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Research Paper

Wayfinding and Navigation in Healthcare Infrastructure: A Case Study of AIIMS Jodhpur

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ABSTRACT: *India's healthcare infrastructure operates through a multi-tiered framework encompassing primary, secondary, and tertiary care institutions, guided by constitutional mandates and public health policies. Despite these provisions, spatial disparities in access remain pronounced, particularly in preventive care and chronic disease management, due to regional imbalances, infrastructural limitations, and workforce shortages. These challenges intensify within large tertiary care hospitals, where complex spatial configurations and dispersed service nodes hinder intuitive navigation. Patients and visitors frequently encounter cognitive strain and emotional distress while locating essential departments such as outpatient clinics, diagnostic units, and pharmacies. In the absence of a standardized navigational model, wayfinding strategies must be contextually adapted to accommodate demographic variability, including age, literacy, health condition, and cultural orientation. The deployment of effective wayfinding systems comprising legible signage, spatial zoning, and navigational aids plays a critical role in enhancing user experience and streamlining institutional workflows. Integrating cognitive and behavioral principles into environmental design not only reduces navigational frustration but also reinforces the operational and therapeutic efficacy of healthcare spaces. Future research could investigate how spatial logic and wayfinding challenges vary across public vs. private hospitals, or urban vs. rural healthcare settings, and further examine the use of spatial analysis tools to evaluate circulation efficiency, departmental adjacencies, and visual connectivity in relation to patient movement and institutional performance.*

KEYWORDS: *Healthcare Architecture, Wayfinding, Spatial Cognition, Patient-Centered Environments, Outpatient Department.*

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I. INTRODUCTION

India's healthcare delivery system operates through a multi-tiered administrative structure encompassing primary, secondary, and tertiary care institutions. This framework is governed by operational policies and regulatory mechanisms implemented by both central and state governments (Jaušovec & Gabrovec, 2023; Kumar, 2023). The public sector provides a wide spectrum of services, ranging from peripheral Primary Health Centers to advanced tertiary care hospitals, while the private sector complements service provision across urban and semi-urban regions. However, this amalgamation of public and private entities introduces significant challenges in maintaining equitable access and consistent quality of care across diverse geographical and socioeconomic contexts (Jana & Harata, 2016; Bajpai, 2014).

Structural and operational heterogeneity within facilities often leads to fragmented service delivery, complicating patient navigation, and referral pathways. In large institutional settings, patients frequently struggle to locate appropriate services, underscoring the need for clear and intuitive wayfinding systems (Tzeng & Huang, 2009). Robust signage, spatial zoning, and effective communication strategies are essential to inform patients about available services and guide them through complex healthcare environments (Sheikh & Kanyal, 2023). Such interventions not only enhance patient engagement but also foster stronger connections between healthcare providers and the communities they serve. Ultimately, well-designed wayfinding systems contribute to seamless patient flow, reduced cognitive burden, and optimized resource utilization, reinforcing their role as a critical component of holistic healthcare delivery (Jamshidi et al., 2020).

II. BACKGROUND AND RATIONALE

2.1 Aspects of Hospital Services

Hospital services encompass a wide range of medical, surgical, and supportive care functions, each requiring clear departmental organization and cohesive circulation systems to ensure efficient delivery (Sheikh & Kanyal, 2023). These include outpatient, inpatient, and emergency services, which demand distinct yet interconnected physical zones that patients must navigate. The effectiveness of these pathways directly influences clinical outcomes, resource allocation, and operational efficiency (Yinusa & Faezipour, 2023).

In complex hospital environments, intuitive wayfinding systems are essential for guiding patients through their care journey, minimizing stress, and improving access to services (Shen et al., 2020). Physical environments act as tangible cues that communicate service quality and shape patient perceptions (Baker, 1992). Well-designed wayfinding contributes to smoother patient flow, enhances productivity, and reduces risks associated with delays and disorientation (Gualandi et al., 2019; Åhlin et al., 2023). Conversely, poorly structured layouts can lead to frustration and inefficiencies (Wahyuningrum & Wardhani, 2020).

Integrating wayfinding strategies early in the design phase, with attention to human behavior, psychological comfort, and staff ergonomics, has been shown to improve patient satisfaction and healing outcomes (Abinama & Jafari, 2015). This holistic approach ensures that spatial organization aligns with both operational goals and patient-centered care.

2.2 Areas of High Unfamiliarity for Patients

In large healthcare environments, areas such as outpatient departments, diagnostic centers, and pharmacies are frequently identified as zones of high unfamiliarity and disorientation for patients (Sheikh & Kanyal, 2023). These spaces, marked by specialized functions and high patient footfall, often feature complex spatial configurations that challenge even repeat visitors (Gulwadi et al., 2009). Navigational ambiguity in these zones contributes to elevated stress levels, diminished confidence, and reduced satisfaction with care delivery (Finaritra, 2021).

The initial impression formed through environmental clarity, particularly signage and spatial layout, plays a critical role in shaping perceptions of service quality and institutional competence (Khatib et al., 2024). Effective wayfinding must integrate both physical design and cognitive behavioral insights to facilitate seamless movement and reduce emotional strain (Gath-Morad et al., 2024; Wei et al., 2025). Ergonomic factors such as signage placement and readability are essential to accommodate diverse patient demographics and ensure interpretability (Basri & Sulaiman, 2013).

By proactively addressing wayfinding challenges in unfamiliar zones, healthcare institutions can enhance patient engagement, foster trust, and improve operational outcomes (Kim et al., 2021; Ubery & Ernawaty, 2024). A well-designed wayfinding system becomes a strategic asset in delivering patient-centered care and meeting stakeholder expectations.

2.3 Research Context

This study is situated within the ambulatory care facilities of the All India Institute of Medical Sciences (AIIMS) Jodhpur, a tertiary healthcare institution serving a diverse patient population in western India. The research focuses specifically on the outpatient care environment, which comprises a range of functional zones distributed across both the ground and upper levels of the complex. These zones include consultation suites, diagnostic services, waiting areas, and support functions that collectively shape the patient journey.

Central to the investigation is an analysis of spatial organization, circulation networks, and architectural features that influence wayfinding behavior. Particular attention is given to how spatial layout, vertical and horizontal movement systems, and environmental cues affect user orientation and navigation. This contextual foundation enables a systematic evaluation of wayfinding performance, with the aim of informing patient-centered design strategies that enhance spatial legibility, reduce cognitive load, and improve overall healthcare experience.

III. AIIMS JODHPUR - SPATIAL CHARACTERISTICS

At AIIMS Jodhpur, the spatial layout, circulation networks, and signage systems form an integrated framework that significantly influences user navigation and overall experience within the ambulatory care zones. This study evaluates both macro-level spatial organization and micro-level design elements to understand how individuals perceive and interact with the built environment (Gath-Morad et al., 2024). Key design features such as visual access, architectural clarity, and landmark placement are examined for their role in supporting intuitive spatial comprehension (Buuren & Mohammadi, 2021; Buuren et al., 2025).

Special attention is given to the effectiveness of existing signage and architectural cues in facilitating orientation and reducing anxiety among patients (Kuliga et al., 2021; Davis & Calkins, 2022; Passini et al.,

2000). The assessment combines qualitative observations with quantitative spatial analysis to identify zones of confusion and inefficiency within the circulation system (Grzywinski et al., 2019). It further explores departmental connectivity and highlights critical nodes and bottlenecks that may hinder seamless movement (Köken et al., 2015).

This holistic investigation informs the development of evidence-based design strategies aimed at improving spatial legibility, enhancing user confidence, and fostering a safer, more efficient healthcare environment (Waller & Masterson, 2015; Wiener & Pazzaglia, 2021).

3.1 Spatial Layout

The architectural layout of AIIMS Jodhpur reflects a hierarchical spatial organization typical of tertiary care institutions, with distinct zones for outpatient services, diagnostics, and administrative functions (Hölscher et al., 2008). While this segmentation supports operational efficiency, it also introduces circulation complexity, especially for first-time users navigating the facility (Kuliga et al., 2021). The layout plan illustrates a central axial corridor extending from Gate No. 4 through the OPD drop-off and lobby, connecting Blocks A, B, and C via designated circulation paths. Three distinct circulation routes are used to guide patient movement within the outpatient department of AIIMS Jodhpur, each represented by a specific colour in the layout plan (Figure 1). The purple line indicates external circulation, directing patients from Gate No. 4 through the OPD drop-off zone and into the main lobby. The green line represents the route for first-time check-ups, leading patients from the registration counter through the lobby and into Blocks A,B, and C via Core 1. The yellow line marks the circulation of follow-up patients, extending from the central corridor through Core 1, ultimately reaching Blocks A,B,C. These circulation paths reflect a layered movement system that supports phased patient flow across functional zones, though their visual differentiation within the built environment remains limited, necessitating stronger spatial cues for intuitive navigation. Although these paths are functionally defined, their visual differentiation within the built environment remains limited, increasing the likelihood of disorientation. Core 1 and Core 2 serve as vertical circulation nodes, yet differ in spatial positioning and perceptual clarity.

This highlights the importance of patient-centered design strategies that improve spatial legibility and reduce cognitive load. Aligning circulation logic with intuitive spatial markers can enhance navigational ease, operational efficiency, and user confidence in complex healthcare environments like AIIMS Jodhpur.

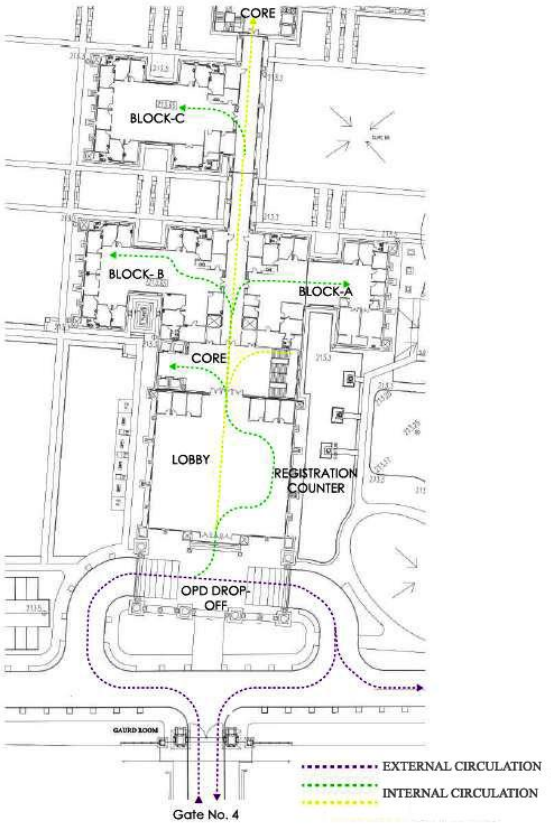

Figure 1. Access and spatial layout – OPD zone

3.2 Zoning and Functional Clustering

The Outpatient Department (OPD) zone at AIIMS Jodhpur is organized into three distinct blocks (A, B, and C) linked by a central corridor measuring 4.5 meters in width (Figure 3). This corridor provides primary circulation across the blocks and is serviced by two vertical cores, of which only one is equipped with toilet facilities. (Figure 2) represents stacking of various specialisations across different OPD Blocks. The OPD block has a floor-to-floor height of 4.2 meters, with a beam soffit height of 3.6 meters and a resultant clear height of 2.8 meters, thereby ensuring adequate spatial proportions for clinical functions. The total floor plate area of the OPD, inclusive of the structural core, is approximately 3,500 sq.m. Internal connectivity between blocks is further facilitated by a floor-to-floor ramp that links Block B with Block C, providing an alternative to vertical circulation via stairs or lifts (Figure 3).

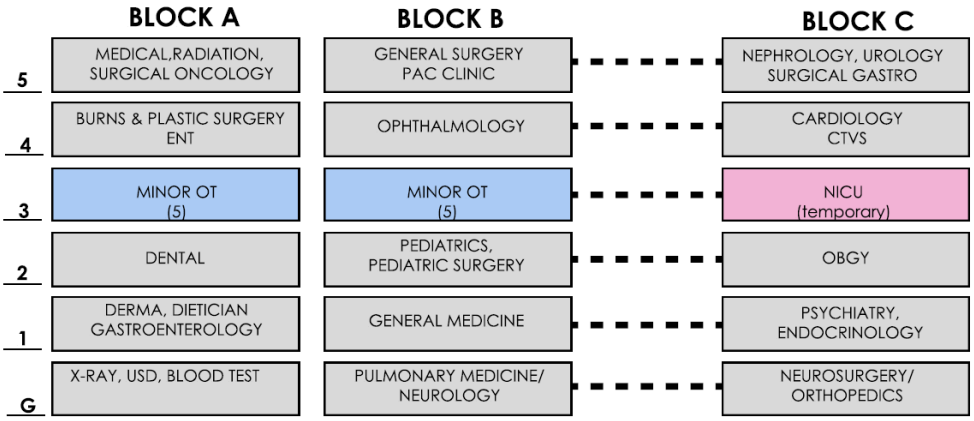

Figure 2. Stacking of various specialisations across different OPD Blocks

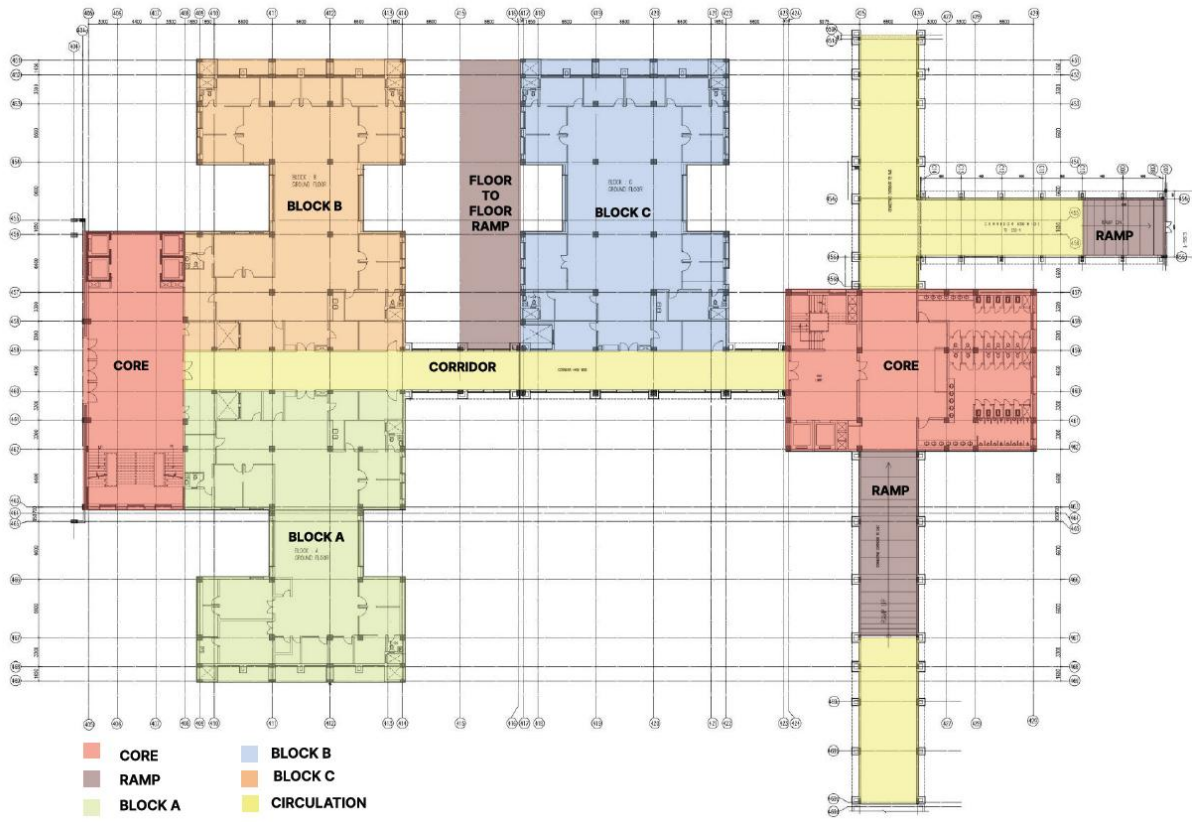

Figure 3. Zoning and functional clustering of outpatient department (OPD) zone

OPD Blocks at AIIMS Jodhpur feature a clearly zoned layout with circulation paths designed to support outpatient care consultations. The plan is anchored by a centrally located waiting area, which serves as the primary orientation node and visual anchor for incoming patients (Figure 4). Surrounding this hub are consultation rooms, surgery units, and allied diagnostic spaces such as the EEG and P.F.T. rooms, organized to facilitate adjacency-based efficiency. The entry sequence is direct, leading users into a wide corridor that transitions seamlessly into the waiting zone, minimizing initial disorientation. Administrative and support functions are positioned along peripheral corridors, maintaining clinical privacy while ensuring operational accessibility. Shaft placements are strategically distributed to support vertical service integration without disrupting patient flow. Overall, the layout balances clarity, accessibility, and functional proximity, demonstrating a patient-centered design approach that supports intuitive navigation and efficient service delivery within a high-footfall outpatient setting.

Figure 4. Internal layout plan of OPD Block-B

IV. ANALYSIS

4.1 Wayfinding Dynamics in Modular OPD Layouts

Hospitals may adopt diverse spatial layout typologies: symmetric (characterized by repetitive, regularly arranged units), asymmetric (comprising non-uniform configurations), or organic spatial arrangement. At AIIMS Jodhpur, the Outpatient Department (OPD) exemplifies a Modular OPD Layout with multiple units organized in a uniform, repetitive sequence along a regular grid. This spatial regularity offers distinct advantages as it reinforces mental mapping for repeat visitors, reduces spatial ambiguity through predictable patterns, and facilitates navigation when one unit structurally resembles another.

However, for first-time visitors or patients unfamiliar with the environment, such repetition may induce spatial confusion. Repeated blocks often lack distinguishing landmarks or sufficient visual differentiation, which can result in disorientation. Identical units tend to obscure decision points, making it difficult for users to discern which module corresponds to their appointment or destination. In such scenarios, reliance on signage intensifies, as visual cues become critical navigational anchors compensating for the absence of spatial distinctiveness. Thus, while a Modular OPD Layout supports wayfinding for familiar users, it may hinder spatial intelligibility for novices unless complemented by strong landmarks, differentiated visual elements, or strategically placed signage (Augustin et al., 2004).

4.2 Environmental Cues at AIIMS Jodhpur

The integration of the built environment with external cues can significantly enhance spatial awareness and reduce the perception of being in an enclosed, disorienting space, offering visual relief and orientation points. This approach can help in the formation of coherent cognitive maps by providing salient environmental features that act as landmarks (Carlson et al., 2011). Strategic placement of windows offering views of recognizable outdoor elements or courtyards can provide crucial orienting information, aiding in the development of a structured mental representation of the hospital's layout (Werner & Schindler, 2004). Incorporating natural elements and varied textures can subtly differentiate areas, reducing monotony and

supporting spatial memory and recognition, which is crucial for reducing cognitive load during navigation (Lindblom & Thorvald, 2019). The deliberate use of varied lighting schemes and unique architectural elements further assists in segmenting large spaces into more manageable and recognizable zones, reducing the likelihood of users feeling lost or overwhelmed (Jeloudarlou et al., 2021). Such strategies not only improve spatial orientation but also contribute to a more positive emotional state for patients and visitors by reducing anxiety associated with navigating complex environments (Lindblom & Thorvald, 2019).

AIIMS Jodhpur features a range of environmental cues that play a critical role in enhancing wayfinding performance and supporting spatial orientation. Signage systems are strategically positioned at key decision points, providing directional guidance and reinforcing the spatial hierarchy of the facility. Complementing these are coloured floor strips that guide movement along primary circulation routes, offering an intuitive visual reference for patients and visitors. Together, these elements create a layered system of cues that enhance navigation efficiency while reducing cognitive load in a complex healthcare environment.

4.3 Color-coded strips on Flooring as Wayfinding Cues

At AIIMS Jodhpur, colour-coded strips installed on corridor flooring function as intuitive wayfinding cues within the modular hospital layout. These linear visual elements use distinct, department-specific colors to guide patients toward outpatient units (Figure 5). In settings where spatial repetition prevails, such as modular OPD blocks with identical architectural configurations, these strips improve environmental legibility by introducing immediate visual contrast. For first-time visitors, they lower cognitive effort and reduce reliance on verbal directions or static signage. Signage is typically positioned at eye level, where human visual attention is naturally oriented. In contrast, floor-based cues require a shift in perceptual focus. Observing and following colored strips at foot level may demand additional visual sensitivity and attentional adjustment, especially in crowded or visually cluttered environments. The system reflects principles of visual cueing and spatial hierarchy, enabling users to associate specific colors with destination zones and facilitating route identification and movement. When combined with directional signage and spatial zoning, colored floor strips act as navigational aids in healthcare environments where architectural uniformity may challenge orientation (Passini, 1996; Carpman and Grant, 2002; Peponis et al., 1990).

Figure 5. Provision of color-coded strips on flooring as wayfinding cues

4.4 Vertical Circulation and Wayfinding

Vertical circulation systems are integral to the spatial organization of multilevel healthcare facilities. In the ambulatory care zone of AIIMS Jodhpur, two primary vertical circulation cores, identified as Core 1 and Core 2, are positioned symmetrically along a central corridor with a measured distance of 70m between them (Figure 6). These cores accommodate elevators and staircases that enable vertical movement across floors, and also include service shafts for mechanical and utility functions. Although both cores fall along the same axial path, their spatial proportions and perceptual accessibility differ. Core-1 is recessed from the main corridor, which may reduce its visual prominence and make it less intuitive to locate. However, its larger footprint

facilitates better patient holding capacity compared to Core-2, making it functionally advantageous during peak outpatient hours (Figure 7). In contrast, Core-2 is more visually aligned with the corridor and easier to perceive. Within a modular and repetitive spatial configuration, such variation in core design influences wayfinding performance. The disparity in core proportions and alignment underscores the need for consistent visual hierarchy and environmental cueing to support intuitive navigation in healthcare settings.

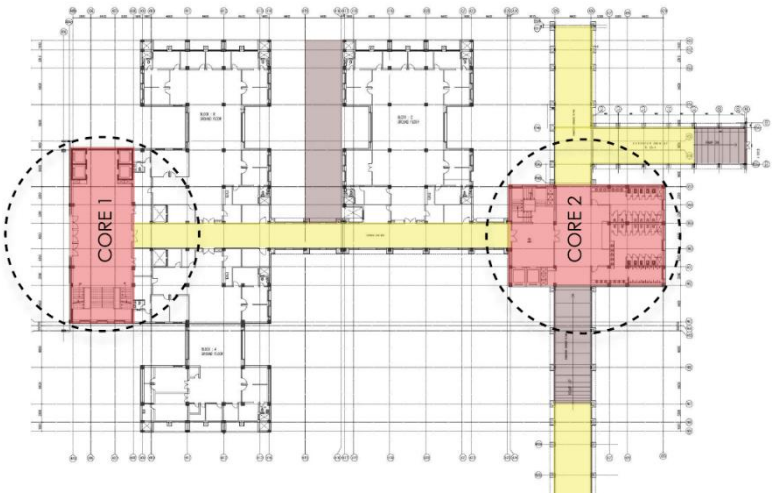

Figure 6. Positioning of vertical circulation cores at AIIMS Jodhpur

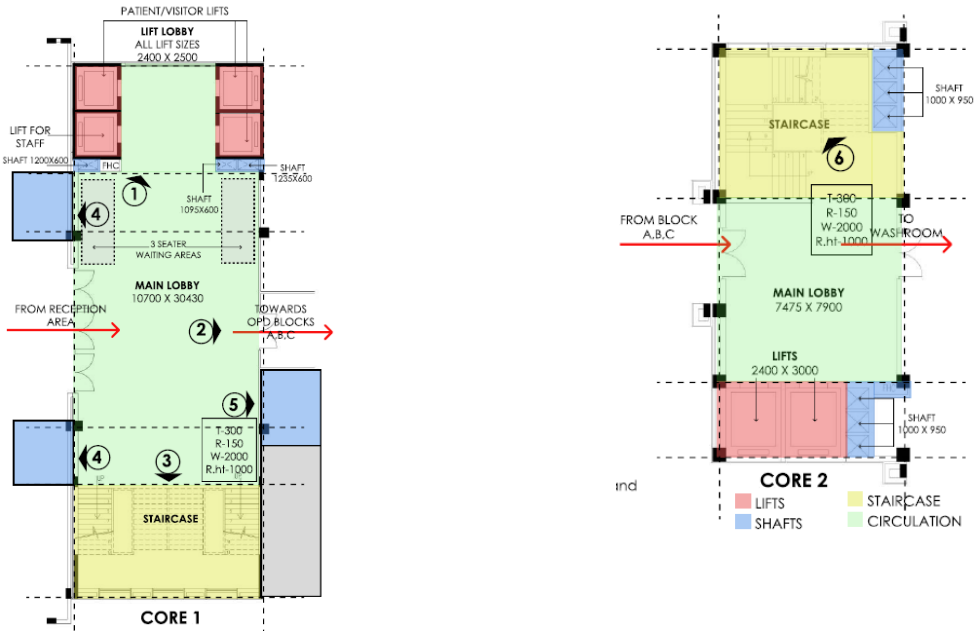

Figure 7. Layout of vertical circulation Core-1 & Core-2 at AIIMS Jodhpur

4.5 Wayfinding Anchors and Landmarks

Wayfinding anchors and landmarks, encompassing both permanent architectural features and strategically placed visual cues, are critical for enhancing spatial cognition and environmental legibility within sprawling healthcare complexes (Lee et al., 2020). These elements serve as vital reference points, aiding individuals in forming accurate mental maps and reducing cognitive load during navigation (Greenroyd et al., 2017). Effective wayfinding systems minimize disorientation, which can be particularly stressful in healthcare settings, and improve the overall patient experience by making complex environments easier to navigate (Bubric et al., 2020). These anchors, such as distinctive artwork, unique architectural elements, or clearly identified departments, offer visual prominence that supports intuitive directional understanding (Trzpuc et al., 2016) (Sui et al., 2023). In complex healthcare environments, distinctive landmarks play a crucial role in supporting spatial orientation and route recognition. Landmarks are defined as visually salient, functionally significant, or

structurally unique elements that anchor mental maps and assist users in identifying decision points and confirming progress along a path (Lynch, 1960; Passini, 1992).

At AIIMS Jodhpur, the spatial layout presents a repetitive architectural configuration with minimal visual differentiation between blocks. The absence of prominent environmental cues such as sculptures, color-zoned walls, or unique spatial features contributes to a homogenous experience that may hinder intuitive navigation. First-time visitors often face difficulty forming cognitive associations between spatial zones and destinations. This limitation increases dependence on signage and verbal instructions, which may not be sufficient in high-traffic or linguistically diverse settings. The lack of environmental legibility can impair wayfinding performance and elevate stress levels in healthcare contexts where clarity and efficiency are essential (Carpman and Grant, 2002; Arthur and Passini, 1992).

4.6 Signage

Signage provisions at AIIMS Jodhpur play a central role in facilitating wayfinding across its different zones. Directional signs are placed at key decision points, including corridor junctions, block entrances, and departmental thresholds (Figure 8). These signs use bilingual text in Hindi and English, supported by color-coded boards and arrows to enhance legibility for a linguistically diverse user base. Prominent identifiers such as “OPD Block A, B & C” and department-specific boards like “PMR” or “Pulmonary Medicine” are mounted at eye level, aligning with established principles of visual accessibility (Carpman and Grant, 2002). However, the signage system relies heavily on textual information, with limited use of pictograms or universally recognizable symbols. In high-footfall zones, visual clutter and overlapping boards may reduce clarity. Effective signage design in healthcare settings must combine linguistic clarity, graphic simplicity, and strategic placement to support intuitive navigation and reduce spatial anxiety (Rousek and Hallbeck, 2011; Mollerup, 2013).

Figure 8. Various signage provisions at AIIMS Jodhpur

V. CONCLUSION

The findings presented in this study affirm the critical role of spatial navigation systems in shaping healthcare delivery and institutional performance. (Table 1) represents functional attributes and wayfinding performance of various spatial zones Navigational clarity, supported by well-integrated signage, spatial zoning, and digital tools, contributes directly to patient safety, operational efficiency, and institutional credibility. When aligned with cognitive and behavioral principles, these systems reduce psychological strain and enhance the overall healthcare experience. Their influence extends beyond functional utility, impacting perceived service quality, patient satisfaction, and long-term engagement. Embedding navigational strategies within the architectural and operational framework of healthcare facilities is essential for advancing patient-centered design and achieving measurable improvements in service outcomes. Furthermore, the integration of wayfinding systems must be viewed not merely as a technical intervention but as a spatial ethic that reflects institutional empathy and inclusivity. Future research could examine how spatial logic and navigational challenges vary across healthcare typologies, and assess circulation efficiency using established spatial analysis tools to inform more context-sensitive design frameworks.

Table1: Functional attributes and wayfinding performance of various spatial zones

Spatial Zone	Primary Function	Observations	Wayfinding Support Present	User Experience
Entry & Drop-off Zone	Arrival and transition	Lack of visual cues, crowding	Basic signage	Initial disorientation, anxiety
Registration Counter	Patient intake and documentation	High footfall, Long queues	Static signage	Crowding, delayed processing
Waiting Area	Patient holding zone, Pre-consultation buffer	Overlapping flows, high occupancy	Staff Reliance, Wall mounted signages	Mixed comfort, spatial ambiguity
Block A & Block-B	Consultations	Repetitive layout, low visibility of room labels	Wall-mounted signs, Color-coded floor strips	Mild disorientation
Core-1	Vertical circulation & transition to Block A, B, C	Recessed placement of elevators, low perceptual visibility	Wall-mounted signs, Digital Floor Plan on LED Board	Missed transitions, delayed movement
Core-2	Vertical circulation, transition to other zones of the hospital, toilet block	Fair perceptual visibility	Wall-mounted signs, Digital Floor Plan on LED Board	Mild disorientation
Block C	Consultations	low visibility of room labels	Wall-mounted signs, Color-coded floor strips	Mild disorientation

A positive patient experience, shaped by intuitive spatial wayfinding, contributes meaningfully to emotional comfort and perceived quality of care (Quigley et al., 2021). This enhanced satisfaction fosters trust in the healthcare environment and encourages deeper engagement between patients and the broader care community (Wang et al., 2024). When spatial navigation is seamless, patients are more likely to feel autonomous and respected, which reinforces their psychological readiness to participate in treatment and follow-up care. Such environments also reduce the cognitive burden associated with unfamiliar settings, allowing patients to focus on their health needs rather than logistical concerns. Over time, this sense of spatial ease cultivates a more inclusive and empathetic care culture, where patients perceive themselves as active participants rather than passive recipients. The cumulative effect of these spatial interactions can influence long-term health-seeking behavior, institutional loyalty, and community-level perceptions of healthcare accessibility and dignity.

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