primary research institutions in society that caters to a broad audience (including children, the elderly, individuals with disabilities, etc.) is the library. It must cater to the needs of all its users to establish social justice. To adequately respond to these needs, utilising inclusive design by creating spaces that provide equal access and use for all users is advantageous. In this context, POE, as 'the most effective building performance evaluation that includes building efficiency during operation' (HEFCE, 2006). Is pertinent for measuring the extent to which the library benefits from inclusive design. In other words, utilising design provisions to address identified problems from POE can enhance the accessibility of architectural spaces for everyone. This makes them more optimal in terms of use, more desirable, and, in a word, more inclusive.

Therefore, it can be stated that the theoretical underpinnings of this research are divided into two primary sections. The first section pertains to the concept of inclusive design and its objectives. The second section offers a clear definition of post-occupancy evaluation and outlines its various stages. This framework provides a comprehensive understanding of the primary keywords of this research. It serves as a foundation for further exploration and analysis.

1.1. Inclusive design

The concept of inclusive design was first introduced in England by Roger Coleman in 1994. He argued that human needs and abilities change throughout life. By considering this in the design process, products, services, and environments can be improved for most audiences. This improvement is not accompanied by negative perceptions of illness or disability. Later, the Design Council of England (2008) defined inclusive design as a general approach. In this approach, designers ensure that their products and services meet the needs of the widest possible range of audiences, regardless of age and ability (Heylighen, Van der Linden, & Van Steenwinkel, 2017).

Indeed, the approach of inclusive design aligns closely with the concepts of universal design, accessible design, and design for all. These principles all advocate for inclusivity and accessibility in design. However, there is a gap in the field when it comes to detailed studies. The specific factors that can be used to evaluate a building from the perspective of inclusive design are not yet fully defined or explained. This presents an opportunity for this research to explore in this area to enhance our understanding and application of these principles in building design and evaluation.

1.2. The Post-Occupancy Evaluation

Post-Occupancy Evaluation (POE) is a systematic and meticulous process used to assess buildings after they have been constructed and occupied for a certain period. This process is centred on the building's occupants and their requirements. It offers insights into the outcomes of past design decisions and the performance of the building that results from these decisions. This understanding lays a robust foundation for the creation of superior buildings in the future (Preiser, White, & Rabinowitz, Post-Occupancy Evaluation (Routledge Revivals), 2015). POE serves a pivotal function in a building's life-cycle, specifically in providing feedback. It encompasses a broad spectrum of activities and advantages, such as evaluating the performance of a building, investigating the correlation between the behaviour of occupants and the utilisation of building resources, optimising the indoor environment for the occupants, making more enlightened decisions about future architectural design, and creating opportunities to strengthen the communication within design teams and their collaborators. However, the assessment of building performance and occupant contentment during the post-occupancy phase is relatively less advanced compared to the evaluation techniques employed during the design phase of a building (Li, Froese, & Brager, 2018).

POE stands out from other building performance evaluations due to its focus on the needs of building occupants. The results of a POE are akin to a treasure trove of instructive lessons. These lessons are invaluable for programs that aim to collect and share information about building successes and failures. The ultimate goal is to enhance the quality and cost-effectiveness of future buildings' life cycles. Ideally, the information gleaned from a POE is utilised in curricula, planning, and new designs to ensure success and prevent the repetition of past mistakes (Preiser, The Evolution of Post-Occupancy Evaluation: Toward Building Performance and Universal Design Evaluation, 2001).

Findings from a variety of studies indicate a lack of consistency in reporting, the employment of methods, tools, and data collected in POE studies. This inconsistency presents a challenge for the field and underscores the need for standardisation in POE practices. This highlights the necessity of the research at hand, as no article has yet scrutinised the topic of POE based on inclusive design. The present article is innovative in this regard (Elsayed, Pelsmakers, Pistore, Castaño-Rosa, & Romagnoni, 2023).

Preiser has categorised post-occupancy evaluation into three levels: "indicative," "investigative," and "diagnostic" POE. Each level consists of three stages: "planning," "conducting," and "applying" (Preiser, White, & Rabinowitz, Post-Occupancy Evaluation (Routledge Revivals), 2015). Figure 1 provides an overall schematic of the post-occupancy evaluation levels, stages, and the effective steps at each level. This approach ensures clarity and ease of understanding.

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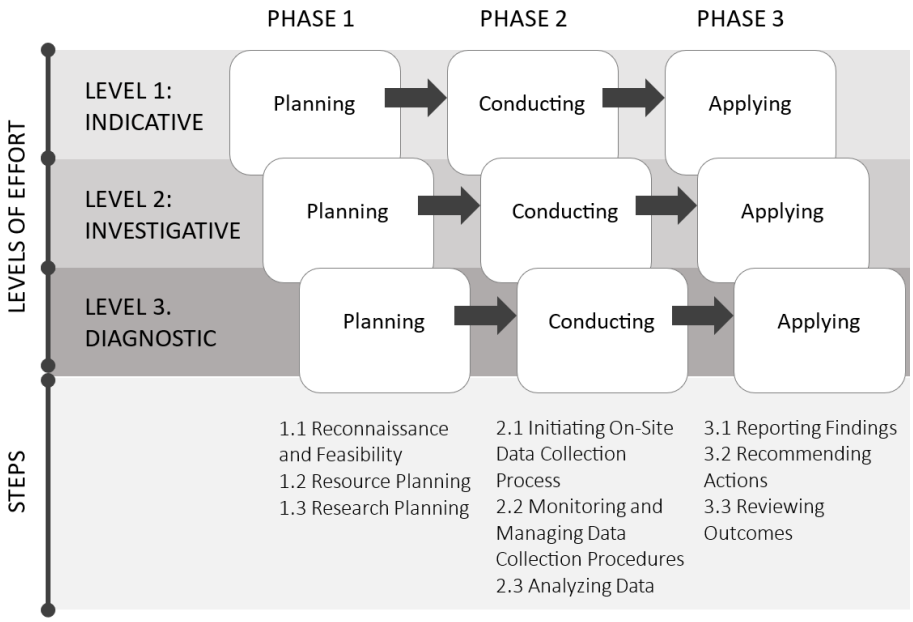
Figure 1. POE process model. Source: (Preiser, White, & Rabinowitz, Post-Occupancy Evaluation (Routledge Revivals), 2015).



2. Methodology

The execution of POE is of paramount importance in the field of architecture and design. It provides a systematic and rigorous approach to understanding how a building or space performs once it is occupied and used. This process allows for the assessment of whether the design objectives have been met and if the space is functioning optimally for its intended users. Furthermore, POE can identify areas for improvement, inform future design decisions, and ultimately contribute to creating more inclusive, accessible, and user-friendly environments. Therefore, the significance of POE cannot be overstated in the pursuit of excellence in architectural design and practice. The POE process unfolds in three primary stages:

1. Planning: This initial stage involves preliminary planning where key elements such as the level of POE, methods and tools for data collection, the number of evaluators, and the time required, and the approach to data collection and interpretation are determined.
2. Implementation: This stage involves conducting field observations and collecting data. A report encompassing the collected data and their interpretation is also prepared during this stage.
3. Application: The final stage presents a summary of the results and offers design recommendations. Each of these stages is elaborated upon in the following sections.

2.1. Phase one: planning

The parameters for conducting the field research were determined at this stage. To achieve this, the following three steps were undertaken:

1. Reconnaissance and Feasibility:
   The aim of this research was to identify the strengths and weaknesses of the sample libraries in terms of inclusive design and to make comparisons. Consequently, among the three levels of Post-Occupancy Evaluation (POE) - indicator, investigative, and diagnostic - the indicator level was chosen. It was anticipated that this level of research would necessitate one to two

days for each sample library studied. The appropriate tool for data collection would be observation and field collection. The case studies were chosen from the libraries of the University of Shiraz in Shiraz city, including the Kharazmi Library (KHL), the Main Library and Documentation Centre (MLDC), and the Art and Architecture Library (AAL). These libraries cater to a wide audience, including students, professors, and many others. Figure 2 displays images of these libraries.

Figure 2. Library images in sequence: KHL, MLDC, AAL.

2. Resource Planning:
   Before the data collection and analysis, a set of assessable criteria and factors for inclusive architectural space design needed to be extracted from the available resources. The extraction of these criteria should ultimately lead to a summarised POE checklist based on an inclusive approach. Alongside this checklist, tools for photography and measurement were required. For this purpose, a camera, a Leica D2 laser meter, and a standard meter were utilised. A two-person team was considered for the evaluation process.
3. Research Planning:
   At this stage, the literature on inclusive design was initially reviewed. An attempt was made to extract an initial checklist for reviewing case samples by categorising this information. In this process, approximately 200 items were extracted, which were reduced to 180 after removing repetitive or highly dispersed items. Then, similar items that were related to measuring the same elements were categorised and formed 20 main factors under evaluation. These factors are placed in four general categories, which are:

   - Spatial Design: Spatial design requirements, floor, ceiling, wall.
   - Accessibility and Circulation: Movement path, ramp and lift, elevator, staircase.
   - Amenities and Equipment: Parking, toilet service, opening, furniture, guide signs.
   - Sensory and Atmosphere: Light, colour, texture and materials, shape and form, scent, sound, temperature.

2.2. Second phase: conducting

This phase was linked to field research and included the subsequent three stages:

1. Launching the On-site Data Collection Process:
   This stage involved data gathering in the chosen libraries. Notably, field surveys for the MLDC, KHL, and AAL of Shiraz University were undertaken on August 3rd, 4th, and 9th, 2022, respectively.
2. Monitoring and Managing Data Collection Procedures:
   The data were meticulously gathered using the tools chosen in the planning phase. To ensure the accuracy of data collection, in each library, checklist data were independently collected by two evaluators. Subsequently, any phrases related to inconsistent responses were re-collected by both evaluators.

3. Data Analysis:
   The data, procured from the surveys, were meticulously processed using the SPSS software, version 26. Each phrase was systematically assigned a binary code; 'one' signified the prevalence of the phrase under review, while 'zero' indicated its absence. This methodology resulted in a binary dataset comprising 180 data points for each library, culminating in an initial dataset of 540 data points. Subsequently, new variables were delineated, each corresponding to one of the 20 factors previously mentioned. The value of each variable was computed as the mean response of the phrases associated with the respective factor. An additional variable, termed 'Overall Inclusiveness', was derived by calculating the mean value of these 20 factors. This rigorous approach to data analysis ensures a comprehensive understanding of the survey results.

2.3. Third phase: applying

In this phase of POE, findings are reported and conclusions are drawn. This stage is composed of three steps:

1. Reporting Findings:
   The discoveries from this stage are detailed in the subsequent section, divided into two categories: descriptive findings and analytical findings.
2. Recommending Actions:
   It's evident that the necessary actions in this step hinge on addressing the shortcomings identified in each library. The analyses conducted in earlier stages yield practical insights for enhancing the current status of the studied samples in terms of inclusive design.
3. Reviewing Outcomes:
   A comprehensive review of the overall results is also provided in the conclusion section. This review provides a basis for future improvements.

3. Results

In the exploration of the research findings, the investigation is divided into two distinct sections. The first section, named as 'Descriptive Findings', is dedicated to presenting the data in a clear and straightforward manner. It provides a succinct summary of the collected data, laying out the facts as they are, without any deeper interpretations or conclusions. The second section, termed 'Analytical Findings', adopts a more in-depth approach. It delves beneath the surface of the data, using statistical tests to scrutinise and interpret the data. The aim of this analysis is to extract meaningful conclusions from the data, thereby aiding in the understanding of the underlying patterns and trends within the data. This comprehensive approach to data analysis ensures a thorough understanding of the research findings.

3.1. Descriptive findings

In this section, the inclusiveness of all items is categorised into four distinct groups:

1. Spatial Design.
2. Accessibility and Circulation.
3. Amenities and Equipment.
4. Sensory Atmosphere.

It should be emphasised that the majority of the figures and specifics mentioned in the ensuing tables are sourced from the book "Urban and Architectural Design Criteria for People with Disability". This book provides a set of guidelines and standards for designing accessible and inclusive urban environments and buildings for people with disabilities (BHRC, 2020).

3.1.1. Spatial design

This category focuses on the physical layout and arrangement of spaces. The factors considered under this category include spatial design requirements, floor, ceiling, and wall. These factors play a crucial role in determining how effectively a space can be navigated and used by all individuals. Table 1 shows the data related to three libraries in the field of Spatial Design.

Table 1. Reviewing inclusivity in the first category: Spatial Design.

Nu	Factor	Item	Item details	KHL	MLDC	AAL
1	Spatial design requirements	Legibility of the placement of various spaces			✓	✓
		Adherence to hierarchy in spatial design				✓
		Utilisation of a specific module in design			✓	
		Expansive vistas and maximum visual connectivity of spaces			✓	
		Implementation of direct and straightforward circulation paths			✓	✓
		Integration of small and large spatial volumes				
		Incorporation of a tranquillity room	At least one			
		Differentiation of spaces with diverse functions			✓	✓
2	Floor	Use of durable materials on the floor			✓	✓
		Non-slip floor coverings		✓	✓	✓
		Smoothness of the floor surface			✓	✓
		No light reflection		✓		✓
		Use of sound-absorbing materials on the floor				
		Control of maximum protrusion on the floor surface	Maximum 2 cm	✓	✓	✓
		Control of maximum distance between floor covering pieces	in: full state: 10 mm/ empty state: 5 mm	✓	✓	✓
		Use of guiding and warning floor coverings				
3	Ceiling	Reducing the ceiling height to adjust the reaction time		✓		✓
		Providing the necessary ceiling height and clearance below suspended objects	Minimum height: 210 cm		✓	✓
		Changing the ceiling height in primary and secondary spaces		✓		
4	Wall	Control of object protrusions on the wall	Maximum 10 cm	✓		
		Placement of handrails at an appropriate height on the wall	Height: 85 and 60 cm			
		Placement of handrails with an appropriate diameter on the wall	Diameter: 3.5 to 4 cm			
		Providing the necessary distance between the handrail and the wall	Maximum 4 cm			
		Absence of sharp objects on the wall		✓		

Table 1 indicates the first spatial design requirement factor comprises 8 items. None of the samples considered combining small and large spaces or including a tranquillity room, key for autism spectrum disorder inclusivity (Karbalaei Hosseini Ghiyasvand, Sattari, Soltanzadeh, & Farahbod, 2018). The KHL struggles with inclusive spatial design due to lack of readability, hierarchy, specific module use, and complex paths. The MLDC excels in spatial design inclusivity. Strengths include clear space location, separated spaces for different uses, direct paths, and open plan for transparency, wide view field, maximum space communication, and specific module use. The AAL also demonstrates hierarchy in spatial layout.

The next factor, floor, encompasses 8 items. All samples overlooked two crucial aspects: sound-absorbing and blind-friendly guiding/warning floor coverings. However, all samples feature non-slip floors. KHL uses diverse floor materials, with parquet in study halls and ceramic in lobbies and communication spaces. The parquet shows wear from furniture movement. In some areas, floor materials change without apparent reason, complicating echolocation for blind individuals. Both the MLDC and AAL use durable, smooth floor materials. The MLDC predominantly uses white ceramic tiles, which can cause glare due to light reflection at certain times (Figure 3).

Figure 3. Floors in the libraries (AAL, MLDC and KHL respectively).

Ceiling design is another important factor in library design. Lowering ceiling height to around 3 meters, as seen in KHL and AAL study halls and open repositories, helps prevent echo and noise (Shabani & Salavatian, 2021). This aspect is less considered in the MLDC Library, with its ceiling exceeding 4.5 meters. Providing necessary ceiling height and at least 2.1 meters clearance under hanging objects is another factor. KHL falls short in some areas with a 1.9-meter ceiling. Changing ceiling height in main and secondary spaces aids blind individuals and other users in distinguishing these spaces. This technique is only applied in KHL Library. In the MLDC, all spaces share the same ceiling height, while the AAL lacks proportionality in ceiling height changes between main and secondary spaces (Figure 4).

Figure 4. Ceilings in the libraries (AAL, MLDC and KHL respectively).

Wall design, comprising 5 items, is another factor. All three examples exhibit a fundamental weakness in this area. Only two items, controlling object protrusion and absence of sharp materials or objects, were observed in the KHL. Controlling wall object protrusion (maximum 10 cm) is crucial for injury prevention. However, some areas in the MLDC and AAL have protrusions exceeding 10 cm, such as bulletin boards or electrical panels. It's also evident that no handrails have been used on the walls in any of the examples (Figure 5).

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Figure 5. Walls in the libraries (AAL, MLDC and KHL respectively).

3.1.2. Accessibility and circulation

This category pertains to how easily individuals can move within and between spaces. Factors such as movement path, ramp and lift, elevator, and staircase are considered under this category. These factors are critical in ensuring that all individuals, including those with mobility impairments, can access and use the spaces without difficulty. Table 2 presents data on accessibility and circulation for three libraries.

Table 2. Reviewing inclusivity in the second category: Accessibility and Circulation.

Nu	Factor	Item	Item details	KHL	MLDC	AAL
1	Movement path	Inclusiveness of corridor path width	Corridor: minimum 180 cm- appropriate size: 250 cm		✓	✓
		Control of transverse slope of paths	Maximum 2 percent	✓	✓	✓
		Control of longitudinal slope of paths	Maximum 5 percent	✓	✓	✓
		Providing an inclusive emergency exit				
2	Ramp and lift	Placement of the ramp near the entrance and parking				
		Control of ramp slope	Up to length: - 300 cm: 8 percent - 500 cm: 7 percent - 800 cm: 6 percent - 900 cm: 5 percent			
		Providing sufficient ramp width	Minimum 120 cm	✓		✓
		Control of ramp length	Maximum 900 cm			
		Provide minimum depth of step	Minimum 150 cm			
		Providing a minimum tread depth	Less than 5 mm	✓		✓
		Control of ramp railing height	Height: 85 and 60 cm			
		Providing a protective edge with an appropriate height	Height: 5 cm	✓		✓
		Installation of tactile colour indicators with a distinct texture at the beginning and end of the ramp	Width of strip: 4-5 cm			
		Providing the necessary dimensions for the lift	Minimum 90 by 120 cm			
		Control of maximum level difference for using the lift	Maximum 200 cm			
		Closing the space under the platform	Fully enclosed			
		Control of lift handrail height	Height: 85 and 60 cm			
3	Elevator	Placement of elevators on all floors				

Nu	Factor	Item	Item details	KHL	MLDC	AAL
		Levelling the elevator floor with the tread of each floor		✓	✓	
		Providing sufficient dimensions for the waiting space in front of the elevator	Minimum 150 by 150 cm	✓	✓	
		Providing sufficient dimensions for the elevator cabin	Minimum 110 by 140 cm			
		Control of door width and location	- Width of opening door: minimum 80	✓	✓	
		Use of automatic sliding doors for elevators			✓	
		Installation of a folding chair inside the elevator				
		Installation of a mirror inside the elevator		✓	✓	
		Placement of elevator handrails at an appropriate height	85 cm			
		Control of elevator control button height	Height: 100 to 120	✓	✓	
		Control of distance between elevator control buttons and corners	Distance from corner: 40			
		Control of diameter of elevator control buttons	Minimum diameter: 3	✓	✓	
		Control of protrusion of elevator control buttons	Projection: 1.5			
4	Staircase	Use of straight stairs as much as possible			✓	✓
		Uniformity of tread depth and stair height		✓	✓	✓
		Installation of a protective edge next to the stairs		✓		
		Providing a minimum stair width	Minimum 120 cm	✓	✓	✓
		Control of tread dimensions	30 cm	✓	✓	✓
		Control of stair height	Maximum 17 cm		✓	✓
		Closing the stair riser		✓	✓	✓
		Control of maximum stair protrusion from riser	Maximum 3 cm	✓	✓	✓
		Control of tread edge radius	Maximum 13 mm	✓	✓	✓
		Providing a minimum landing dimension	120 by 120 cm	✓		✓
		Control of the number of steps in each arm	Maximum 12	✓		
		Installation of a handrail at an appropriate height on the stairs	Height: 85 and 60 cm			
		Presence of tactile indicators with a distinct texture on the stairs		✓	✓	
		Avoid creating unnecessary stairs				✓

According to Table 2, another factor is the movement path. The MLDC and AAL meet inclusive standards for path width and slope. However, KHL falls short in some areas, with path widths less than the required 1.8 meters. Despite this, the library's path slopes, under 2% transversely and 5% longitudinally, are commendable. Unfortunately, none of the libraries feature inclusive emergency exits, compromising user safety (Figure 6).

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Figure 6. Movement paths in the libraries (AAL, MLDC and KHL respectively).

Ramps and lifts are crucial for accessibility, especially for those with physical disabilities. Regrettably, all three libraries fall short in this regard. The MLDC lacks a ramp to the first-floor entrance, leaving a long staircase as the only access point. The other two libraries do have ramps, but they fail to meet necessary standards, with only the width, step dimensions, and edge guard appropriately designed. Critical aspects such as ramp location, slope, length, railing height, handrails, and tactile indicators are significantly lacking. Furthermore, none of the libraries have lifts for main entrance access (Figure 7).

Figure 7. Ramps in the libraries (AAL and KHL respectively).

The evaluation of the elevators in the libraries reveals several shortcomings. The AAL, located on the second floor, lacks an elevator. KHL's elevators serve alternate floors, necessitating stair use or multiple elevator trips. Other issues include non-sliding doors, narrow door width (70cm), small cabin dimensions (100x80cm), absence of a folding chair and handrail, and poorly placed control buttons. The MLDC lacks a ground floor accessible elevator, and its cabin dimensions (90x150cm), high handrail height (95cm), and lack of a folding chair further reduce inclusivity. However, both the MLDC and KHL provide ample waiting space, floor-level access, mirrors, and appropriately sized and placed control buttons (Figure 8).

Figure 8. Elevators in the libraries (MLDC and KHL respectively).

While the design of staircases in the libraries incorporates many inclusive features, there are notable shortcomings. None of the libraries have handrails at two necessary heights and on both sides. The MLDC and AAL feature straight staircases with over 12 steps without intermediate treads or protective edges. KHL's design includes unnecessary breaks and interior stairs exceeding the standard height of 17cm by 1cm. Tactile indicators on the tread edges are present in KHL and MLDC but absent in the AAL. Unnecessary stairs and level differences are prevalent in KHL, and the MLDC has stairs at toilet entrances and within (Figure 9).

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Figure 9. Staircases in the libraries (AAL, MLDC and KHL respectively).

3.1.3. Amenities and Equipment

This category includes factors that contribute to the functionality and usability of the space. Factors such as parking, toilet service, opening, furniture, and guide signs fall under this category. Table 3 presents data on amenities and equipment for three libraries.

Table 3. Reviewing inclusivity in the third category: Amenities and Equipment.

Nu	Factor	Item	Item details	KHL	MLDC	AAL
1	Parking	Providing a sufficient number of disabled parking spaces	Number: 4 percent of total			
		Ensuring the necessary dimensions for disabled parking spaces	Parking width: minimum 350 cm			
		Controlling the distance from parking to the entrance of the building	Minimum possible distance	✓		✓
2	Toilet service	Providing the necessary number of disabled toilets	Number: 10 percent of total			
		Providing the minimum necessary dimensions for disabled toilets	Minimum 150 by 170 cm			
		Control of toilet bowl height from the floor	45 cm			
		Control of distance between toilet bowl and adjacent wall	Minimum 30 cm			
		Placement of horizontal auxiliary handrails on both sides of the bowl				
		Control of horizontal auxiliary handrail height	70 cm			
		Control of protrusion of horizontal auxiliary handrail from bowl edge	20 cm			
		Placement of vertical auxiliary handrail on adjacent wall to bowl				
		Control of distance between vertical auxiliary handrail and front edge of bowl	30 cm			
		Control of vertical auxiliary handrail height from bowl seat level	40 cm			
		Control of vertical auxiliary handrail height swing range	80 to 40 cm from the floor			
		Providing the necessary space in front of the sink	75 by 120 cm	✓	✓	✓
		Control of faucet distance from sink front edge	60 cm	✓	✓	✓
		Control of free space height under sink	75 cm	✓	✓	✓
		Control of free space depth under sink	- for knee: 20 cm - for toe tip: 45 cm	✓	✓	✓
		Placement of sink mirror at an appropriate height from the floor	90 cm			✓

Nu	Factor	Item	Item details	KHL	MLDC	AAL
		Considering outward opening direction for doors				
		Placement of handrails on doors				
		Installation of emergency bell in disabled toilet at an appropriate height	Maximum 120 cm			
		Control of hanger and shelf height	Maximum 120 cm			
		Control of soap and electric dryer height	Maximum 100 cm			
3	Opening	Providing the minimum required width for the main entrance	Minimum 100 cm	✓	✓	
		Control the width of other entrances	Minimum 80 cm	✓	✓	✓
		Control the opening angle of doors	Minimum 90 degrees		✓	✓
		Control the maximum height of door thresholds	Maximum 2 cm	✓	✓	✓
		Avoid using revolving, rotary, sliding doors		✓	✓	
		Consider a low footrest with a suitable height	Low door sill height: 25 cm		✓	
		Control the height of door handles	90 cm			
		Lever type door handles		✓	✓	✓
		Control the distance of the handle from the door surface	3.5 to 7 cm	✓	✓	✓
		Provide handrails on doors at a suitable height	At a height of 85 cm, with a length of 30 to 65 cm			
		The mechanism of opening and closing the door is automatic, gravity or spring type				
		Placement of coloured signs on glass openings				
		Control the height of windows from the floor	Maximum 80 cm			
		Use double or multi-walled windows				
		Sufficient dimensions of windows to provide natural view and lighting			✓	✓
4	Furniture	Control the height of the loan desk surface	Maximum 90 cm		✓	
		Control the height of the free space under the loan desk	Between 70 and 85 cm		✓	
		Control the depth of the free space under the loan desk	50 cm			
		Provide a sufficient number of tables and benches	Number: 5 percent of total	✓	✓	
		Provide suitable dimensions for the surface of study tables	Minimum 75 by 50 cm	✓	✓	✓
		Control the height of the surface of study tables	Minimum 70 cm	✓	✓	✓
		Control the height under study tables	Between 70 and 85 cm	✓	✓	✓
		Control the height of shelves and cabinets	Accessible height: 40 to 120 cm	✓	✓	
		Control the height of free space under drinking fountains	Minimum 70 cm			✓
		Control the depth of free space under drinking fountains	Minimum 45 to 50 cm			✓
		Control the maximum height of drinking fountain fountains	90 cm			

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Nu	Factor	Item	Item details	KHL	MLDC	AAL
		Provide free space in front of drinking fountains	75 by 120 cm	✓	✓	✓
5	Guide signs	Presenting information with simple words and readable font		✓		
		Presenting information in various visual and auditory forms				
		Placement of user guide signs on each floor			✓	
		Placement of floor signs on the wall opposite the elevator door				
		Installation of tactile exit signs				
		Installation of tactile warning signs on doors in hazardous spaces				
		Equipping elevator floor buttons with Braille lines				
		Using signs in emergencies to guide people on their way out				
		Considering the limitations of people with colour blindness in sign design		✓	✓	
		Using audio and visual warning systems			✓	
		Installing signs at a suitable height	Between 140 to 170 cm			
		Simplicity of equipment and providing usage instructions			✓	

Table 3 reveals that parking is a key factor under review, with three considerations for inclusive design: the number of disabled parking spaces, standard dimensions for allocated parking, and proximity of parking to the entrance. None of the libraries studied offer dedicated disabled parking spaces, which should ideally be a marked 2.5m-wide space for car parking, with an adjacent 1m-wide passage. In all cases, parking is employee-only. The MLDC's covered parking is a significant 150m from the entrance, a distance that, coupled with lack of route coverage, poses difficulties even for employees. However, the KHL and AAL have more favourable distances (Figure 10).

Figure 10. Parking areas of the libraries (AAL, MLDC and KHL respectively).

Toilets are another key factor in this study. All libraries studied have significant shortcomings in this area, as none have toilets designed for disabled users. Common issues include inward-opening doors, lack of auxiliary handrails, absence of emergency bells, and non-standard heights for shelves, hangers, and soap dispensers. The KHL and AAL lack toilets on all floors. All libraries meet necessary standards for sinks and faucets. While mirrors are present in all libraries, only the Art and Architecture Library's mirror is at an appropriate height (90cm) (Figure 11).

Figure 11. Toilets in the libraries (AAL, MLDC and KHL respectively).

Doors and windows, crucial to this study, meet standards for interior door width, door thresholds, handle types, and handle distance from the door surface across all libraries. However, KHL struggles with stiff revolving doors, less than 90-degree opening sanitary service doors, high handle heights, absence of coloured strips on glass doors, and lack of door handrails. The MLDC shares similar issues, with high handle heights, lack of door handrails, stiff revolving doors, and no warning strips on glass doors. The AAL's main entrance width is often less than the required 1m, and the sliding door at the study hall entrance could be better replaced with easy-to-open revolving or automatic doors. Issues also exist with handle height on doors, door handrails, and warning signs on glass doors. Window dimensions are satisfactory in the MLDC and AAL, but KHL's small, deep, and generally closed windows limit natural light and airflow (Figure 12).

Figure 12. Doors in the libraries (AAL, MLDC and KHL respectively).

The twelfth factor in this study is furniture, which includes the loan desk, study tables and benches, shelves and cabinets, and drinking fountains. The MLDC has a loan desk that meets the first two standards for height and under-desk space. However, all libraries have shortcomings in other areas. While all libraries use inclusive furniture, the AAL does not have group study tables in the study hall. The height of storage cabinets varies in all three libraries, catering to a wide range of users. The AAL's open repository has upper shelves that are too high for wheelchair users to reach. Despite sufficient space around the drinking fountains, their dimensions and height make them difficult to access for some users (Figure 13).

Figure 13. Furniture in the libraries (AAL, MLDC and KHL respectively).

Guide signs are crucial in inclusive design as they enhance readability, accessibility, and security. The MLDC excels in this area by providing user guide signs on each floor, considering colour blindness limitations, and using audio-visual warning systems. However, information is presented in small fonts and only visually, and glare sometimes hinders readability. The KHL offers clear

signage due to suitable font and dimensions, but lacks user guides on each floor and diverse information formats. The Art and Architecture Library lacks designed guide signs altogether, with space names merely placed on paper or small boards above doors (Figure 14).

Figure 14. Guide signs in the libraries (AAL, MLDC and KHL respectively).

3.1.4. Sensory and Atmosphere

This category relates to the sensory experiences within the space. Factors such as light, colour, texture and materials, shape and form, scent, sound, and temperature are considered under this category. These factors can greatly influence the overall atmosphere of the space and the comfort and well-being of its users. Table 4 shows the data related to three libraries in the field of sensory and atmosphere.

Table 4. Reviewing inclusivity in the fourth category: Sensory and Atmosphere.

Nu	Factor	Item	KHL	MLDC	AAL
1	Light	Adequate use of natural and artificial light		✓	✓
		Avoiding intense and dazzling light	✓		✓
		Using light and shadow contrast to display the separation of environments			
		Using lighting to display the separation between floor, ceiling and wall elements			
		Using lighting to display the path and guide the individual			
		Using coloured lights to indicate danger in the event of an accident			
		Avoiding rhythmic or patterned sequences of light and shadow		✓	✓
		Using light dimmers			
		Using light intensity control panels			
		Indirect, extensive and decentralised lighting			
		Not using fluorescent lamps	✓	✓	
2	Colour	Using a specific colour palette in design		✓	
		Using natural colours			
		Using colours with less light reflection	✓		✓
		Using colours that are in contrast to skin colour in space design		✓	✓
		Appropriate colours for people with autism			
		Using a variety of symbolic colours to identify specific spaces			
		Using furniture with a specific colour in each space			
		Benefiting from guiding coloured lines from the lobby to spaces			
		Colour difference between wall, floor and ceiling or using coloured strips at the connection point	✓		✓
		Colour difference between doors and their frames with adjacent walls	✓	✓	
		Colour distinction between columns and walls			✓

Nu	Factor	Item	KHL	MLDC	AAL
		Colour difference between baseboards and up and down stairs or colour difference between the front edge of stairs			
		Colour difference between elevator control buttons and background colour	✓	✓	
		Colour difference between handrail bars and surrounding environment		✓	
3	Texture and materials	Using natural textures and materials (wood, stone, brick and ...)			
		Using soft textures instead of rough and harsh textures	✓	✓	✓
		Using materials with distinct texture on floor, wall and ceiling surfaces	✓	✓	✓
		Changing floor materials in different spaces (echolocation technique)	✓		
4	Shape and form	Using symmetry in design			✓
		Using repetition in design		✓	✓
		Using rhythm in design		✓	
		Using readable shapes and familiar geometries		✓	✓
		Using organic forms or fractal design			
		Using soft and curved corners		✓	
		Using human scale	✓	✓	✓
		Establishing clear relationships in design		✓	✓
		Avoiding creating unnecessary breaks			✓
		Establishing communication between horizontal, vertical and oblique elements in design		✓	
		Coordination and coherence between different parts to create a single unit		✓	
5	Scent	Using natural materials with a desirable scent			
		Using fragrant flowers and plants in space			
		Preventing the mixing of different smells in space	✓	✓	✓
6	Sound	Preventing noise pollution			
		Using a sound amplification system			
		Using the sound of natural elements			
		Changing the shape, dimensions, distance and depth of space to change the acoustic pattern	✓		
7	Temperature	Changing heat and humidity in different spaces			
		Distinguishing the temperature of materials on different surfaces			

Lighting is key in library design. The KHL Library uses skylights, the MLDC balances natural and artificial light, and the AAL controls glare. However, all libraries lack features like light contrast for space delineation, coloured warning lights, and dimmers. Some spaces in KHL lack natural light, and its windows can disrupt those with autism. The MLDC's study space has intense light, and the Art and Architecture Library's fluorescent lights can be noisy for sound-sensitive individuals (Figure 15).

Figure 15. Lights in the libraries (AAL, MLDC and KHL respectively).

The colour factor, with 14 items, lacks inclusive design in 6 aspects across all libraries. However, KHL uses colour contrasts between walls, floors, door frames, and elevator buttons, and less reflective floor colours. The MLDC uses a specific palette and skin-tone contrasting colours to aid the deaf. The AAL uses less reflective colours and maintains colour distinction between walls, ceilings, and floors (Figure 16).

Figure 16. Colours in the libraries (AAL, MLDC and KHL respectively).

The subsequent consideration pertains to texture and materials. All libraries have focused on two aspects: the preference for soft textures over rough ones, and the differentiation of materials or textures on the floor, walls, and ceiling. Despite the visual confusion caused by the extensive texture variety in KHL, this diversity enhances echolocation techniques by altering floor materials (Figure 17).

Figure 17. Texture and materials in the libraries (AAL, MLDC and KHL respectively).

Research indicates that creating order in design can enhance the capabilities of individuals with attention disorders. Indeed, Karami and Ardalan have identified key concepts that contribute to the establishment of order in design (Karami & Ardalan, 2015). These include symmetry, hierarchy, repetition, rhythm, unity (which involves coordination and coherence), and axis (which provides direction). These principles are fundamental in shaping form and structure in design. They play a crucial role in enhancing the abilities of individuals with attention disorders when applied effectively in the designed environment. In this context, the MLDC and AAL outperform the KHL. The latter's strength lies in its use of human scale. Its exterior design is simple and readable, thanks to a hierarchical approach, use of familiar shapes, repetition, and relative symmetry. However, these elements are absent in its interior design. Conversely, the MLDC uses repetition and rhythm in both exterior and interior designs, resulting in a comprehensive form.

The AAL also employs symmetry, repetition, readable shapes, human scale, and proportionality, while avoiding unnecessary breaks (Figure 18).

Figure 18. Forms in the libraries (AAL, MLDC and KHL respectively).

The scent factor is less emphasised in the samples. This could be improved by using fragrant plants. A strength is the prevention of unwanted odours in the library. The next factor is sound. In this field, several items were scrutinised in this regard: the conspicuous absence of natural sound elements such as water, the deficiency in sound control and amplification systems, and the ineffectiveness of strategies aimed at mitigating noise pollution. It was observed that these limitations were prevalent across all three samples under investigation. The last factor under investigation is temperature. It aids audiences, particularly the visually impaired, in understanding spaces and their elements through touch. This involves variations in heat and humidity across different spaces and temperature differences on various surfaces. Unfortunately, these aspects have not been purposefully incorporated into the design of the studied libraries.

Table 5 present the POE data on inclusive design in the selected libraries. The overall inclusivity scores are low, with the MLDC, AAL, and KHL scoring 37.5%, 35.10%, and 34.35% respectively, highlighting design weaknesses. The inclusivity percentages for the four assessed categories are: Accessibility and Circulation (45.34%), Spatial Design (42.34%), Amenities and Equipment (30.14%), and Sensory and Atmosphere (28.67%).

Table 5. Summary of data procured from post-occupancy evaluation, grounded on the principles of inclusive design.

Category	Factor	Inclusivity ratio			Cumulative inclusivity ratio	Inclusivity percentage	Category inclusivity percentage
Library name		KHL	MLDC	AAL			
Spatial Design	Spatial design requirements	0.00	0.63	0.50	1.13	37.67%	42.34%
	Floor	0.50	0.63	0.75	1.88	62.67%	
	Ceiling	0.67	0.33	0.67	1.67	55.67%	
	Wall	0.40	0.00	0.00	0.40	13.33%	
Accessibility and Circulation	movement path	0.50	0.75	0.75	2.00	66.67%	45.34%
	ramp and lift	0.23	0.00	0.23	0.46	15.33%	
	elevator	0.38	0.54	0.00	0.92	30.67%	
	staircase	0.71	0.64	0.71	2.06	68.67%	
Amenities and Equipment	parking	0.33	0.00	0.00	0.33	11.00%	30.14%
	toilet service	0.19	0.19	0.24	0.62	20.67%	
	opening	0.40	0.60	0.40	1.40	46.67%	
	furniture	0.50	0.67	0.50	1.67	55.67%	
	guide signs	0.17	0.33	0.00	0.50	16.67%	

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Category	Factor	Inclusivity ratio			Cumulative inclusivity ratio	Inclusivity percentage	Category inclusivity percentage
Sensory and Atmosphere	light	0.18	0.27	0.27	0.72	24.00%	28.67%
	colour	0.29	0.36	0.29	0.94	31.33%	
	texture and materials	0.75	0.50	0.50	1.75	58.33%	
	shape and form	0.09	0.73	0.55	1.37	45.67%	
	scent	0.33	0.33	0.33	0.99	33.00%	
	sound	0.25	0.00	0.00	0.25	8.33%	
	temperature	0.00	0.00	0.00	0.00	0.00%	

Figure 19 illustrates the percentage of scores allocated to each component for every library. The chart reveals a significant diversity in the inclusivity levels of the factors, with scores ranging from 0 to 75%. This chart allows a comparison between the libraries in terms of the inclusivity level of each factor. For instance, in the case of the 'Circulation Path' factor, both the AAL and the MLDC are 75% inclusive, while the KHL is 50% inclusive.

Figure 19. Comparative chart of the level of inclusivity of each factor by libraries.

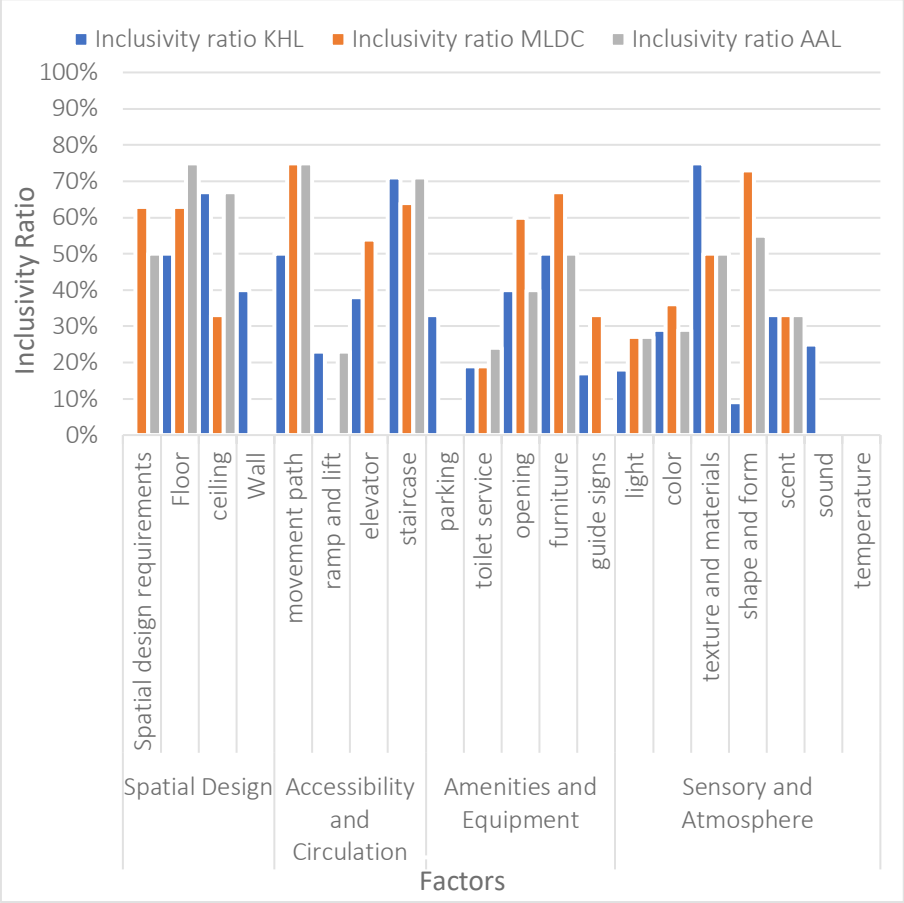

Figure 20 provides a comprehensive summary of all the samples under consideration, enabling the ranking of factors based on their cumulative inclusivity percentage. The chart indicates that the cumulative inclusivity is as follows: Staircase, Movement Path, Floor, Texture and Materials, Ceiling, Furniture, Openings, Shape and Form, Spatial Design, Scent, Colour, Elevator, Light,

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Parking, Restroom, Signage, Ramp and Lifts, Wall, Sound, and Temperature. This chart suggests that in initial cases such as staircases, movement paths, or floors, minor modifications can enhance the level of inclusivity. However, in final cases, substantial changes are required.

Figure 20. Cumulative inclusivity percentage chart of libraries for each factor.

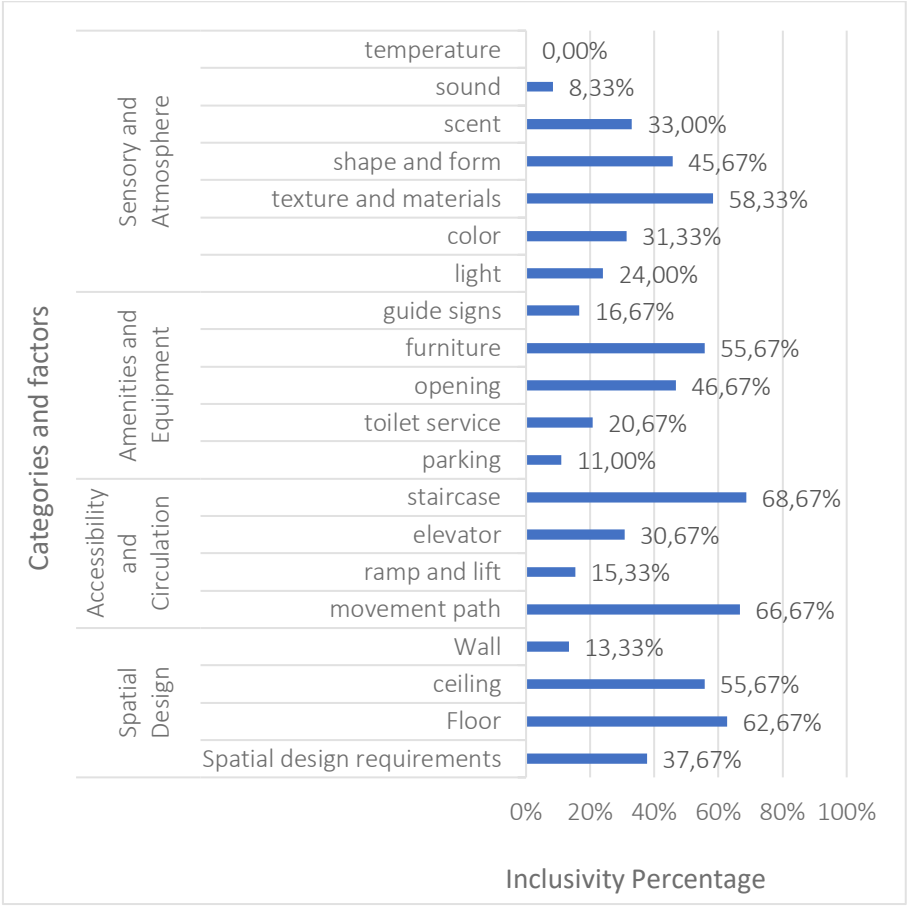
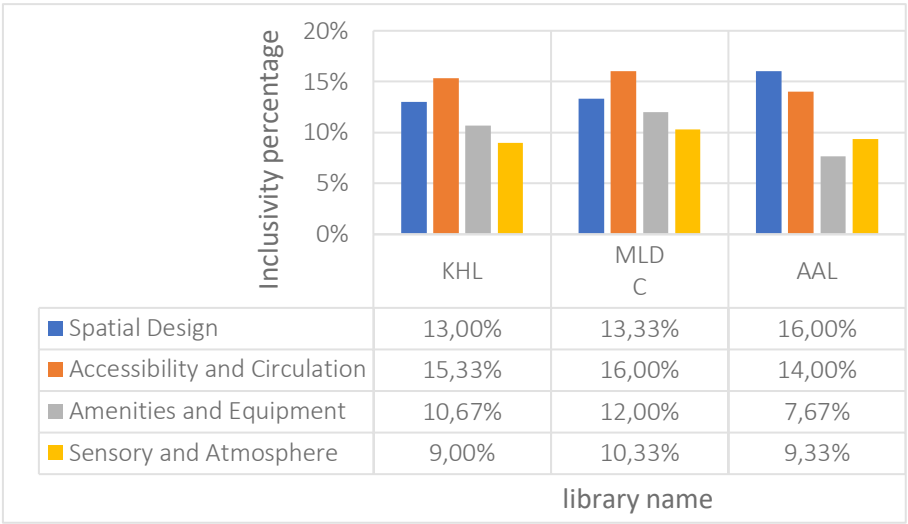


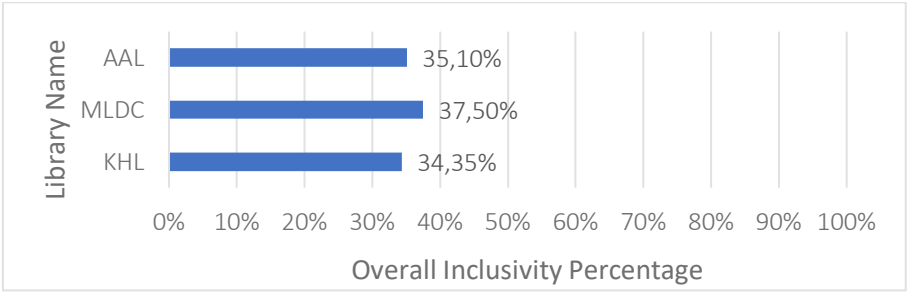
Figure 21 presents a comparative chart of the inclusiveness of four categories. For instance, it suggests that in the Main Library, the categories of Accessibility and Circulation are more inclusive than the other three categories.

Figure 21. Comparative chart of the inclusiveness of the four categories.



As previously noted, all the samples under investigation exhibit a few strengths and numerous weaknesses in terms of inclusive design. However, based on the preceding charts, it's not possible to rank them in terms of overall inclusivity. Consequently, the subsequent chart compares the overall inclusivity of the samples under investigation, assuming equal value for each item. According to Figure 22, the MLDC, AAL, and KHL have inclusivity levels of 37.50%, 35.10%, and 34.35% respectively.

Figure 22. Comparison of overall inclusivity percentage of libraries.



The low values obtained reaffirm the hypothesis that there is a significant deficiency in inclusive design across all the samples under investigation. Furthermore, due to the minimal difference between the results obtained, it appears that there is no significant difference in terms of inclusivity among these libraries. This needs to be verified with a statistical test. The following section, titled 'Analytical Findings', is dedicated to conducting such statistical tests.

3.2. Analytical findings

This section presents a data analysis conducted using statistical hypothesis tests in SPSS version 26. It's important to note that due to the non-normal distribution of the statistical population (asymmetric triadic data), comparisons should be made using nonparametric methods. The data measurement level is considered ordinal. The significance of the differences between the samples studied has been measured on four different scales. These scales, in order from part to whole, are:

1. Factor Inclusiveness per Library: This measures the significance of the difference between the inclusiveness of factors for each library.
2. Cumulative Factor Inclusiveness: This represents the cumulative inclusiveness of factors.
3. Category Inclusiveness per Library: This denotes the inclusiveness of four categories for each library.
4. Overall Inclusiveness: This signifies the overall inclusiveness of the data.

3.2.1. Factor Inclusiveness per Library

This test compares each factor across the three libraries. All three libraries are evaluated, but the scale for measuring their differences is confined to each factor. Given the independence of the samples and the three-way comparison, the Kruskal-Wallis test is apt for this measurement. The Kruskal-Wallis test, a non-parametric rank-based test, can ascertain whether there are statistically significant differences between two or more groups on a continuous or ordinal dependent variable. Table 6 presents the results of this test on 20 factors studied. The significance value for all cases exceeds 0.05, indicating no significant difference in the inclusiveness of factors.

Table 6. The Kruskal-Wallis statistical test for measuring factor inclusiveness per library.

Nu	Factors	Kruskal-Wallis H	df	Asymp. Sig.
1	Spatial design requirements	2.000	2	0.368
2	Floor	2.000	2	0.368
3	Ceiling	2.000	2	0.368
4	Wall	2.000	2	0.368
5	movement path	2.000	2	0.368
6	ramp and lift	2.000	2	0.368
7	elevator	2.000	2	0.368
8	staircase	2.000	2	0.368
9	parking	2.000	2	0.368
10	toilet service	2.000	2	0.368
11	opening	2.000	2	0.368
12	furniture	2.000	2	0.368
13	guide signs	2.000	2	0.368
14	light	2.000	2	0.368
15	colour	2.000	2	0.368
16	texture and materials	2.000	2	0.368
17	shape and form	2.000	2	0.368
18	scent	2.000	2	1.000
19	sound	2.000	2	0.368
20	temperature	2.000	2	1.000

3.2.2. Cumulative Factor Inclusiveness

This test compares 20 factors in pairs cumulatively to ascertain if a significant difference exists between them. Given the variables are dependent with three repetitions (for each library), the Friedman Test was employed. The Friedman test, a non-parametric test, is used to compare three or more dependent or correlated groups measured at least at the ordinal level. Table 7 presents the test statistic or the final results of the Friedman ranking test. It's evident that there is a significant difference between the average cumulative inclusiveness of the factors in this study, as the significance value obtained is 0.003, which is less than 0.05.

Table 7. The Friedman test for measuring cumulative factor inclusiveness.

Related-Samples Friedman's Two-Way Analysis of Variance by Ranks Summary	
Total N	3
Test Statistic (Chi-Square)	40.054
Degree Of Freedom (df)	19
Asymptotic Sig. (2-sided test)	.003

Upon confirming the significance of the difference in cumulative inclusiveness of factors, pairwise comparisons were conducted. The Friedman test examined 190 cases for pairwise comparison among 20 factors, with significant differences detected in 37 cases. These are listed in Table 8.

Table 8. Pairwise comparison between the cumulative inclusiveness of factors.

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.
Temperature - Shape and form	10.167	4.830	2.105	.035
Temperature - Opening	10.667	4.830	2.208	.027
Temperature - Ceiling	12.167	4.830	2.519	.012
Temperature - Texture and materials	12.833	4.830	2.657	.008
Temperature - Furniture	13.500	4.830	2.795	.005

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.
Temperature - Floor	14.500	4.830	3.002	.003
Temperature - Stairs	15.500	4.830	3.209	.001
Temperature - Path of movement	16.000	4.830	3.312	.001
Sound - Opening	9.500	4.830	1.967	.049
Sound - Ceiling	11.000	4.830	2.277	.023
Sound - Texture and materials	11.667	4.830	2.415	.016
Sound - Furniture	12.333	4.830	2.553	.011
Sound - Floor	13.333	4.830	2.760	.006
Sound - Stairs	14.333	4.830	2.967	.003
Sound - Path of movement	14.833	4.830	3.071	.002
Ramp and lift - Ceiling	10.333	4.830	2.139	.032
Ramp and lift - Texture and materials	-11.000	4.830	-2.277	.023
Ramp and lift - Furniture	-11.667	4.830	-2.415	.016
Ramp and lift - Floor	12.667	4.830	2.622	.009
Ramp and lift - Stairs	-13.667	4.830	-2.829	.005
Ramp and lift - Path of movement	14.167	4.830	2.933	.003
Signage - Furniture	10.000	4.830	2.070	.038
Signage - Floor	11.000	4.830	2.277	.023
Signage - Stairs	12.000	4.830	2.484	.013
Signage - Path of movement	12.500	4.830	2.588	.010
Wall - Furniture	-9.500	4.830	-1.967	.049
Wall - Floor	10.500	4.830	2.174	.030
Wall - Stairs	-11.500	4.830	-2.381	.017
Wall - Path of movement	12.000	4.830	2.484	.013
Light - Floor	10.000	4.830	2.070	.038
Light - Stairs	11.000	4.830	2.277	.023
Light - Path of movement	11.500	4.830	2.381	.017
Bathroom service - Floor	9.500	4.830	1.967	.049
Bathroom service - Stairs	10.500	4.830	2.174	.030
Bathroom service - Path of movement	11.000	4.830	2.277	.023
Parking lot – Stairs	-10.000	4.830	-2.070	.038
Parking lot – Path of movement	-10.500	4.830	-2.174	.030

3.2.3. Category Inclusiveness per Library

This test compares the inclusiveness of four categories in pairs to determine if there is a significant difference between them. The Kruskal-Wallis test was used for this comparison. According to Table 9, the significance value obtained is 0.368, which is greater than 0.05. Therefore, no significant difference can be observed between the inclusiveness of the libraries in terms of the four groups under measurement.

Table 9. The Kruskal-Wallis statistical test for measuring category inclusiveness per library.

Category	Spatial Design	Accessibility and Circulation	Amenities and Equipment	Sensory and Atmosphere
Total N	3	3	3	3
Test Statistic	2.000	2.000	2.000	2.000
Degree Of Freedom	2	2	2	2
Asymptotic Sig. (2-sided test)	.368	.368	.368	.368

3.2.4. Overall inclusiveness

The results of this test are useful for overall comparison between the three libraries. If a significant difference exists, it can be inferred that one or two libraries are superior to others in terms of inclusive design. For this comparison, the Kruskal-Wallis test was used, considering that three independent samples (three libraries) needed to be compared. The results of the Kruskal-Wallis test, as shown in Table 10, indicate that the significance value obtained is 0.368, which is greater than 0.05. Consequently, it can be stated that statistically, there is no significant difference between the inclusiveness of the libraries under consideration, and the samples cannot be ranked based on their inclusiveness.

Table 10. The Kruskal-Wallis statistical test for overall inclusiveness comparison.

dependent-Samples Kruskal-Wallis Test Summary	
Total N	3
Test Statistic	2.000
Degree Of Freedom	2
Asymptotic Sig. (2-sided test)	.368

Statistical tests have demonstrated that there is no significant difference in the overall inclusiveness of libraries or the inclusiveness of each factor individually in the samples studied. However, significant differences can be observed in the cumulative inclusiveness of certain factors. This suggests that in all three samples studied, some factors such as shape and form, opening, ceiling, texture and materials, furniture, floor, stairs, and movement path have been better designed in terms of inclusive design than other factors such as temperature or sound. These statistics provide guidance on prioritisation when addressing the shortcomings of these libraries.

4. Conclusions

The importance of inclusive design in architectural practice cannot be overstated. It is a critical approach that caters to the widest possible range of users, ensuring that spaces are accessible and user-friendly for all, regardless of their abilities or disabilities. This is particularly pertinent in the context of public libraries, which serve diverse communities and play a crucial role in promoting social justice and equality. This study has evaluated the post-occupancy inclusivity of three libraries at Shiraz University, namely the Main Library and Documentation Centre (MLDC), the Khwarizmi Library (KHL), and the Art and Architecture Library (AAL). The research was conducted using a systematic and rigorous Post-Occupancy Evaluation (POE) process, which comprised planning, implementation, and application stages.

In the planning stage, a comprehensive checklist of 180 items was compiled. This checklist served as a guiding tool for the evaluation, ensuring that all relevant aspects of inclusive design were considered. These items were categorised into four main areas:

1. Spatial Design: Factors include spatial design requirements, floor, ceiling, and wall.
2. Accessibility and Circulation: Factors include movement path, ramp and lift, elevator, and staircase.
3. Amenities and Equipment: Factors include parking, toilet service, opening, furniture, and guide signs.
4. Sensory and Atmosphere: Factors include light, colour, texture and materials, shape and form, scent, sound, and temperature.

The implementation stage involved conducting field observations and collecting data over a period of one to two days for each library. A two-person evaluation team carried out the observations, utilising tools such as photography and metric measurement for data collection. The data were meticulously gathered and any inconsistencies were addressed through re-collection by both evaluators. In the application stage, the collected data were analysed using IBM SPSS Statistics 26.0 software. A binary weighting system was employed for each item in the checklist, with 'one' signifying the prevalence of the item under review, and 'zero' indicating its absence. This approach allowed for a detailed and nuanced understanding of the data.

The results of the study revealed several weaknesses in terms of inclusive design across all three libraries. The average inclusiveness scores assigned to the MLDC, AAL, and KHL were 37.50%, 35.10%, and 34.35%, respectively. These findings underscore the need for improvements in the design of these libraries to better cater to all users. Despite the challenges identified, the study highlights the potential of inclusive design in creating more accessible and welcoming public spaces. The findings provide valuable insights and practical recommendations for architects, designers, and other stakeholders involved in the design and management of public libraries and other similar spaces. Looking ahead, future research in this field should consider two key points:

- The data collection method used in this study was primarily based on observation and field measurement. However, to foster a more inclusive POE process, future research could benefit from incorporating a wider range of data collection methods. Specifically, questionnaires could be employed to gather data that cannot be quantitatively measured with common tools. This approach would not only enrich the data but also involve a more diverse audience in the research process.
- In this study, a binary weighting system was employed for each item in the checklist. Future research could address this issue by employing more nuanced weighting techniques such as the Delphi technique or a Likert scale questionnaire. These techniques would allow for the assignment of different value codes to each item, providing a more detailed and nuanced understanding of the data. With a sufficient sample size, the results of such research could serve as a source for scoring and comparing various buildings with different uses in terms of inclusive design, and could even be considered as an evaluation standard by reputable institutions.

In conclusion, this study contributes to the growing body of knowledge on inclusive design and post-occupancy evaluation. It provides a robust framework for future research in this field, offering valuable insights and practical recommendations for enhancing inclusivity in architectural environments.

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