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Developing a Framework for Inclusive Education in Schools for the Visually Impaired: Advancing SDG 4 on Quality Education

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Abstract

According to data from the Indonesian Ministry of Health, around 1.5% of the total population, or about 4 million people, are visually impaired. This contrasts with the limited availability of educational facilities in Indonesia that are specifically designed with sensory environments for the blind. Most Special Schools (SLB) still combine different types of disabilities in one learning environment, which creates serious challenges since the spatial orientation and learning needs of blind students are unique. This study is based on the limitations of national regulations, namely the Regulation of the Ministry of Public Works and Housing (PUPR) No. 14 of 2017, the Regulation of the Ministry of Education No. 33 of 2008, and the Inclusive Education Guidelines (2022). These regulations only emphasize general physical accessibility and do not accommodate a multisensory approach. The research develops an architectural design framework using the Systematic Literature Review (SLR) method and comparative analysis of three government regulations, as well as precedent studies of blind schools in India, Mexico, and Thailand. The findings reveal a significant gap: the precedent studies apply innovative strategies in sensory-based spatial design. The proposed framework integrates four sensory modalities haptic, auditory, olfactory, and visual to optimize five key aspects: navigation, safety, comfort, education, and stimulation. This framework offers practical guidance for architects while also laying the groundwork for future policy improvements to foster genuinely inclusive learning environments.

Keywords

Special needs school, regulations, multisensory, visually impaired

Introduction

Based on data from the Ministry of Health of the Republic of Indonesia, around 1.5% of the total population in Indonesia are people with visual impairments. With a population of over 270 million people, it is estimated that there are around 4 million blind or visually impaired individuals across the country. On the other hand, the need for special education facilities continues to grow. Data from the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) in 2023

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shows that there are more than 2,300 active special schools (SLB) in Indonesia, and the number of students with special needs increases every year. This trend indicates that the provision of educational infrastructure for people with disabilities, especially the visually impaired, is becoming more urgent and must be addressed architecturally. However, the condition of special schools in Indonesia is still mostly integrative, meaning that one school serves various types of disabilities physical, sensory, intellectual, or multiple without facilities that are specifically designed to meet the different needs of each group.

The architect Juhani Pallasmaa (2012), in the book The Eye of the Skin, once said, "Vision is regarded as the most noble of the senses, and the loss of eyesight as the ultimate physical loss." This statement shows the dominance of the visual sense over other senses. In this context, blind individuals are at risk of being excluded or underserved because the general approach used in special schools does not yet consider their specific needs for spatial perception, orientation, and sensory interaction (Pallasmaa, 2012).

This issue is further emphasized by the absence of regulations that adequately address the physical design requirements of schools for blind students. Three main references Minister of Public Works and Housing Regulation No. 14 of 2017 on Accessibility in Buildings (Kementerian PUPR, 2017), the Inclusive Education Implementation Guidelines(Kementerian Pendidikan Kementerian Pendidikan, 2022), and Minister of Education Regulation No. 33 of 2008 on the Standards of Facilities and Infrastructure for Special Schools(Ministry Regulation Number 33, 2008) only provide general guidance on accessibility and basic facilities. They do not sufficiently cover detailed design needs that specifically respond to the requirements of visually impaired students. These three regulations generally complement each other in providing basic normative direction for inclusive educational infrastructure.

Research by Baktara and Santoso (2020) explored zoning and spatial planning effectively. However, regarding the multisensory concept, the study mainly adhered to the existing regulatory standards. In another study. Darmawati et al. (2023). presented a design that already applied the multisensory concept. Yet, the application placed greater emphasis on the visual sense, while less attention was given to other senses that are highly significant for individuals with visual impairments. In addition, a case study on SLB-A in Bandung revealed that the multisensory concept was not fully implemented in several aspects of safety, such as narrow corridors and slippery flooring, as well as comfort aspects, such as classrooms without natural ventilation and room designs that did not meet existing regulations (Aulia & Raidi, 2021). Meanwhile research by Herlambang and Suteja (2023) provided a strong conceptual foundation. However, To advance it into a clearer and more practical design, further technical details would be beneficial on how the multisensory concept can be applied for users with visual impairments.

Conversely, numerous academic studies and architectural journals have examined special schools and inclusive education facilities. However, most of them only focus on partial aspects, such as space programs, size standards, or circulation. Comprehensive studies that address facility design and design frameworks for creating an inclusive spatial experience remain limited. Therefore, this research aims to develop a design framework and architectural facilities that are adaptive and inclusive, which can be used as a reference in designing schools specifically for the blind in Indonesia. This framework is expected to meet the specific needs of blind students, enabling them to access and use learning spaces safely, independently, and inclusively.

Methodology

This study uses the *Systematic Literature Review* (SLR) method by comparing regulatory studies and precedent studies. The literature search was carried out using several keywords relevant to the research, such as “multisensory,” “visually impaired,” and “special schools.” Data sources were collected from books and online journal databases that can be accessed through university platforms, including Elsevier, ScienceDirect, Google Scholar, and Connected Papers.

To identify the inclusion criteria for several aspects navigation, safety, comfort, education, and stimulation two main sources were used: a review of government regulations and an analysis of architectural precedents at both international and national levels. First, the regulatory data was reviewed through three key documents that serve as standard references for providing educational facilities for people with disabilities: the Regulation of the Ministry of Public Works and Housing No. 14 of 2017(Kementrian PUPR,2017), the Inclusive Education Guidelines by the Ministry of Education and Culture (Kemendikbud, 2022), and the Regulation of the Ministry of National Education No. 33 of 2008(Kementerian Pendidikan Nasional Republik Indonesia Nomor 33,2008). These regulations were analyzed to identify the concept of multisensory design within the five aspects mentioned above.

Next, the data was compared with precedent studies from three schools: the *School for the Blind* in Gandhinagar, India (Archdaily, 2022); the *School for the Blind* in Mexico (Archdaily, 2011); and the *Multisensory Classroom of Pattaya Redemptorist School* in Thailand (Archdaily, 2019). The analysis applied a thematic-comparative method, classifying multisensory concepts into the five aspects. Each dataset from regulations and precedent studies was examined using content analysis to identify similarities and gaps between the sources. The results of this research are a set of design principles that not only meet basic regulatory standards but also respond to the sensory needs of visually impaired students in terms of spatial experience, daily activities, and social interaction. The output of this study is intended as an initial reference for architects, planners, and educational institutions in designing and developing inclusive, safe, and adaptive schools for the visually impaired.

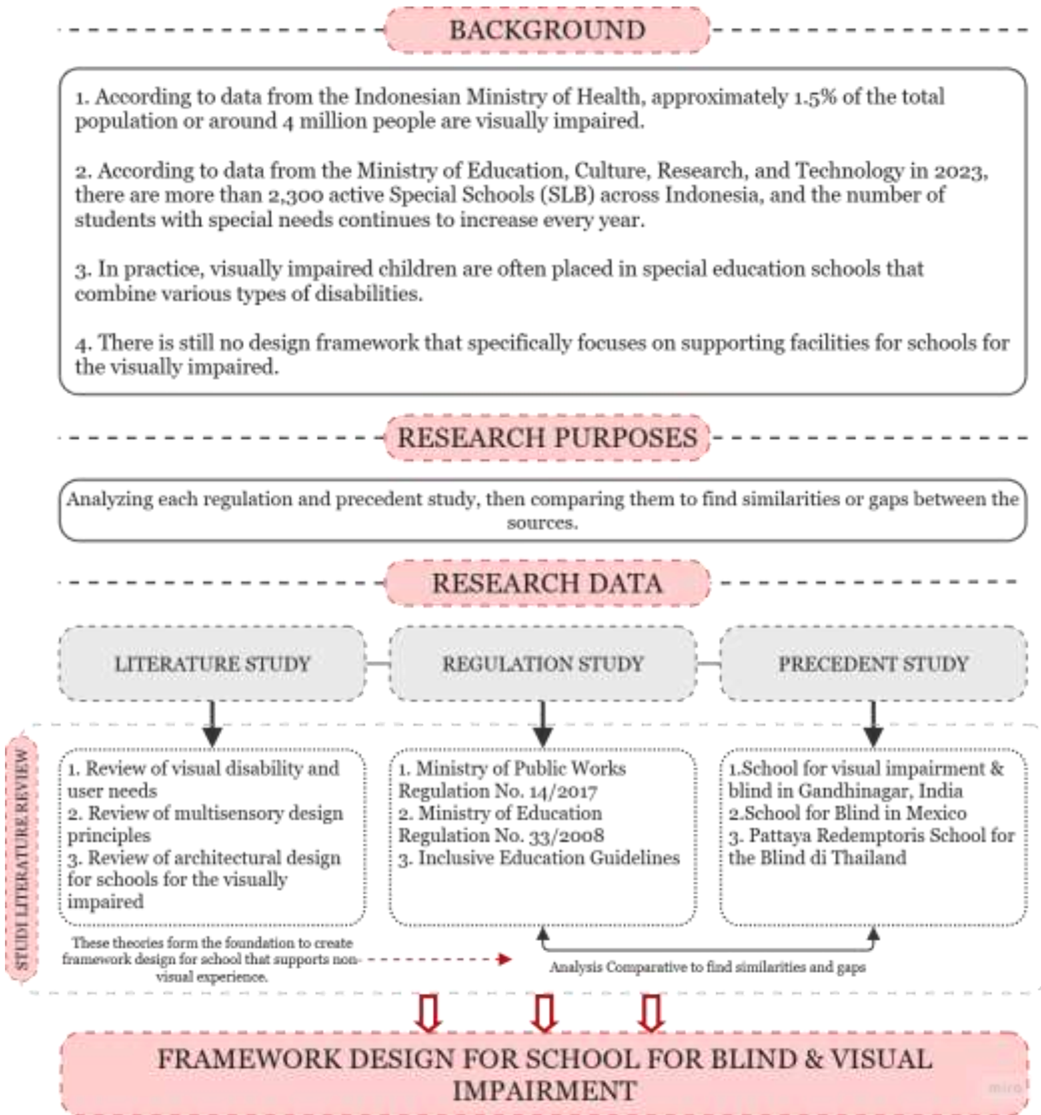


Figure 1. Conceptual framework

Results and Discussion

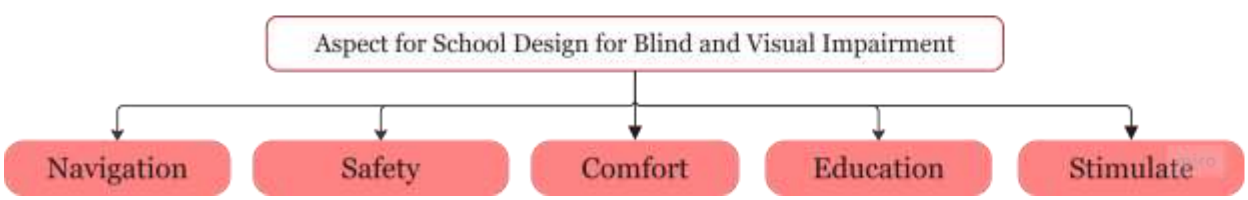


Figure 2. Five aspects of special school for visual impairment

The series of theories reviewed in this study includes multisensory theory, spatial perception by visually impaired individuals, and the relationship between the senses and architecture. These theories are drawn from various seminal works (Chen et al., 2022; Pallasmaa, 2012, 2009; Sari et al., 2022; Wu et al., 2022; Holl et al., 2006; Spence, 2020; Kafaei et al., 2025).

in this study includes multisensory theory, spatial perception by visually impaired individuals, and the relationship between the senses and architecture. These theories together form the conceptual framework for designing a school specifically for the visually impaired. The concept of multisensory design serves as the foundation, emphasizing that architectural design should not rely only on visual perception. Instead, it must include other sensory experiences, especially for users with limited vision. Below is a synthesis of the multisensory design concept based on the literature review:

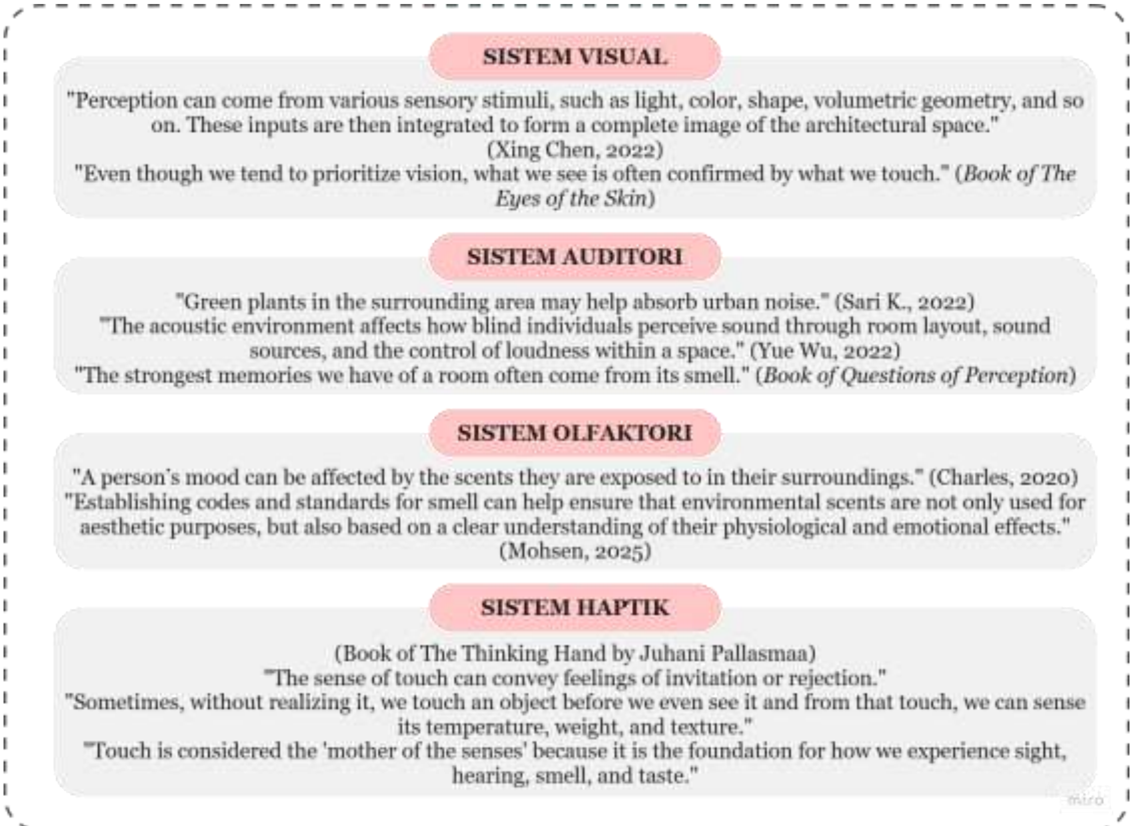


Figure 3. Diagram Analytic from study literature review

Ministerial Regulation No. 33 of 2008 (Kementerian Pendidikan Nasional Republik Indonesia Nomor 33,2008) explains the space requirements and relationships between different areas in the design of special schools, including the education, management, and service zones. The literature review also shows that the design of inclusive schools must consider clear zoning, which allows for more effective spatial transitions. In addition, the Inclusive Education Guidebook (Kementerian Pendidikan Kementerian Pendidikan, 2022) describes the characteristics of students with visual impairments and learning programs that can be used as part of the curriculum for visually impaired students. Regulation from the Ministry of Public Works and Housing No. 14 of 2017 (Kementrian PUPR,2017) provides general guidelines on accessibility and supporting facilities for people with disabilities. However, it does not fully accommodate the specific design needs required for students with visual impairments.

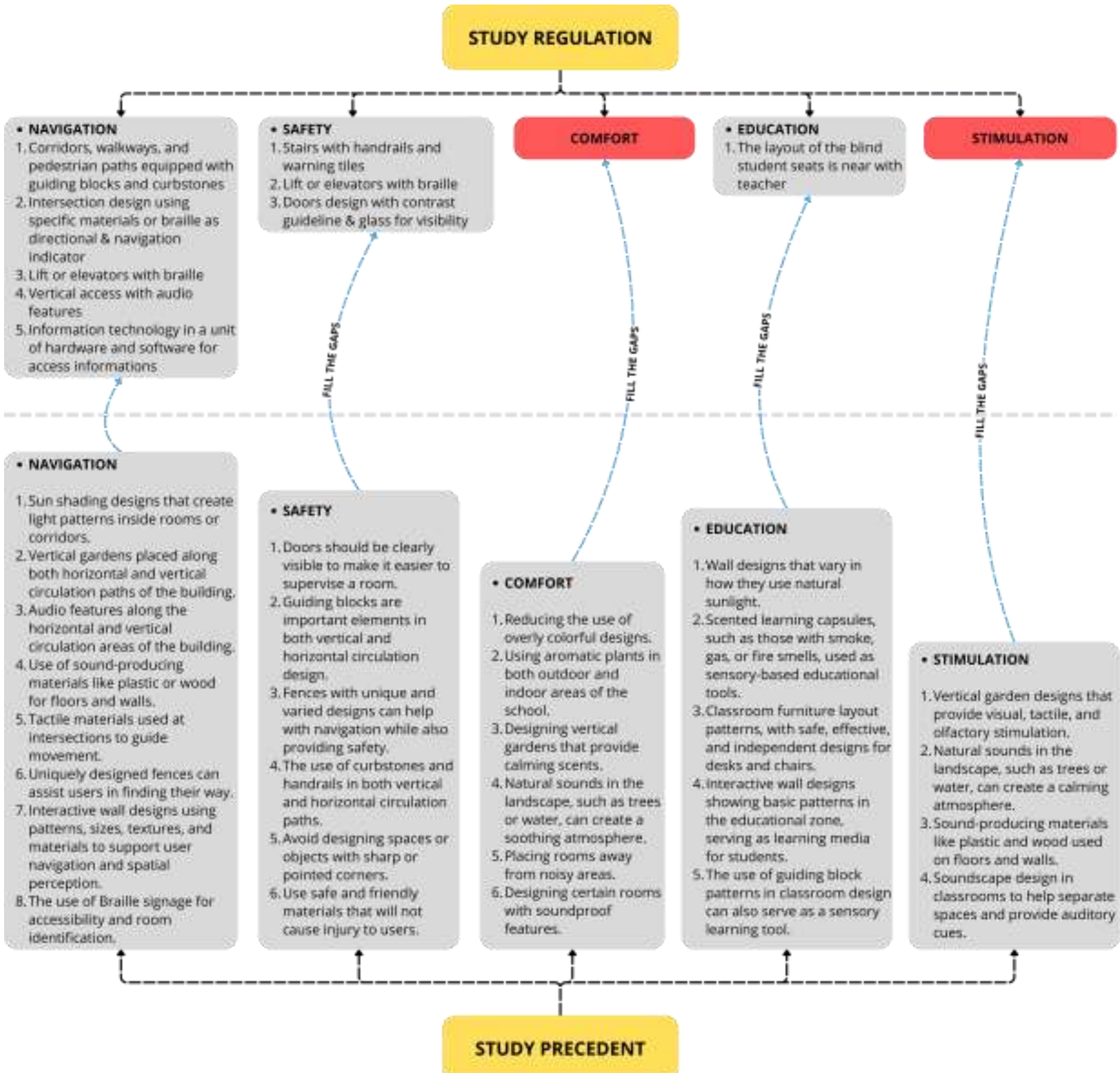
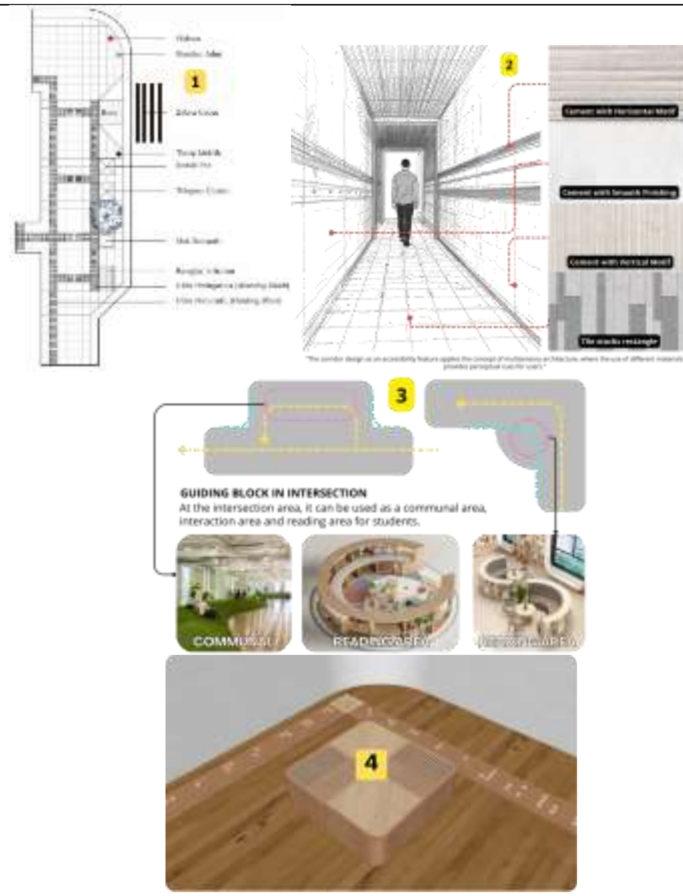


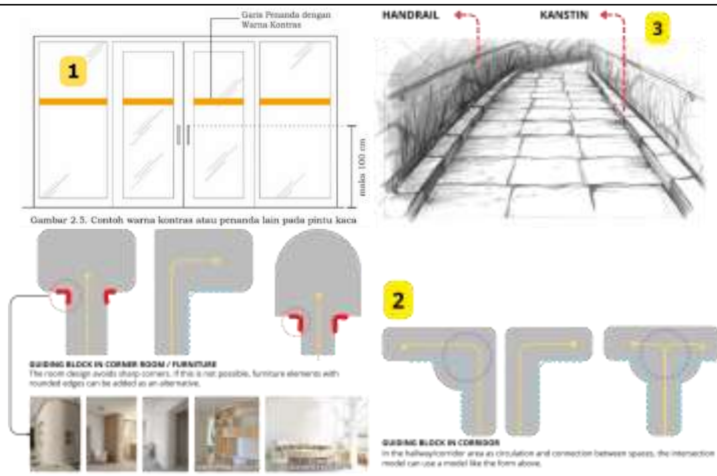
Figure 4. Diagram Analytic from Study Regulation & Precedent Review

The precedent studies reviewed show more progressive design practices in providing sensory-based support facilities. The following are the results of the analysis from several precedent studies: The School for the Blind in Gandhinagar, India, which features spatial layout based on haptic guidance, The School for the Blind in Mexico, which applies a multisensory concept that highlights the use of natural materials, The Pattaya Redemptorist School in Thailand, known for its design focused on pre-Braille education. The results of the precedent analysis and regulation are shown in the following diagram above

The results of this study indicate that national regulations in Indonesia, such as Ministry of Public Works Regulation No. 14/2017 and Ministry of Education Regulation No. 33/2008, remain limited to basic physical accessibility and have not yet accommodated the specific sensory needs of visually impaired students. These findings emphasize the importance of developing a multisensory-based design that integrates haptic, auditory, and olfactory systems as a more holistic approach to support five key aspects: navigation, safety, comfort, education, and stimulation. The design criteria can be seen in the following table:

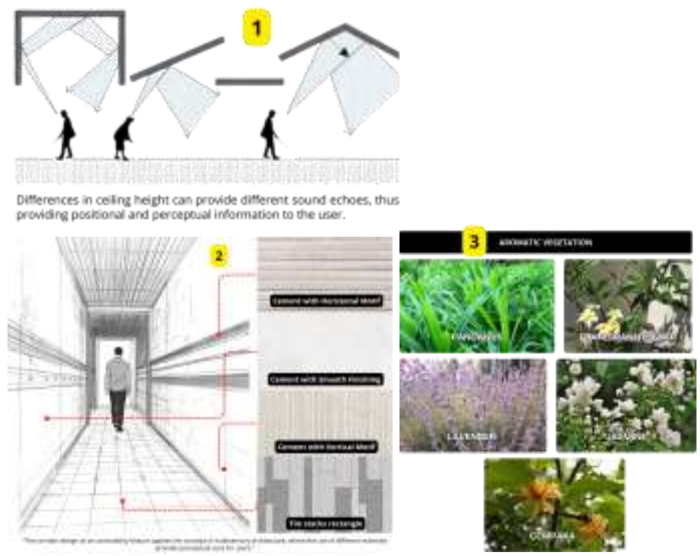
Table 1. Framework Design for Visual Impairment School

No.	Design Aspects	Aplication	Support Facilities
1	Navigation (Transforming physical elements into features that can provide information about the user's position and location when on site).	1. **Building circulation**: Guiding blocks are provided as connectors between different areas, such as from the parking area to the entrance and lobby, and from the lobby to each room. A guiding line is also extended along the corridor. 2. **Texture differences**: The design considers the selection of materials to help users perceive and recognize spaces more easily. 3. **Intersection design**: At turning points or intersections, guiding elements are added, such as changes in material, to signal direction. 4. **Interior Space**: Guiding blocks	

		are also applied in several rooms, but designed with interactive patterns, such as guiding blocks that use Braille letters.	
2	Safety (The design aims to ensure the safety of its users).	1. **Door and entrance design:** The use of contrasting colors on doors helps users with low vision to identify entrances more easily. 2. **Rounded walls:** The design applies rounded corners, both in room edges and furniture, to avoid sharp corners that may cause accidents. 3. **Space boundaries:** The use of elements such as handrails and curbstones provides users with a clearer understanding of spatial limits or boundaries.	

3	Comfort (The design provides comfort for its users.)	1. **Layout:** Certain rooms need to be arranged in a way that minimizes noise. 2. **Vertical garden:** Besides stimulating the sense of smell, it also provides comfort for users. 3. **Natural soundscape:** Created from sounds such as the trickling of fountains and the rustling of trees around the site. 4. **Aromatic vegetation:** The selection of aromatic plants provides comfort for the users' sense of smell. Examples include frangipani, jasmine, pandan leaves, lavender, and champaca. 5. **Minimalist colors**: The use of minimalist colors prevents overstimulation and supports comfort for	

		users with low vision.	
4	Education (The design does not only focus on aspects of navigation, safety, and comfort, but also provides information and education for its users).	1. **Mini library**: A mini library located at the corridor intersection serves as a space for both interaction and learning for students. 2. **Classrooms**: Designed to be interactive and enjoyable. Unlike typical classrooms, these are divided into several phases: Phase 1 (basic shapes), Phase 2 (complex shapes), Phase 3 (Braille), and Phase 4 (math, reading, and writing). 3. **Interactive walls**: Designed like lock-in toys that encourage children's curiosity and motivation to learn interactively. 4. **Interactive garden**: A garden designed not only to provide shade but also to function as a	

		learning and interaction space for users.	
5	Stimulation (Visually impaired individuals need stimulation that can enhance their perceptual skills and senses).	1. **Auditory stimulation**: The height of the ceiling can affect the echo of a room. The design can provide information to users through sound perception. Sound perception can also come from natural soundscapes such as rustling trees and water fountains. 2. **Tactile stimulation**: Users can understand spatial boundaries or areas through differences in materials. 3. **Olfactory stimulation**: Aromatic plants in the garden provide positive stimulation for the users' sense of smell.	

The design framework developed in this study offers a novelty by creating spatial guidelines that are not only functional but also attentive to non-visual spatial perception. This research connects regulatory data and design precedents through comparative analysis. Precedent studies from India, Mexico, and Thailand demonstrate more sensory adaptive design approaches, which have become important references in shaping this framework.

Nevertheless, it is important to recognize several potential challenges in applying this framework within the Indonesian context. Budget limitations may restrict the integration of advanced sensory features, while the maintenance of elements such as sensory gardens and tactile materials requires long-term institutional commitment. In addition, the availability of contractors and builders with adequate expertise in multisensory design remains limited, which could affect the quality of implementation. Acknowledging these challenges highlights the need for capacity building, careful planning, and sustainable policies to ensure that the proposed framework can be effectively realized in practice.

Conclusion

This study concludes that Indonesia's current regulations for special schools remain insufficient in fully addressing the unique sensory and spatial needs of visually impaired students. To bridge this gap, we developed a practical, multisensory design framework that guides the creation of school environments enhancing navigation, safety, comfort, education, and stimulation through haptic, auditory, olfactory, and visual elements. For architects and policymakers, an important next step would be to consider integrating these sensory-based guidelines into official building codes and initiate pilot projects to test the framework's effectiveness in real-world settings. Furthermore, this work opens important questions for future research, such as measuring the long-term impact of sensory-rich design on student learning and adapting the framework for different cultural contexts. By moving from theory to practical application, this framework offers a clear pathway to create truly inclusive schools that align with the global goal of quality education for all (SDG 4).

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