Beyond Vision: An Empirical Study of Multisensory and Universal Design in Inclusive Institutional Environments for Visually Impaired Users

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Abstract. Architecture has traditionally emphasised vision as the primary means by which our senses engage with space. It is through sight that we imagine, understand, and judge architectural works. Unfortunately, this focus on the visual has, in fact, been at odds with the experiences of people who are partially or totally blind. The goal of this paper is to enhance accessibility and special experiences for people with visual impairments. The paper presents a comprehensive evidence-based multisensory architectural framework that integrates the theory of multisensory design, the principles of universal design, and empirical findings to enhance the inclusiveness of architecture for visually impaired users. The empirical study conducted in a library setting included measuring illuminance, conducting special documentation, and analysing user tasks based on user performance. The users in this study had low vision conditions, such as albinism. This paper integrates a conceptual framework with on-the-ground evidence, identifies environmental barriers, and offers innovative design proposals that rely on non-visual sensory stimuli and assistive technologies. The findings reveal a discrepancy between traditional design standards and the real needs of visually impaired users, thereby calling for a change in attitude toward environments that are truly inclusive and responsive.

Keywords: Multisensory Architecture, Universal Design, Inclusive Design, Visual Impairment, Spatial Experience.

1 Introduction

1.1 Background and Context

The built environment plays a major role in shaping human cognition, mobility, independence, and social participation. However, the architecture of today remains largely visual [1]. Architectural design conventions, such as plans, elevations, perspectives, lighting design, material selection, and spatial aesthetics, are mostly based on sight-oriented representation. Although this approach benefits the majority of users, it marginalises people with visual impairment [1].

The number of people living with visual impairment and low vision is increasing worldwide due to ageing populations, chronic health conditions, and demographic

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change [2]. Even though various assistive technologies exist for the visually impaired, architectural environments still play a decisive role in an individual's autonomy and accessibility. Public institutional buildings, libraries, universities, government offices, and cultural centers are of great importance because they represent knowledge, public participation, and equal opportunity.

Libraries, for example, are organised around a predominantly visual-spatial environment: signage, classification systems, digital catalogues, and book spines. Lighting is typically designed for the average user rather than being adjustable to different visual abilities. Glare from shiny surfaces, a lack of contrast between floors and walls, and visually cluttered wayfinding systems place a high cognitive and physical burden on visually impaired users, making the library experience considerably more difficult for them [1, 3, 2].

The central hypothesis of this study is that the institutional design norms, which mainly focus on premium design, might not be capable of catering to the physical and mental necessities of the visually impaired user (especially the ones with albinism and photophobia). Besides, it is also assumed that adopting multisensory architectural methods and universal design concepts can greatly help in removing these environmental difficulties, leading to better independence and comfort of the user.

1.2 Research Methodology

The research methodology is built on a structured, user-centred mixed-methods framework that connects theory with real-world spatial experience. The initial phase of the research involved identifying the background and context that highlight the dominance of vision-oriented architectural practice in public institutional spaces.

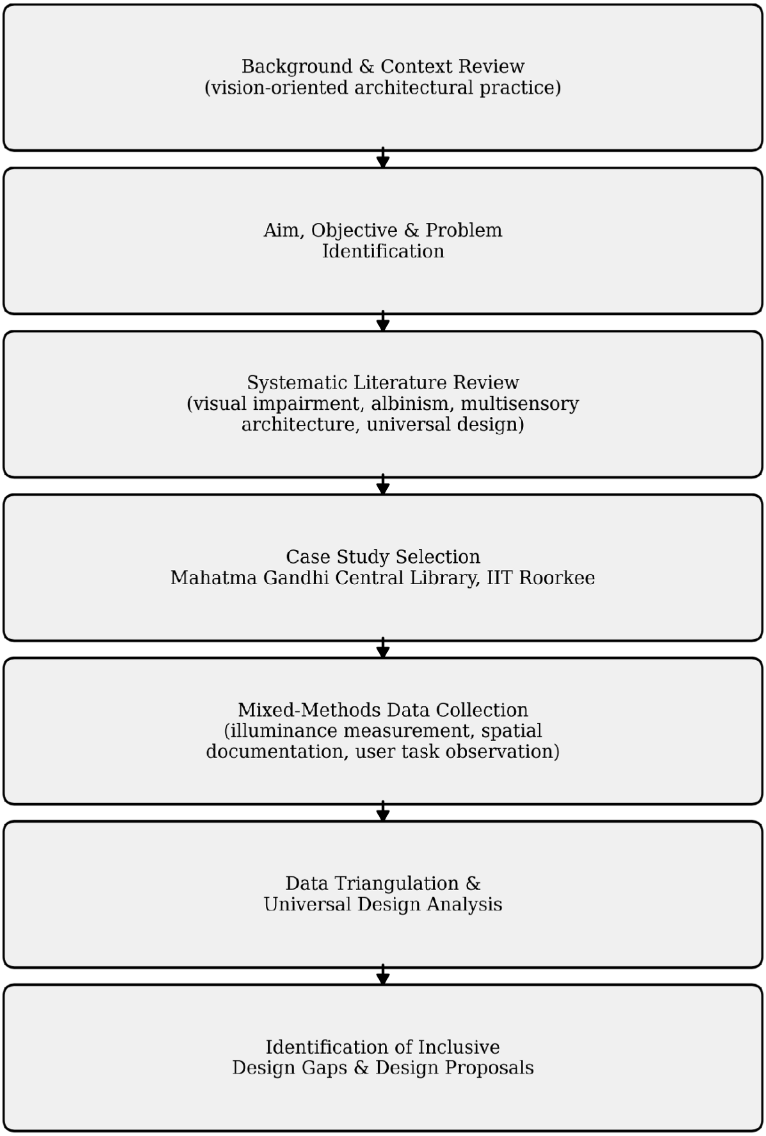

Fig. 1. Flow diagram of the research methodology.
Source: Author.

After thoroughly reviewing the background and context and identifying the aim, bjective, and problem statement, a systematic literature review was conducted, overing visual impairment and albinism, the general effects of visual impairment on mobility and cognition, the theoretical bases of multisensory architecture and universal design, multisensory design strategies for visually impaired users, and universal design parameters applicable to spatial planning.

The case study focused on the Mahatma Gandhi Central Library at IIT Roorkee, selected for its complex institutional layout. The participant profile was a visually impaired user with albinism and photophobia. The research design integrated environmental data (illuminance measurements, spatial mapping) with user-centred observation (task performance, experiential feedback). Data triangulation and universal design analysis were conducted with due ethical consideration, ultimately revealing gaps in inclusive design related to glare, contrast, wayfinding, and ergonomics.

Reflexivity Statement of Participant Profile and Sample Size. This is a single-case study of a person with low vision due to albinism. The participant is the researcher himself (first author), enabling detailed experiential observation and environmental evaluation. Medically, albinism is linked with visual impairment such as impaired visual acuity, glare sensitivity, and photophobia, which together highlight the spatial perception difficulties faced by visually impaired persons in built environments. A single-participant design is considered sufficient for this qualitative, exploratory study, which aims to thoroughly investigate the experience of a visually impaired person navigating institutional architectural environments.

2 Visual Impairment

Visual impairment generally refers to a partial or complete loss of vision that cannot be corrected to a normal level with glasses, contact lenses, medication, or surgery and that consequently limits the ability to perform daily tasks [4, 5]. The term encompasses all types of vision loss, from low vision (some usable vision remaining) to total blindness (complete absence of vision). Visual impairment can manifest in various ways, including blurred vision, loss of central or peripheral vision, colour blindness, or light sensitivity, depending on the underlying eye condition [6].

2.1 Visual Impairment Categories under the RPwD Act, 2016

In India, the Rights of Persons with Disabilities (RPwD) Act, 2016, defines visual impairment in two parts: “blindness” and “low vision”. Blindness is a severe visual impairment in which a person either completely loses the sense of sight or has visual acuity in the better eye of less than 3/60 or 10/200 (Snellen), even with the best possible corrective lenses. A severe restriction of the field of vision, of an angle no greater than 10 degrees, is also regarded as blindness under the Act [7].

Low vision is a condition characterised by considerable visual impairment, though not as severe as total blindness, that significantly limits an individual’s abilities. A person is said to have low vision when visual acuity in the better eye, after the best possible correction, is not better than 6/18 or 20/60. A narrowing of the field of vision to an angle of 40 degrees or less, but more than 10 degrees, is also considered low vision [7].

2.2 Albinism

Albinism refers to a set of hereditary genetic conditions that result in reduced or absent melanin pigment in the skin, hair, and/or eyes [8]. The visual system is one of the principal targets of albinism, which often causes a range of ophthalmic disorders in addition to visible changes in hair and skin pigmentation. Common ocular features include decreased vision, nystagmus (involuntary eye movement), strabismus (misaligned eyes), photophobia (light sensitivity), and foveal hypoplasia (underdevelopment of the fovea, the part of the retina responsible for high-resolution vision) [8].

2.3 Prevalence and Demographics

The World Health Organisation reported in 2017 that approximately 253 million people worldwide had vision impairment: 36 million blind and 217 million with moderate to severe vision impairment, with 81% of these individuals aged 50 or older [9]. More recent WHO projections indicate that by 2026, around 2.2 billion people globally will have some form of vision impairment, near or far, with at least 1 billion of those impairments being preventable or treatable [10].

In India, approximately 5.03 million people were recorded as having a visual disability, representing approximately 18.8% of the total disabled population of 26.81 million. Men are slightly more likely to be in the visually impaired group, with approximately 2.6 million men and 2.4 million women reported as visually impaired. This makes visual impairment one of the three largest categories of disability, alongside hearing and mobility impairment [11].

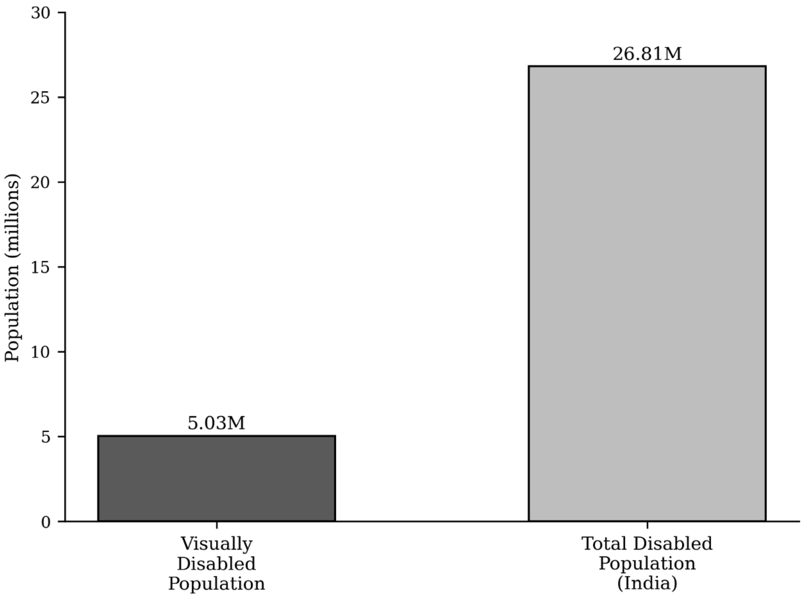

Fig. 2. Disability in India.
Source: Author, based on data from [11].

2.4 Multifaceted Impacts of Visual Impairment

Visual impairment involves more than the loss of a single sense; it can also lead to broader problems affecting a person's physical, emotional, and social well-being. The sections below describe the different areas affected by poor vision.

Reduced Quality of Life. A significant loss of overall quality of life is one of the most direct effects of visual impairment, as everyday activities such as reading, cooking, dressing, or travelling independently become increasingly difficult and sometimes impossible without assistance. As the level of disability increases, individuals may experience reduced work output, narrower social participation, and lower overall life satisfaction [12, 13].

Increased Dependence. A lower level of functional independence is often accompanied by an increasing reliance on caregivers, family members, or assistive devices. Such reliance can erode privacy and self-determination, leaving the person feeling burdened and less confident. Reduced ability to move and make decisions independently further limits social and economic engagement [13].

Mobility Challenges and Risk of Falls. Visual impairment has a strongly negative effect on a person's ability to orient and comprehend the surrounding space. Inability to perceive a step, a ramp, an uneven surface, or a moving object can dramatically increase the risk of falls. As a result, people may avoid going outside for fear of injury, which in turn reduces physical and social interaction and further aggravates functional decline [13].

Subsequent Injuries and Fractures. Falls induced by visual impairment can result in injuries ranging from minor bruises and sprains to major fractures, particularly of the hip and wrist. Such injuries can exacerbate existing mobility limitations, prolong dependence, and eventually contribute to long-term disability. The risk of further falls is heightened in environments lacking adequate lighting, visual contrast, and tactile guidance [13].

Mental Health Impacts. The psychiatric ramifications of visual impairment are great. People can feel anxious, frustrated, less confident, and socially stigmatised. The fear of falling and the difficulty of navigating public places might lead to social isolation and withdrawal. These elements, taken over a period, might set one up for depression and other mental health disorders [13].

Cognitive Strain. By losing visual input, the brain must work harder, as the person must rely more on what they hear, touch, and remember to understand and navigate the environment. This compensatory dependence might overwork the brain, increasing cognitive load. In the long run, chronic cognitive strain may reduce one's spatial awareness, attention, and overall cognitive abilities [13].

Increased Mortality Risk. Studies have demonstrated that visually impaired people have a higher chance of dying during their lifetime. Limited ability to move, falling frequently, lessening physical activity, having other health problems, and getting mentally worse are some of the factors that contribute to this unfortunate event. These co-occurring effects highlight that vision impairment is not only a visual issue but also a major public health problem [13].

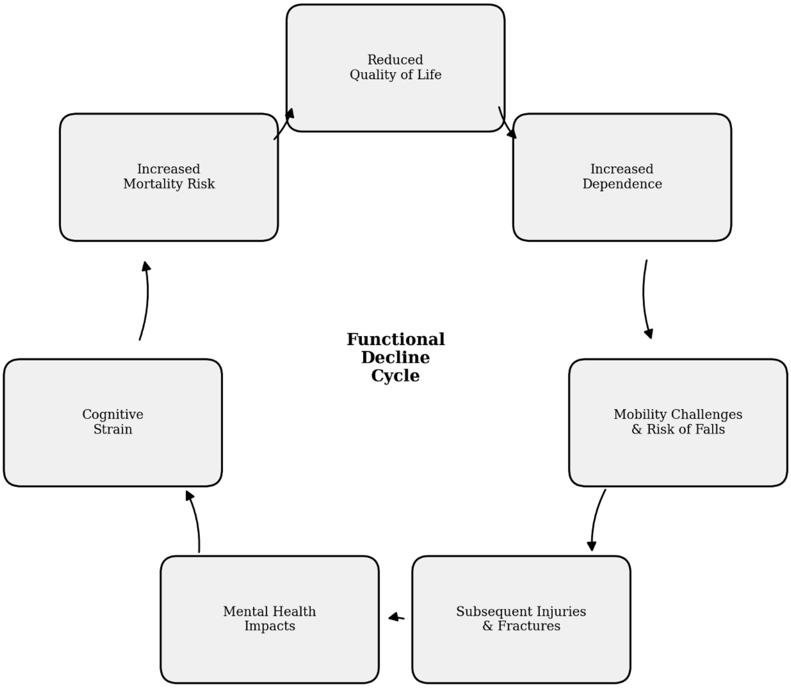

Fig. 3. The cyclical, compounding impacts of visual impairment on quality of life. Source: Author, adapted from [12].

3 Theoretical Foundations: Multisensory Architecture and Universal Design

Studies have demonstrated that visually impaired people have a higher chance of dying during their lifetime. Limited ability to move, falling frequently, lessening physical activity, having other health problems, and getting mentally worse are some of the factors that contribute to this unfortunate event. These co-occurring effects highlight that vision impairment is not only a visual issue but also a major public health problem [14, 15].

3.1 The Principles of Multisensory Architecture

The core of multisensory design lies in creating environments that can "talk" through the full range of human senses, beyond just sight [16]. For a visually impaired person, these non-visual senses, mainly the sense of physical contact with objects, hearing, smell, and muscle awareness, become the essential means of obtaining information about space and interacting with it [16]. There is experimental evidence that the human brain has a very wonderful ability to change, called neuroplasticity, when the areas of the brain that under normal circumstances would do the visual processing are turned to the use of auditory and tactile inputs more when the visual information is lacking [17].

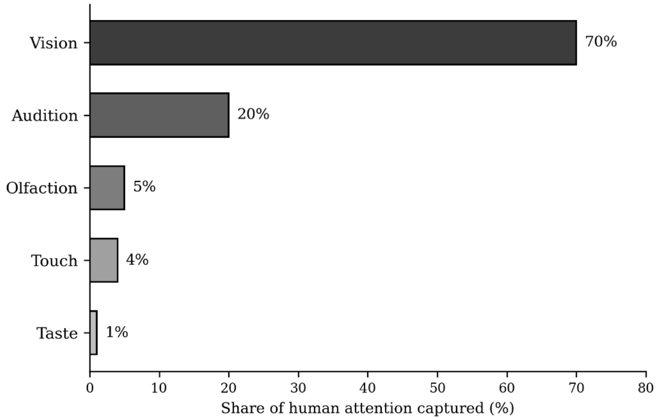

Fig. 4. Estimated share of human attention captured by each sense. Source: Author, as reported in [16].

Key non-visual sensory channels and their architectural applications are as follows.

Haptic Design. This is about integrating tactile elements that communicate the most necessary information through the skin [15]. Examples include textured flooring to signal a transition or a dangerous area, raised symbols, Braille signage, and changes in materials to indicate boundaries or decision points. Research suggests that tactile cues are a key element in safety and navigation, as well as in creating mental maps of the environment [15]. For instance, raised dots before a staircase and ribbed paving for directional guidance are examples of such cues [18].

Auditory Design. Sound signals are involved in judging distance, identifying object locations, and confirming the path [19]. Pedestrian beacons, audio announcements in public transport systems, and tonal markers are among the elements of successful auditory design [20]. Most importantly, it encompasses proper acoustic control, reducing background noise and limiting echo to improve environmental clarity [19].

Olfactory Cues. Certain scents can serve as location-recognition and orientation anchors. The study of environmental psychology shows that smell is strongly associated with memory and the ability to recall a location [19]. When used moderately, uniquely, and appropriately, without causing overstimulation, scents can be a decent navigation aid, for example, a specific type of plant in a garden or courtyard.

Visual Contrast (for Low-Vision Users). Alongside non-visual senses, it is equally important to consider the needs of low-vision individuals who retain some visual capability [21]. For these users, contrast is often more important than fine detail. High-contrast edges, well-balanced lighting, and distinct shadow patterns improve depth perception, facilitating the identification of obstacles, edges, and openings [20, 21]. Properly illuminated staircases, contrasting handrails, and prominent floor markings significantly enhance navigation accuracy and reduce the risk of falling [20].

Architecture that incorporates these multisensory elements moves beyond mere visual appeal, creating spaces that are inherently easier to navigate, that require less mental effort, and that are more usable — both physically and digitally — not only for visually impaired people but also for a broader range of users, such as children and older adults [14].

Table 1. Multisensory design strategies for visually impaired users.

Multisensory channel	Design strategies	Why it helps visually impaired users
Haptic/tactile cues	Use tactile paving at transitions, junctions, and entrances. Vary floor textures to signal zones. Provide handrails with texture changes at decision points. Use tactile maps and 3D models. Use warm/cool materials to differentiate zones. Avoid slippery or overly smooth surfaces.	Provides spatial information through touch; supports movement, orientation, and decision-making, and conveys crucial information about boundaries, surfaces, and spatial edges.
Auditory cues	Use sound-reflective materials to provide helpful echoes. Avoid excessive noise or echo saturation. Provide audio beacons at entrances and lifts. Maintain consistent soundscapes along routes.	Helps users judge volume, distance, geometry, and direction using echoes and environmental sound.
Olfactory cues (smell)	Introduce distinctive scents in specific zones (gardens, courtyards). Use plants with identifiable smells along pathways. Ensure good indoor air quality and avoid confusing, overpowering odours.	Supports landmarking and spatial memory through scent association.
Contrast and colour (for low-vision users)	Use high-contrast edges. Enhance contrast at door frames, switches, and handrails. Avoid pattern-heavy surfaces.	Helps low-vision users distinguish boundaries and hazards.

Source: Author.

The theoretical basis for inclusive design is the Seven Principles of Universal Design, which are discussed next.

3.2 Seven Principles of Universal Design

Universal Design is an all-encompassing philosophy whose main goal is to make products and environments usable by as many people as possible [22]. The approach centres design around human diversity, catering to the whole spectrum of people rather than a so-called "average" user; people with disabilities are thereby naturally included within the wider population that benefits from the resulting design solutions.

The foundational framework for this inclusive design philosophy was established in 1997 by Ron Mace and a committee at North Carolina State University, who formulated the Seven Principles of Universal Design [22]. These principles serve as guidance for designing, assessing, and teaching inclusive products and environments.

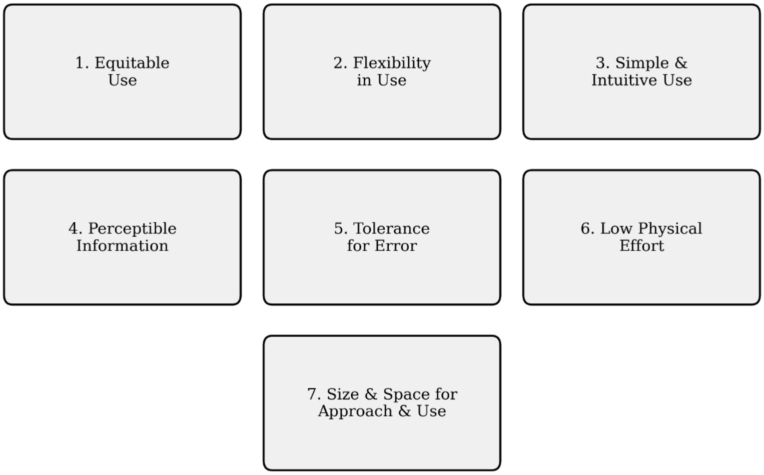

Fig. 5. The Seven Principles of Universal Design.
Source: Author, after [23].

Principle 1: Equitable Use. The essence of this principle is that a design should be equally functional and useful for people with different abilities, without isolating or stigmatising any user group [22]. A public transport system with audio announcements is a good example: it makes the system accessible to visually impaired users while simultaneously providing a redundant information channel for sighted users [22].

Principle 2: Flexibility in Use. A universally designed product or service should accommodate diverse preferences and abilities while offering choices in modes of use and interaction pace [22]. A visually impaired person can, for instance, be assisted by devices that support physical orientation through environmental cues, such as tactile elements on furniture or digital interfaces with customisable settings [22].

Principle 3: Simple and Intuitive Use. It is important that users can easily understand a design regardless of their experience, knowledge, language skills, or current level of concentration [22]. This principle substantially lowers the mental effort required and makes interaction smoother for both new and experienced users.

Principle 4: Perceptible Information. Effective designs always communicate essential information clearly, regardless of ambient conditions or the user's sensory abilities [22]. This is of particular concern for visually impaired users, who require key information to be conveyed redundantly across multiple senses [22].

Principle 5: Tolerance for Error. A design should minimise the hazards and negative consequences that might result from accidental actions or user error [22]. Visually impaired users depend heavily on this principle, as designs must effectively eliminate the risk of falling or colliding with objects [22]; emphasising safety and error prevention benefits all users by creating a more forgiving, secure environment.

Principle 6: Low Physical Effort. The objective of this principle is to enable efficient and comfortable use with minimal fatigue [22]. It concerns the level of physical effort required to navigate an environment and aims to make movement and operation easy for everyone [22].

Principle 7: Size and Space for Approach and Use. Adequate size and space should be provided for approach, reach, manipulation, and use, taking into account people of different body sizes, postures, and levels of mobility [22]. This permits users with guide dogs or mobility equipment to interact with and move through the environment comfortably [22].

By adhering to these principles, architects can make the built environment accessible to people with vision loss, facilitate their independence, and substantially improve their spatial experience [22]. The synergy between universal design and multisensory architecture offers a solid theoretical foundation for developing genuinely inclusive architectural solutions. In addition, Universal Design for Learning (UDL) offers educators a framework for teaching students with disabilities while addressing the needs of a diverse student population [24]. The underlying aim is to achieve designs that are not merely compliant with accessibility standards but inclusive and supportive of all people by their very nature.

Table 2. Design for visually impaired people using universal design parameters.

Universal design principle	Explanation (UD concept)	How to design for visually impaired people
1. Equitable use	Design usable by all people without segregation.	Provide multisensory wayfinding cues (tactile, auditory, olfactory). Ensure entrances, routes, and facilities are equally accessible without separate paths. Use auditory announcements in lifts, buses, and public spaces.

2. Flexibility in use	Accommodates a wide range of preferences and abilities.	Provide both tactile maps and audio guides. Allow adjustable lighting levels for low-vision users. Offer multiple information formats (audio, raised text, Braille, colour contrast).
3. Simple & intuitive use	Design is easy to understand, regardless of the user's experience.	Provide clear, linear circulation paths with minimal confusion. Use tactile floor guidance to signal changes (stairs, corners, crossings). Avoid complex layouts; create predictable spatial organisation.
4. Perceptible information	Communicates information effectively through different senses.	Use high colour contrast for low-vision users. Provide tactile indicators at stairs, entrances, and hazards. Use audible crossing signals, beacons, and alerts, and consistent textures to mark path versus danger zones.
5. Tolerance for error	Minimises hazards and consequences of mistakes.	Provide guardrails, handrails, and tactile warning surfaces at drop-offs. Round edges on furniture and projections. Use slip-resistant flooring and avoid sudden level changes. Maintain clear buffer zones near obstacles.
6. Low physical effort	Can be used with minimal fatigue.	Provide smooth, continuous handrails along circulation routes and resting points at regular intervals. Ensure lightweight or automatic doors. Reduce unnecessary detours or long routes.
7. Size & space for approach & use	Adequate space for movement regardless of mobility.	Provide wide, unobstructed corridors free from clutter. Maintain clear headroom for cane-sweep detection. Ensure consistent walking surfaces without abrupt transitions.

Source: Author.

4 Empirical Findings: Barriers and Opportunities in Institutional Library Space

The study presents empirical evidence from an on-site mixed-methods investigation at the Mahatma Gandhi Central Library of IIT Roorkee. Using a "researcher as a participant" model, the study aimed to locate architectural, environmental, and ergonomic barriers that limit access and usability for individuals with low vision. Illuminance measurements, along with a detailed observation of the activities of a low-vision participant and direct feedback from him, were used to disclose fundamental incompatibilities between usual library design and the specific requirements of visually impaired users [25].

Fig. 6. Photographs of the Mahatma Gandhi Central Library, IIT Roorkee
Source: Author.

4.1 Circulation, Vertical Movement, and Material Legibility

While moving through the library's circulation routes and performing vertical movements, the low-vision participant found it quite difficult. The main reasons for this were the lack of visual cues and contrast.

Staircases. One of the most serious problems was the condition of the stairs in the vertical circulation area. The lack of high-contrast nosing or clear edge markings made it very difficult for participants to identify the marks and shapes of each staircase. This problem not only increased the risk of mistakes and thus reduced safety, but also meant the participant barely saw the stairs. Therefore, they directly contradict Universal Design Principle 4: Perceptible Information, which states that the necessary information should be clear and unambiguous.

Fig. 7. Staircase Visibility Deficiency Due to Lack of Edge Contrast
Source: Author.

Transparent Entrances. Finding the way through the glass entrance doors and walls was even more difficult. These surfaces were completely transparent and lacked contrast bands or visual markers, making them invisible to the participant. The fact that they appeared in the environment increased the risk of collision, leading to an essential design error: for viewers who require visual clarity, it became a danger for the less sighted.

Fig. 8. Transparent Glass Entrance Without Visual Markers
Source: Author.

4.2 Digital Catalogue Workstations: Ergonomics and Lighting Impact

Ergonomic Issues. The participant had significant trouble using the catalogue workstation due to poor ergonomics. The participant had to bend over a lot to use the bottom screen and keyboard, which worsened his posture and made typing difficult. In addition, the text on the screen was too short and had little contrast, and there was no dark mode, voice typing, or screen reader support, all of which are essential features for accessibility. The participant's ability to find books independently was very low. This directly impacts Universal Design Principles 6: Less Physical Effort and 4: Easy-to-Understand Information.

Daylight Glare. The daylight placement of the digital catalogue workstation was a huge blunder. When the glare was too intense, the user simply refused to read the screen. During the day, the illuminance levels were measured at 806 lux. At night, the luminance was lowered to a more comfortable 66 lux, which quite clearly indicates that uncontrolled ambient light has a very strong impact on screen legibility and user comfort. This completely overlooked the fact that people with low vision, e.g., those with albinism, are often photophobic (light sensitive) and therefore need to be considered when designing such spaces [26].

Fig. 9. Catalogue Workstation Under Daylight Glare
Source: Author.

4.3 Shelving Aisles: Spatial Contrast and Anthropometric Constraints

Library shelving aisles, which are essentially the main function of a library, surprisingly ended up being the areas with the most challenging and unstable environmental conditions.

Uneven Lighting and Shadows. According to the observation, the lighting on the shelves was highly uneven, and dark shadows were mostly observed between the shelves. Light intensity measurements showed a significant discrepancy between the amounts of light in different aisles. For example, some aisles had less than 60 LUX. A participant identified very low lighting as the main obstacle to finding a book, as it was nearly impossible to see. Where there are no brighter ones evenly distributed across the areas for book searching, this issue is further intensified by unminimised shadows. The ability to understand information and to find one's way is impaired.

Fig. 10. Uneven Illuminance in Shelving Zones
Source: Author.

Signage Legibility. Signage indicating directions inside the shelving zone was found to be mostly ineffective. They lacked high-contrast marking and the right-sized font, so the participant had to seek help most of the time. The backlighting of the topic label often caused flashes, making the text unreadable. The lighting of the shelf numbers was uneven, with some completely shadowed and others showing smaller, less-contrasted numbers. In addition, the subject names and serial number lists were in small type on the top shelf, making them difficult to read comfortably. These issues run counter to Universal Design Principles 4: Perceptible Information and 7: Size and Space for Approach and Use.

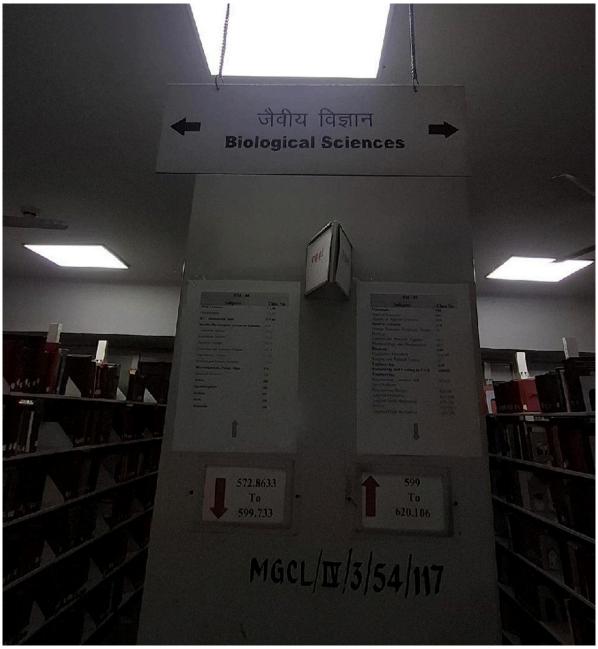

Fig. 11. Low-Contrast Signage
Source: Author.

Book Retrieval Challenges. The participant had a great deal of difficulty getting books from both the bottom and top shelves, whereas those on the middle shelves were easy to reach. One had to bend or kneel to pick up items from the lower shelves, and the user could not read the books on the upper shelves. The challenge of identifying and accessing independently was compounded by the faded book numbers and titles. This reveals issues of human body-dimension mismatches and a lack of product flexibility.

Glare from Overhead Lighting. The direct overhead lighting in the shelving aisles casts deep shadows across the spines of the books, reducing their readability. At the same time, the direct light was so intense that the participant had trouble seeing and had to cover his eyes with his hands to shield them from the glare. The tale highlights the need for a proper lighting layout that, on the one hand, avoids glare and, on the other, enhances contrast.

Fig. 12. Glare from Overhead Lighting
Source: Author.

4.4 Reading Areas: Excessive Brightness and Surface Glare

Although overall illumination levels in the reading spaces conformed to standard library specifications, the participant's recorded experience revealed a substantial gap between quantitative compliance and qualitative comfort.

Illumination Level versus User Comfort. One reading space measured 1000 lux during the day, far exceeding the participant's stated optimal reading comfort range of 50–100 lux. Above 125 lux, the light level caused eye discomfort, while below 30 lux, visual clarity decreased. This result demonstrates that, for individuals highly sensitive to light, excessive illumination can be a greater barrier to performance than insufficient illumination.

Glare from the paper's surface also caused discomfort and diminished the overall reading experience. The fixed height of the reading desk and the absence of ergonomic adjustability in the chair made it difficult to sit comfortably for extended periods without straining the eyes. Because the furniture could not be adjusted, its design limited the space's ability to accommodate different users' needs.

4.5 Computer Rooms and Screen Interaction

Computer rooms presented a challenging environment for the low-vision participant due to ambient lighting conditions and the effects of display interaction.

Ambient Light and Screen Glare. Computer rooms had an average illuminance of 290 lux, which the participant judged to be too bright for screen-based work. Excessive ambient light washed out screen sharpness; while a high-contrast display mode increased sensitivity to glare, a dark display mode was less clear due to reduced contrast.

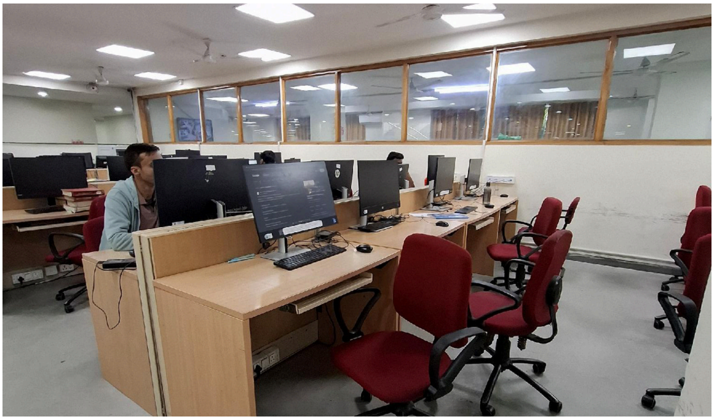

Fig. 13. Computer Room Lighting and Screen Glare
Source: Author.

Recommendations for Lighting and Display Settings. The participant suggested that the most practical approach would combine soft, warm, tinted ambient lighting below 60 lux with adjustable display settings, underscoring the importance of both environmental lighting control and accessible, customisable digital interface settings.

4.6 Role of Assistive Technology

Assistive technologies were acknowledged as crucial tools, although their implementation and accessibility could be improved.

Kibo XS Assistive Reading Station. The participant used the Kibo XS, a device that combines a handheld scanner, magnifier, contrast adjuster, and text-to-speech features. While effective in operation, the device was less convenient as a single, fixed unit that required a network connection. The participant suggested that mobile scanning applications with similar features might be a more flexible and affordable alternative, underscoring the need for more accessible, widely available technological aids [27].

4.7 Integrated Lux Data Assessment

Illuminance levels varied greatly between different areas of the library. Different lighting levels directly affected users' comfort and functionality. Some parts of the library were so well lit that the light level exceeded the standard maximum permissible level, and there were other parts that were so poorly lit that they were hardly usable. Consequently, the participant's freedom of movement, their willingness to spend long hours reading, and their use of digital content were affected. This research result clearly indicates that lighting measurements, even when they meet code requirements, often do not account for important factors such as light sensitivity, contrast dependence, and ergonomic adjustments, all of which are critical in universally designed environments. Photometry is the science of light that measures it in a way consistent with human perception, and it plays an important role in creating pleasant and functional lighting environments [28].

The comprehensive study reveals that public libraries, including the Mahatma Gandhi Central Library at IIT Roorkee, continue to pose major obstacles for people with visual impairments at the physical, structural, and systemic levels. These difficulties include insufficient visual contrast in building and wayfinding elements, non-ergonomic furniture and workspaces, and poorly considered lighting design.

Table 3. Illuminance (lux) levels and user comfort assessment.

Space	Min.	Avg.	Max.	Visual issue identified	User response
Reading areas	20	240	750	Excessive glare	Eye strain, reduced reading duration
Shelving areas	0	100	590	Low contrast	Difficulty locating titles
Computer room	60	290	530	Screen glare	Visual fatigue

Source: Author.

Adaptive technology has huge potential, but it requires a holistic approach to successful implementation that considers users' individual needs and the principles of universal design. This aligns with the general finding that library websites, as well as their physical premises, are not very accessible to visually impaired users [29]. Universal Design is a concept that strives to make environments usable by all people as much as possible. It is therefore an essential part of the solution for this situation [30].

5 Discussion

The study results reveal that accessibility difficulties in institutional settings stem not only from physical barriers but also from sensory mismatches in the spatial environment. Strong glare, low contrast between building surfaces, and poorly placed lighting fixtures greatly alter how space is perceived by low-vision users. Likewise, differences in furniture height and unclear layout of circulation areas cause problems in moving around independently. From the perspective of multisensory architecture, such problems underscore the need to use multiple sensory signals, including texture surfaces, auditory instructions, visual contrasts, and variable lighting, to make the environment more understandable. Adding these aspects can change institutional environments from merely meeting the rules to becoming genuinely inclusive and supportive places for the visually impaired.

6 Conclusion

This research argues that for architecture to become truly inclusive, there must be a transition from designing primarily for the visual senses to designing for multiple senses. The study of the library in an academic setting highlighted numerous access issues, including intense glare, low contrast, ergonomic inconsistencies, and limited digital interface accessibility, which are just a few of the barriers faced by visually impaired users.

By integrating concepts from both multisensory architecture and universal design, this study demonstrates that high-quality lighting, distinct spatial orientation cues, varied tactile surfaces, and the availability of adaptive technologies can substantially enhance the functional usability of spaces for visually impaired people.

The findings strongly suggest that accessibility should not be treated merely as a baseline regulatory requirement but as a vital design consideration that architects must actively pursue in practice. Future institutional and educational spaces should therefore embrace holistic design methods that account for sensory differences among individuals, affording visually impaired users greater freedom, comfort, and opportunity for social participation.

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