
OPTIMIZING PATIENT FLOW IN WAYFINDING AND FUNCTIONAL ZONING IN TRAUMA HEALTHCARE FACILITIES

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ABSTRACT

Trauma-related mortality and morbidity in Nigeria are compounded by healthcare facilities whose spatial organization was never designed to meet the demands of emergency and trauma care. The physical configuration of a healthcare building—its circulation systems, functional zoning, and departmental adjacency—directly determines whether clinical intervention reaches patients efficiently and safely. This study aimed to examine how circulation systems and spatial layout configurations influence the operational efficiency, clinical safety, and user functionality of trauma healthcare facilities in Nigeria. A qualitative descriptive case study design was employed. Two Nigerian facilities were purposively selected: the Ondo State Trauma and Surgical Centre, Ondo—a purpose-built trauma facility and the Accident and Emergency Unit of the National Orthopaedic Hospital, Igbobi, Lagos—an adapted facility. Structured visual field surveys were conducted at both sites in 2024 and analysed using a thematic comparative framework assessed against WHO, AIA, and evidence-based design standards. The purpose-built facility outperformed the adapted facility across all five criteria examined: entrance accessibility, horizontal circulation efficiency, functional zoning, vertical circulation provision, and wayfinding effectiveness. The most critical deficiency identified at the adapted facility was the spatial separation of the intensive care unit from the surgical suite—a departmental adjacency failure with direct patient safety consequences. Even the better-performing facility exhibited incomplete separation of public and clinical circulation routes, indicating that purpose-built design is necessary but not sufficient for optimal spatial performance. Design origin is the primary determinant of spatial performance in Nigerian trauma facilities, shifting the policy imperative from reactive

infrastructure upgrading toward evidence-based planning standards enforced at the commissioning stage.

KEYWORDS: trauma centre design, healthcare circulation, spatial layout, functional zoning, evidence-based design, Nigeria

INTRODUCTION

Road traffic crashes, occupational injuries, and violent trauma collectively constitute one of the most significant and underaddressed public health burdens in sub-Saharan Africa. In Nigeria alone, the World Health Organization estimates that road traffic injuries account for over 40,000 deaths annually, with millions more requiring emergency surgical and trauma care a demand that existing healthcare infrastructure is critically ill-equipped to meet (WHO, 2021). Globally, the Lancet Commission on Global Surgery has established that 5 billion people lack access to safe, affordable surgical care, with low- and middle-income countries bearing 93% of the world's burden of surgically treatable conditions (Meara et al., 2015). Within this context, the design of trauma healthcare facilities is not just a initial architectural concern it is a determinant of whether care reaches patients at all, and whether it reaches them in time. Poorly designed circulation pathways, inadequate spatial zoning, and ineffective wayfinding systems have been shown to delay patient access to emergency care, increase staff travel distances, and heighten anxiety among both patients and caregivers (Ahmed et al., 2020; Ulrich et al., 2008). Joseph and Rashid (2007) demonstrated that the physical configuration of a healthcare building directly shapes clinical response capacity, patient safety, and operational efficiency, establishing built environment design as a legitimate and consequential variable in healthcare outcomes research.

Within Nigeria, this challenge is acute and growing. Ibadan alone is among the fastest-growing cities in sub-Saharan Africa, with a metropolitan population approaching six million is driving a sustained increase in trauma incidence at a pace that existing healthcare facilities are structurally unprepared to absorb (UN-Habitat, 2022). Many of the institutions currently designated to provide trauma and emergency care were not designed for that purpose: they are repurposed colonial-era buildings, military rehabilitation facilities, or general hospitals expanded incrementally without reference to the spatial logic that trauma care demands. The consequences are observable and documented. Ahmed et al. (2020) found that complex and poorly organised layouts in Nigerian hospitals directly impair wayfinding performance, heighten patient and visitor anxiety, and delay access to appropriate care conditions that, in a

trauma context, translate into preventable deterioration and death. These conditions generate tangible operational failures: emergency units located distant from surgical suites, intensive care wards disconnected from related clinical departments, and public circulation routes that intersect with restricted clinical areas all of which impede the rapid, coordinated patient flow that trauma care demands (Olatunji, 2022). Yet despite the scale and urgency of this problem, the spatial design of Nigerian trauma facilities has received negligible systematic scholarly attention.

The broader literature on healthcare facility design has established robust principles for circulation efficiency, functional zoning, and evidence-based spatial organisation (Ulrich et al., 2008; Zimring et al., 2005). Studies have demonstrated that optimized spatial planning can reduce patient transfer distances by up to 33%, thereby improving throughput and quality of care (Mäkelä et al., 2022), also Studies have demonstrated that linear and structured circulation typologies outperform informal or ad hoc corridor arrangements in terms of movement predictability and staff workflow (Ching, 2023); that deliberate functional zoning separating public, clinical, and support zones reduces infection risk and operational congestion (Lee & Kim, 2022); and that integrated wayfinding systems produce measurable improvements in user orientation and satisfaction (Gomez & Liu, 2023). However, this body of knowledge has been developed almost exclusively in high-income, purpose-built hospital contexts internationally. Its application to Nigerian healthcare facilities and specifically to the trauma centre typology, with its distinct programmatic demands of simultaneous high-acuity patient management, rapid multi-directional staff deployment, and critical departmental adjacency requirements has not been examined. No study has directly compared the circulation and spatial layout performance of purpose-built and adapted trauma facilities within the Nigerian context using a consistent observational framework. This is the gap the present study addresses.

This study examines how circulation systems and spatial layout configurations influence the operational efficiency, clinical safety, and user functionality of trauma healthcare facilities in Nigeria, using comparative field observation of two contrasting institutional cases in order to generate evidence-based design principles for a proposed trauma centre in Oyo State. The specific research objectives are: first, to analyse and compare the circulation systems and spatial layout configurations of two selected Nigerian trauma and orthopaedic healthcare facilities; second, to assess how spatial configuration relates to operational efficiency, patient flow, and staff movement in each facility; and third, to identify evidence-based design strategies for circulation and spatial planning applicable to the proposed Oyo State Trauma

Centre. The remainder of this article is structured as follows: Section 2 presents a thematic review of the relevant literature on healthcare circulation, spatial layout, and evidence-based design in the Nigerian context. Section 3 describes the research methodology, including case selection criteria, data collection protocol, and analytical framework. Section 4 presents the findings organised thematically across five spatial criteria. Section 5 discusses the findings in relation to existing literature and their implications for practice and policy. Section 6 states the conclusion and directions for future research.

LITERATURE REVIEW

Circulation Systems in Healthcare Facility Design

Circulation in healthcare facilities encompasses far more than the physical arrangement of corridors; it is a foundational determinant of operational efficiency, infection control, and patient safety. Joseph and Rashid (2007) established that the architecture of healthcare spaces directly governs how patients, staff, and equipment move through a building, arguing that poorly conceived circulation pathways contribute to delayed clinical responses, staff fatigue, and compromised care outcomes. A systematic review of hospital circulation zones identified links between circulation design and wayfinding difficulties, spatial disorientation, communication patterns, noise levels, falls, and stress (Jiang & Verderber, 2017). This position has been consistently reinforced in subsequent study. Smith et al. (2021), writing in the context of post-COVID healthcare redesign, demonstrated that inadequate separation of circulation zones—particularly between clinical and public areas—significantly elevates cross-infection risk, calling for deliberate pathway planning in both new-build and retrofit facilities. Lee and Kim (2022) extended this argument to emergency and quarantine environments specifically, where the spatial logic of route configuration can either accelerate or obstruct clinical response times with direct consequences for patient survival.

These studies agree that linear and loop-based circulation systems consistently outperform irregular or uncoordinated corridor arrangements in terms of predictability and movement efficiency. However, a critical limitation of this body of work is that it has been developed almost exclusively within high-income, purpose-built hospital contexts in North America and Europe. The applicability of these findings to Nigerian healthcare facilities—many of which were not originally designed as hospitals and have been incrementally adapted over decades—has received negligible systematic attention. Meka et al. (2023) began to address this gap by demonstrating how the spatial relationship between a hospital building and its surrounding urban fabric can obstruct emergency access, a problem particularly acute in dense Nigerian

cities. Yet their focus remained at the urban rather than the building scale. The internal circulation logic of Nigerian trauma and orthopaedic facilities, and the specific consequences of adaptive reuse for circulation performance, remain underexamined in the literature.

Spatial Layout, Zoning, and Wayfinding in Nigerian Healthcare Contexts

Spatial layout is the deliberate organisation of departments, support areas, and patient zones. It is widely recognised as a critical variable in healthcare performance globally. Ulrich et al. (2008), in one of the most cited reviews in healthcare design research, established that thoughtful spatial organisation reduces patient stress, supports staff workflow, and produces measurable improvements in clinical outcomes. Zimring et al. (2005) formalised the principle of functional zoning – the separation of clinical, administrative, and public zones to minimise workflow interference – as a cornerstone of evidence-based healthcare design. Johnson and Patel (2020) subsequently argued that flexible spatial layouts, capable of adapting to changing healthcare demands without disrupting circulation logic, are increasingly essential in hospital planning.

Within the Nigerian context specifically, Ahmed et al. (2020) provided one of the most directly relevant contributions to this literature, finding that complex and poorly organised building layouts in Nigerian hospitals directly impair wayfinding performance and heighten anxiety among patients and visitors. Their study, conducted across multiple Nigerian hospital environments, demonstrated that users unfamiliar with a facility's layout experienced significant disorientation, increased stress, and delays in accessing appropriate care areas – outcomes with particular severity in trauma and emergency contexts where time is clinically critical. Olatunji (2022) applied space syntax analytical methods to Nigerian hospital floor plans and confirmed that prevailing spatial configurations inhibit efficient movement and generate operational bottlenecks, attributing these deficiencies partly to the absence of standardised spatial planning guidelines enforced at the design and approval stage.

Despite these contributions, existing Nigerian-focused studies have addressed wayfinding and spatial layout in general hospital settings rather than trauma-specific facilities. The particular programmatic demands of trauma care – simultaneous multi-directional movement of high-acuity patients, rapid staff deployment across interdependent clinical zones, and the need for immediate adjacency between emergency, theatre, and intensive care units – have not been examined as a distinct design challenge in the Nigerian literature. This gap is the precise problem this study addresses.

Evidence-Based Design and Healthcare Infrastructure in Nigeria

Evidence-based design the systematic application of research findings to inform architectural decisions in healthcare settings has gained considerable traction in North American and European hospital planning over the past two decades (Ulrich et al., 2008). Studies from these contexts have consistently demonstrated that deliberate design interventions, including decentralised nurse stations, optimised departmental adjacencies, and integrated wayfinding systems, produce measurable improvements in patient recovery times, staff retention, and operational throughput (Hendrich et al., 2008; Wang et al., 2022).

However, the application of Evidence-based design principles to Nigerian healthcare infrastructure has been uneven and largely aspirational rather than systematic. Many facilities across Nigeria continue to operate within building stock that predates contemporary design thinking entirely, having been constructed or adapted with limited reference to evidence-based spatial standards (Ahmed et al., 2020). The National Orthopaedic Hospital, Igbobi originally established as a military rehabilitation camp in 1943 and subsequently designated as a national trauma and orthopaedic centre represents an extreme but instructive case of this condition: a facility whose spatial organisation reflects its military origin rather than the clinical logic of the trauma care it now delivers. The WHO (2021) and AIA (2022) provide broad international spatial standards for healthcare facilities, but these guidelines do not account for the particular programmatic demands of trauma care, nor for the resource constraints, climate conditions, and site characteristics of mid-sized Nigerian cities. In sum, while the global literature establishes robust principles for healthcare circulation, spatial zoning, and evidence-based design, there is a notable absence of studies that bring these three themes together within the specific context of trauma centre design in Nigeria. Existing research has either addressed circulation in general Nigerian hospital settings, examined wayfinding in isolation, or applied Evidence based design frameworks without reference to West African conditions. This study addresses that directly by examining two Nigerian trauma and orthopaedic facilities in depth, generating design recommendations grounded in locally observed conditions and internationally established evidence.

METHODS

Research Design

This study employed a qualitative, descriptive case study design to investigate circulation systems and spatial layout configurations in trauma and emergency healthcare facilities within Nigeria. The case study method was selected because it enables in-depth, contextually

grounded examination of real-world phenomena within their natural settings particularly appropriate when the boundaries between the phenomenon and its context are not clearly defined (Yin, 2018). This design was well suited to the research aim of identifying design strategies for improving circulation and spatial organisation in Nigerian trauma centres, where spatial conditions, operational patterns, and user behaviours are highly context-dependent and resist reduction to standardised metrics alone.

Study Setting and Case Selection

Two healthcare facilities were purposively selected as case study sites, both located in southwest Nigeria and both providing trauma care as primary or significant institutional functions. The first was the Ondo State Trauma and Surgical Centre, located on Medical Village, Laje Road, Ondo Town, Ondo State. Established as Nigeria's first dedicated, purpose-built trauma care facility, the centre covers approximately 49,000 square metres and provides a comprehensive range of services including emergency outlet, resuscitation, trauma theatre, intensive care, radiology, laboratory, pharmacy, and in-patient wards across male, female, and paediatric categories. Its purpose-built status and comprehensive departmental programme made it the most structurally complete Nigerian trauma facility available for study and an appropriate benchmark against which adapted facilities could be assessed. The second site was the Accident and Emergency Unit of the National Orthopaedic Hospital, Igbobi, located at Onipan Bus Stop, Yaba, Lagos State. Established in 1943 as a rehabilitation facility for soldiers returning from the Second World War and subsequently redesignated as a national orthopaedic and trauma centre, the hospital is the largest and most historically significant trauma management institution in Nigeria and sub-Saharan Africa. Its origins as a non-purpose-built facility, combined with its scale and institutional prominence, made it an analytically valuable contrast case representing the condition of adaptive reuse under which a large proportion of Nigerian healthcare infrastructure operates. Sites were selected on the basis of four purposive criteria: institutional relevance to trauma care as a primary function; variation in design origin purpose-built versus adapted to enable comparative insight into the effect of planning typology on spatial performance; geographic location within southwest Nigeria, ensuring contextual comparability in terms of climate, urban density, and healthcare system characteristics; and accessibility for direct field observation by the researcher. Convenience of access was not the primary selection rationale; the contrasting institutional histories and design typologies of the two sites provided the analytical logic for their selection.

Data Collection

Data were collected through direct visual field surveys conducted by the researcher at both case study sites during facility visits in 2024. Each facility was visited on 2 occasions, with the visit lasting approximately six hours, conducted during operational hours between 9am and 5pm, to capture typical patient and staff movement patterns. Observations were conducted across both peak and off-peak periods where possible to ensure representativeness of circulation behaviour. A structured observation protocol was applied consistently across both sites, covering the following spatial criteria: entrance configuration, visibility, and accessibility provisions including ramp availability, door clearance, lighting, and emergency exit marking; corridor widths, linearity, and the presence or absence of separation between public and clinical circulation routes; functional zone arrangement, including the spatial relationship between emergency, theatre, intensive care, in-patient, and support departments; vertical circulation provision, including staircases, ramps, and lift availability and placement; nurse station positioning and visual oversight of patient areas; wayfinding elements including signage, colour coding, and spatial landmark features; and external circulation, including vehicular access, pedestrian pathways, and parking provision. Observations were recorded through contemporaneous field notes and systematic photographic documentation of spatial features, circulation elements, and departmental configurations. Photographs were captioned and organised by site and spatial criterion immediately following each visit to minimise recall error. Architectural site layout plans were obtained during field visits and used to verify and supplement observational data. No data were collected from patients, clinical staff, or any human participants; the study focused exclusively on the observable spatial and architectural characteristics of the built environment.

Data Analysis

Data were analysed using a structured comparative framework informed by the principles of thematic content analysis (Braun and Clarke, 2006). Analysis proceeded in three stages. In the first stage, each case study was profiled individually through descriptive summaries of its spatial organisation, circulation typology, accessibility features, and observed strengths and deficiencies, organised according to the five criteria established in the observation protocol. In the second stage, a cross-case comparative analysis was conducted, identifying recurring patterns and contrasting characteristics between the two facilities across all criteria. Architectural floor plans obtained during field visits were reviewed and annotated in

AutoCAD to verify spatial relationships and departmental adjacencies, while Microsoft Excel was used to organise and tabulate comparative data across the five assessment criteria, enabling systematic comparison and making differences and similarities explicit rather than impressionistic. In the third stage, the comparative findings were interpreted against the spatial standards and evidence-based design principles reviewed in the literature including WHO (2021) and AIA (2022) guidelines to identify gaps, validate observations, and derive design recommendations applicable to the proposed Oyo State Trauma Centre. Analysis was conducted manually using structured observation checklists and comparative matrices, consistent with the descriptive and comparative nature of the study design. Findings were reviewed iteratively against the original research objectives to ensure internal consistency and alignment with the stated research questions."

Ethical Considerations

This study was conducted in accordance with the ethical guidelines of the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Nigeria, under the supervision of the assigned project supervisor. The research did not involve clinical data, patient records, or identifiable personal information of any kind. Site observations were conducted with the knowledge of facility management at both institutions, and no data were collected from patients, clinical staff, or any other human participants. Photographic documentation was restricted to architectural and spatial features of the built environment and did not capture identifiable individuals. As the study involved no human participants in the methodological sense no interviews, surveys, clinical data extraction, or experimental procedures were administered formal ethics committee review was not required under the applicable institutional framework. All data were stored securely on password-protected devices accessible only to the researcher and supervisor throughout the duration of the study.

RESULTS / FINDINGS

This section presents findings from the comparative analysis of two Nigerian trauma and orthopaedic healthcare facilities: the Ondo State Trauma and Surgical Centre, Ondo, and the Accident and Emergency Unit of the National Orthopaedic Hospital, Igbobi, Lagos. Results are organised thematically around five criteria derived from the research objectives: entrance configuration and accessibility; corridor design and horizontal circulation efficiency; functional zoning and departmental adjacency; vertical circulation provision; and wayfinding

and signage effectiveness. Each finding is interpreted comparatively across both cases and linked to the core research question concerning how circulation and spatial layout influence the efficiency, safety, and functionality of trauma healthcare facilities in Nigeria.

Finding 1: Entrance Configuration and Accessibility

Entrance design emerged as one of the most consequential spatial variables between the two facilities, directly shaping the first point of operational contact between arriving patients and the healthcare system. The contrast between the two cases on this criteria was stark and attributable primarily to the difference in their design origins.

The Ondo State Trauma and Surgical Centre demonstrated strong performance across all entrance accessibility criteria. The main entrance was prominently positioned and visible from a distance along the approach road, sufficiently wide to accommodate simultaneous multi-directional pedestrian flow, and equipped with wheelchair ramps and wide-clearance doors meeting basic accessibility requirements. Lighting provision was observed to be adequate both during daytime and night-time hours, ensuring that the facility remained safely navigable and visually welcoming at all times. Emergency exits were clearly marked and illuminated, supporting rapid egress in crisis scenarios. Multiple secondary entrances distributed access load across the building perimeter, reducing the risk of bottlenecking at peak arrival periods a particularly important feature for a facility receiving high volumes of trauma patients.



Figure 1: View of the Major hospital complex, national orthopedic hospital, Lagos.

Source: Authors' Fieldwork (2026).

The National Orthopaedic Hospital, Igbobi presented significantly more problematic entrance conditions. The most critical deficiency observed was the spatial relationship between the main vehicular access point and the emergency and casualty unit: the accident ward occupied

the position nearest to the main entrance, while the emergency and casualty department the unit most dependent on rapid patient access was located further into the site, requiring additional travel time for arriving emergency cases. This arrangement, a direct consequence of the facility's non-purpose-built origin and subsequent incremental expansion, inverts the spatial priority logic that trauma care demands. The rear entrance compounded this problem by opening directly into a dense residential neighbourhood, exposing the facility's secondary access point to public foot traffic and environmental conditions incompatible with the clinical requirement for a controlled, low-contamination approach environment.

Table 1: Comparative Assessment of Entrance Configuration.

Criteria	Ondo State Trauma Centre	NOH Igbobi, Lagos
Visibility from access road	High	Moderate
Wheelchair accessibility	Yes	Partial
Dedicated emergency entrance	Yes	No
Night-time lighting	Adequate	Inadequate
Multiple entrances	Yes	Yes
Emergency unit proximity to main access	Adequate	Poor
Controlled perimeter environment	Adequate	No

Source: Author's Field Survey and Compilation, (2024)

The pattern established by this finding is unambiguous: purpose-built design enables the deliberate positioning of entrance elements in alignment with clinical priority, while adaptive reuse embeds spatial relationships that cannot be corrected without whole redesigning.

Finding 2: Corridor Design and Horizontal Circulation Efficiency

Corridor configuration proved to be the most consequential determinant of day-to-day operational efficiency at both facilities. The analysis distinguished between the linear corridor system employed at the Ondo Centre and the informal cluster arrangement that characterises the Igbobi site.

The Ondo State Trauma and Surgical Centre employed a broadly linear corridor system linking major functional departments along a primary circulation spine. Field observation confirmed that this arrangement produced relatively clear sightlines and predictable movement paths for both patients and staff across the facility's extensive footprint. Users could orient themselves by reference to the corridor's directionality, reducing the cognitive load of navigation in an environment that serves many first-time and distressed visitors. However, one significant deficiency was observed: the absence of clearly demarcated

separation between public circulation routes and clinical service corridors used for equipment, linen, and waste transport. This overlap created periodic congestion, particularly in zones adjacent to the main theatre and intensive care unit where clinical traffic density was highest, and introduced infection control risks that a dedicated clean and dirty corridor system would mitigate.

The NOH Igbobi presented the most problematic horizontal circulation conditions observed in the study. Because the facility comprises several clusters of detached buildings connected by covered external pathways rather than integrated internal corridors, movement between departments requires outdoor traversal exposing patients, staff, and equipment to weather conditions and cross-contamination risks that enclosed internal circulation would prevent. The intensive care ward was observed to be spatially distant from the surgical suite, representing a critical adjacency failure in a trauma care context where post-operative patients require immediate and continuous monitoring proximity between these two units. The spinal cord ward, children's ward, and accident ward were dispersed across the site without coherent zoning logic, requiring staff and users to navigate long, indirect, and often unmarked routes between functionally interdependent spaces. Most significantly, the surgical suite was located along a shared public corridor, exposing a restricted clinical zone to general foot traffic and compromising both infection control and patient privacy in ways that represent active clinical risk.

Table 2: Corridor Configuration and Horizontal Circulation Performance.

Criteria	Ondo State Trauma Centre	NOH Igbobi, Lagos
Circulation typology	Linear	Cluster/informal
Separation of public/clinical routes	Partial	No
ICU–theatre adjacency	Adequate	Poor
Corridor width	Adequate	Variable
Congestion observed	Moderate	High
Internal vs. external movement	Internal	Predominantly external
Surgical suite exposure to public corridor	No	Yes

Source: Author's Field Survey and Compilation, (2024)

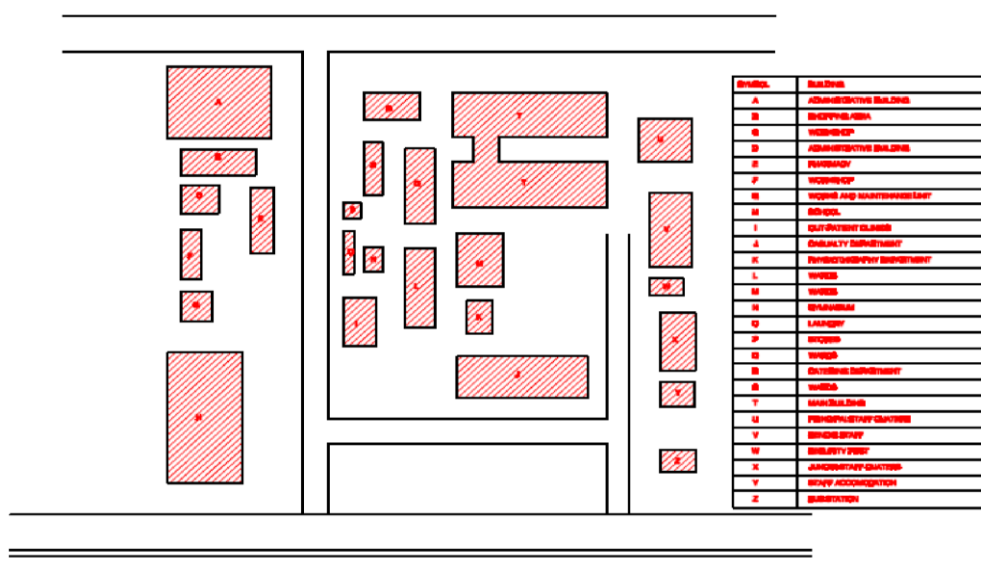


Figure 2: Layout of National Orthopedic Hospital Igbobi, Lagos.

Source: Authors' Fieldwork (2026).

Finding 3: Functional Zoning and Departmental Adjacency

Functional zoning the deliberate spatial grouping of departments by type of use and operational interdependency emerged as the criterion on which the two facilities diverged most sharply, and the one with the most direct implications for clinical safety.

The Ondo State Trauma and Surgical Centre demonstrated effective zoning at the macro level. Administrative, clinical, and support functions were distributed across distinct areas of the site, with the central administration and outpatient zone separated from the emergency and resuscitation area, which in turn was proximate to the main and trauma theatres. The inclusion of a dedicated trauma theatre, separate from the general surgical theatre suite, reflected an understanding of trauma care's distinct operational tempo and supported more effective spatial separation between elective and emergency surgical streams. The facility's blood bank was positioned within the laboratory cluster rather than isolated from it, supporting efficient specimen and product transfer. Support services laundry, medical store, and physiotherapy were grouped in a distinct zone away from primary clinical areas, reducing service traffic interference with patient and visitor flow.

The NOH Igbobi presented the most acute zoning failures observed in this study. Inadequate segregation between departments was attributable directly to the hospital's non-purpose-built origin and its evolution through decades of incremental, unplanned expansion. Educational and training facilities were co-located with active clinical zones with minimal physical separation, generating user conflict and ambient noise in areas requiring clinical

concentration. In-patient wards of functionally distinct types spinal cord injury, paediatric, accident, and general medical were dispersed across the site rather than consolidated into a coherent nursing zone, imposing additional movement burdens on nursing staff responsible for coordinating care across scattered locations. The intensive care ward was observed to be located at a significant distance from the surgical suite the single most critical adjacency failure in a trauma facility, where the post-operative transfer of unstable patients across an extended route constitutes a measurable clinical risk. The vehicular access from the Ikorodu Expressway, while functional, did not feed directly into the emergency and casualty area, further extending the time and distance between patient arrival and clinical intervention.

Table 3: Functional Zoning and Departmental Adjacency Assessment.

Criteria	Ondo State Trauma Centre	NOH Igbobi, Lagos
Macro-level zone separation	Effective	Inadequate
Emergency/theatre/ICU adjacency	Adequate	Poor
Dedicated trauma theatre	Yes	No
In-patient ward consolidation	Yes	No
Training/clinical zone separation	Yes	No
Support services separated from clinical	Yes	Partial
Emergency access from main road	Adequate	Poor

Source: Author's Field Survey and Compilation, (2024)

Finding 4: Vertical Circulation Provision

Both case study facilities operated primarily as low-rise or single-storey complexes in their principal clinical zones, limiting the vertical circulation challenge relative to multi-storey international facilities. Nevertheless, vertical circulation provision including staircases, ramps, and lift availability remained a significant accessibility criterion, particularly given that both facilities serve patient populations with high rates of mobility impairment.

At the Ondo State Trauma and Surgical Centre, ramp provision was confirmed at the entrance level, and door widths were observed to accommodate wheelchair users. The facility's predominantly single-storey clinical configuration reduced dependence on mechanical vertical circulation, though the absence of documented lift provision for movement between levels where multi-storey elements existed was noted as a potential gap for patients with severe mobility limitations or those being transferred on trolleys or beds.

At the NOH Igbobi, the main hospital building rises to approximately four floors and accommodates a significant concentration of medical services. Given that the facility serves a

patient population that includes spinal cord injury cases, paediatric patients, and severe trauma cases with acute mobility impairment, the absence of clearly visible and accessible lift provision observed during the field survey represents a significant accessibility failure. The dispersed site layout further compounded vertical circulation limitations: because clinical functions are spread across multiple detached buildings of varying heights rather than consolidated within a single connected structure, vertical and horizontal circulation challenges interact, making patient transfer between departments a complex and time-consuming undertaking.

Finding 5: Wayfinding and Signage Effectiveness

Wayfinding performance was assessed through observation of signage systems, spatial legibility, and the presence of architectural features that support intuitive navigation without requiring prior knowledge of the facility. This criterion was directly informed by the literature finding that complex layouts in Nigerian hospitals disproportionately impair navigation for first-time and distressed users (Ahmed et al., 2020).

The Ondo State Trauma and Surgical Centre demonstrated functional wayfinding provision. Directional signage was present at key decision points, and the facility's broadly linear corridor organisation supported orientation by providing a legible spatial structure that users could follow without heavy reliance on signage alone. The linear typology itself functioned as a passive wayfinding device, channelling movement along a comprehensible route and reducing the number of navigational decisions required of unfamiliar users. However, the absence of colour-coded departmental differentiation, spatial landmark elements, or graphic wayfinding beyond text-based signage represented a missed opportunity to further reduce navigation difficulty, particularly for patients arriving in distress or visitors unfamiliar with clinical environments.



Figure 3: Showing the view of the Intensive Care Unit.

Source: Authors' Fieldwork (2024).

The NOH Igbobi presented the most significant wayfinding deficiencies of the two cases. The dispersed cluster layout, combined with the absence of a coherent internal signage system and the reliance on external covered pathways as primary circulation connectors, meant that navigation between departments required either prior familiarity with the site or active assistance from staff. No colour-coded zone differentiation was observed. No spatial anchor or landmark element was identified that could orient a first-time user to the overall facility structure. Nurse stations, where observed, did not consistently command visual oversight of approach corridors a placement failure that reduces the availability of informal wayfinding assistance from staff and diminishes patient monitoring capability simultaneously.

Table 4: Wayfinding and Signage Provision.

Criteria	Ondo State Trauma Centre	NOH Igbobi, Lagos
Directional signage present	Yes	Minimal
Colour-coded zoning	No	No
Spatial anchor/landmark element	Partial	No
Nurse station corridor visibility	Adequate	Poor
Layout legibility for first-time users	Moderate	Low
Passive wayfinding through layout typology	Yes (linear)	No

Source: Author's Field Survey and Compilation, (2024)

Taken together, the five findings establish a consistent and reinforcing pattern: the Ondo State Trauma and Surgical Centre, as a purpose-built facility, outperformed the National

Orthopaedic Hospital, Igbobi across all five criteria examined, despite both institutions operating within the same national healthcare system and regional context. The performance differential is not attributable to differences in institutional scale, funding, or clinical prestige the Igbobi facility is by several measures the larger and more historically significant institution. It is attributable to foundational spatial decisions made at the planning and design stage, and to the compounding effect of decades of unplanned adaptation on a building stock never intended for trauma care delivery.

DISCUSSION

Principal Findings

The most significant finding of this study is that the design origin of a healthcare facility whether purpose-built for trauma care or adapted from a prior use is the primary determinant of spatial and circulation performance, overriding differences in institutional scale, clinical reputation, and resource endowment. The Ondo State Trauma and Surgical Centre, purpose-built and comprehensively programmed, consistently outperformed the National Orthopaedic Hospital, Igbobi across all five assessed criteria despite Igbobi's status as the largest and most historically prominent trauma institution in sub-Saharan Africa. This finding is significant because it reframes the dominant discourse around healthcare facility inadequacy in Nigeria: the core problem is not primarily one of insufficient funding or maintenance failure, but of foundational spatial decisions embedded at the point of design and commissioning that cannot be corrected without wholesale reconstruction. A secondary finding of equal practical importance is that even the better-performing Nigerian facility the Ondo Centre exhibited addressable deficiencies in circulation separation, wayfinding integration, and passive ventilation strategy, suggesting that purpose-built design is a necessary but not sufficient condition for optimal spatial performance.

Interpretation in Light of Existing Literature

The finding that adapted facilities suffer systematic circulation deficiencies directly confirms and substantially extends the argument advanced by Ahmed et al. (2020), who demonstrated that complex building layouts in Nigerian hospitals impair wayfinding and heighten user anxiety. The present study moves beyond wayfinding as an isolated variable to show that the same underlying condition non-purpose-built spatial organisation simultaneously undermines functional zoning, departmental adjacency, infection control separation, and staff movement efficiency across a trauma-specific institutional context. This represents a broader

and more structurally grounded account of spatial failure than prior Nigerian studies had established.

The critical adjacency failure at Igbobi where the intensive care unit and surgical suite are spatially separated by a significant site distance directly corroborates Joseph and Rashid's (2007) foundational argument that the architecture of safety is a clinical, not merely aesthetic, concern. In a trauma facility, the distance between theatre and intensive care is not an abstract spatial variable; it is a determinant of post-operative survival risk for unstable patients whose condition can deteriorate during transfer. The present study provides a concrete Nigerian case that substantiates this theoretical claim with field-observed evidence, extending its relevance beyond the high-income hospital contexts in which Joseph and Rashid originally developed it.

The performance of the Ondo Centre's linear corridor system aligns with the broader literature on circulation typology, which consistently identifies linear and loop-based arrangements as superior to informal cluster configurations in terms of predictability and flow efficiency (Ching, 2023; Natapov et al., 2020). However, the partial separation of public and clinical routes at Ondo where equipment and patient corridors overlap in zones adjacent to the theatre identifies a specific implementation gap in an otherwise sound typological approach. This finding extends the work of Lee and Kim (2022), who argued for clear circulation path separation as an infection control imperative, by demonstrating that linear typology alone does not guarantee separation: deliberate design of parallel clean and dirty corridor systems is required as a supplementary measure.

The wayfinding findings at both facilities confirm and contextualise the conclusions of Olatunji (2022), whose space syntax analysis of Nigerian hospital layouts identified spatial configuration as a primary driver of movement inefficiency. The present study adds an observational dimension to Olatunji's computational findings: the Igbobi case demonstrates in practice what space syntax metrics predict in theory that spatially complex, low-legibility layouts produce navigational failure for users who lack prior site knowledge, with particular severity in trauma contexts where cognitive load is already elevated by clinical distress.

Theoretical and Practical Contribution

This study makes a specific and previously unestablished contribution to the literature: it provides the first direct observational comparison of circulation and spatial layout performance between a purpose-built and an adapted trauma healthcare facility within the Nigerian context, using a consistent analytical framework applied across both sites

simultaneously. Prior Nigerian studies addressed wayfinding or layout in general hospital settings without distinguishing between purpose-built and adaptive typologies as an explanatory variable. By isolating design origin as the primary differentiating factor between two facilities operating within the same national and regional healthcare context, this study demonstrates that typological planning decisions made at inception have performance consequences that persist across decades of institutional operation and resist correction through subsequent investment alone. This finding shifts the policy framing from reactive infrastructure upgrading to proactive planning standards a reframing with direct implications for how Nigeria commissions, approves, and regulates new healthcare facility construction.

Limitations

Several limitations must be acknowledged. The sample of two case studies, while analytically productive, is small, and the findings cannot be generalised to the full population of trauma facilities across Nigeria. Both sites were observed through field surveys conducted by a single researcher without inter-rater reliability verification, introducing the possibility of observer bias in the assessment of qualitative criteria such as wayfinding legibility and zoning clarity. The study did not collect data from facility users patients, visitors, or clinical staff meaning that the experiential and operational dimensions of circulation performance are inferred from spatial observation rather than grounded in user testimony. Furthermore, the absence of detailed original architectural drawings for the Igbobi facility limited the precision with which departmental relationships and corridor dimensions could be verified against design intent rather than observed condition. These limitations notwithstanding, the findings retain validity for their primary purpose: generating evidence-based spatial design principles to inform the proposed Oyo State Trauma Centre, for which the comparative observational logic of the case study analysis is an appropriate and sufficient evidential basis.

Implications for Practice and Policy

The findings carry specific implications for architects, healthcare planners, and government commissioning bodies involved in trauma centre development in Nigeria. First, the study strongly cautions against the adaptive reuse of non-clinical buildings as primary trauma facilities. Where new construction is possible as in the proposed Oyo State facility a purpose-built linear typology should be adopted from the outset, with critical departmental adjacencies between the emergency department, trauma theatre, and intensive care unit established as non-negotiable spatial constraints in the design brief rather than post-hoc

accommodations. Second, functional zoning must be enforced at the planning approval stage through explicit spatial standards that mandate separation of public, semi-public, and restricted clinical zones. The Igboobi case demonstrates the compounding long-term operational cost of zoning failures embedded at inception costs that accrue in staff time, patient safety risk, and infection control expenditure that far exceed the cost of correct planning at the design stage. Third, corridor design in new Nigerian trauma facilities should incorporate parallel clean and dirty circulation routes from the outset, resolving the partial separation deficiency observed even at the better-performing Ondo Centre. Fourth, wayfinding should be treated as an integrated architectural discipline rather than a signage procurement exercise: passive wayfinding through legible linear layout, colour-coded zone differentiation, and strategic nurse station placement should be specified at the design stage and evaluated at planning approval. At the policy level, the Oyo State Ministry of Health and the Nigerian Federal Ministry of Health should develop and enforce minimum spatial standards specifically calibrated to trauma centre design, drawing on WHO (2021) and AIA (2022) guidelines but adapted to local site conditions, climate, construction practice, and the specific programmatic demands of trauma care delivery.

Directions for Future Research

Several questions raised by this study remain unanswered and warrant dedicated investigation. Future studies should examine the lived experiences of patients, visitors, and clinical staff navigating trauma facility environments in Nigeria, using semi-structured interviews or ethnographic observation methods to ground circulation assessments in user testimony rather than researcher inference alone. A post-occupancy evaluation of the Ondo State Trauma and Surgical Centre the stronger-performing facility in this study would provide longitudinal data on how its circulation systems perform under sustained operational load over time and whether design intentions have been maintained or informally modified through use. Researchers should apply space syntax computational analysis specifically to Nigerian trauma centre floor plans, building on the preliminary work of Olatunji (2022) to generate a quantitative evidence base for circulation efficiency capable of informing national planning standards. Finally, studies examining the feasibility and cost-effectiveness of retrofitting separated clean and dirty corridor systems into existing Nigerian hospital buildings would address a gap this study identified but could not resolve namely, whether the circulation deficiencies of adapted facilities like Igboobi are correctable through targeted spatial intervention or only through comprehensive rebuilding and redesigning.

CONCLUSION

This study set out to examine how circulation systems and spatial layout configurations influence the efficiency, safety, and functionality of trauma healthcare facilities in Nigeria. The evidence drawn from comparative field observation of two contrasting Nigerian facilities demonstrates clearly that design origin specifically, whether a facility was purpose-built for trauma care or adapted from a prior use is the primary determinant of spatial performance. Purpose-built linear spatial organisation, deliberate functional zoning, and integrated accessibility provision produce measurably superior circulation outcomes; adaptive reuse, however institutionally distinguished the facility, embeds spatial deficiencies that compound over time and resist correction through investment alone.

The principal contribution of this study is the establishment of design origin as an explanatory variable for circulation performance within the Nigerian trauma care context a relationship that prior literature had not isolated or empirically demonstrated through direct comparative field observation. By documenting this relationship across two facilities operating within the same national healthcare system, the study provides an evidence base that did not previously exist for trauma-specific spatial planning guidance in Nigeria, and translates that evidence into concrete design recommendations for the proposed Oyo State Trauma Centre. The significance of these findings extends beyond a single proposed facility. As Nigeria's urban population continues to grow and trauma incidence rises correspondingly, the decisions made at the planning and commissioning stage of new healthcare infrastructure will shape clinical outcomes for decades. Getting those decisions right grounded in evidence, enforced through policy, and calibrated to the specific demands of trauma care is not an architectural ambition. It is a public health imperative.

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