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ARTICLE

Study of Spatial Disorientation and Wayfinding Challenges in Buildings Using Axial Analysis: A Case of Hospital Buildings in Nigeria

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ABSTRACT

All living creatures rely on spatial orientation to navigate through familiar environments. For humans, everyday activities depend on spatial orientation for navigating routes from outside locations to final destinations. The study suggests that the larger buildings get, the more the challenges of spatial orientation for their users. Likewise, building forms and configurations impact significantly on the course of wayfinding. In the case of hospitals, spatial configuration has been identified as significant in influencing human movements, performances of users and efficiency of services. This paper analyses the layout configurations of selected large hospital buildings in Nigeria using axial lines and relates the analysis with spatial orientation and wayfinding process. The aim of the study was to identify the extent of the impact of building layout configuration on spatial orientation and wayfinding process. The three large-sized hospitals selected for the study presented different scenarios which identified simplicities and complexities of building layout configurations as significant in the process of wayfinding. A comparative summary of the three hospitals in the study suggests that the less complex hospital layout presented the least spatial disorientation effect. This is mostly due to the linear sightlines utilized in the layout configuration design with fewer turns that enable visual connectivity to destination points thus indicating lesser challenges for wayfinding.

Keywords: Spatial orientation; Wayfinding; Spatial disorientation; Wayfinding challenges; Axial analysis; Axial map

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1. Introduction

Disorientation is a common phenomenon that affects every human especially when visiting new and unfamiliar places. Often described as the condition of having lost one's sense of direction, this phenomenon is a common occurrence experienced in mostly large spaces. While disorientation is a common terminology in aviation owing to the vastness of the sky and space where pilots are meant to navigate, the same experiences are likewise predominant in built environments, especially in large-sized buildings.

According to the psychology of the human system, there exist four (4) physiologic systems that interact in order to enable humans to orient themselves in space. They include:

- Vision: regarded as the most dominant sense for orientation;
- Vestibular system: regarded as the system that functions to detect the human head position and movement in space. This system is responsible for the coordination of eye movements, posture, and equilibrium;
- Proprioceptive system: regarded as the system that provides a sense of body awareness, detects and controls force and pressure, as well as assists the body in controlling responses to sensory stimuli and
- Auditory system: regarded as the system that processes sounds within the environment.

According to Rachel K. Meeks et al., in order to achieve adequate orientation, the human body depends on accurate perception and cognitive integration of these systems. The study also agrees that the collective systems of visual, vestibular, and proprioceptive stimuli differ in magnitude, direction and frequency and the inappropriate coordination of these systems results in spatial disorientation [1]. The study of the human body interaction also justifies the relationships of these systems for appropriate spatial orientation [1]. While the human eye provides visual and spatial orientation with about 80% of the sensory inputs required for maintaining spatial orientation, other systems like the vestibular system which lies in the inner ear contribute about 15%, the proprioceptive sensory system composed of receptors located in the skin, muscle, tendons, and joints are responsible for the remaining 5% of the total sensory information required to establish spatial orientation [2]. The interactions of these systems also produce complex coordination between all the sensory inputs, which are relatively translated and interpreted by the human brain and the case of misinterpretation or inaccuracy resulting from three sources of information consequently produces sensory mismatch, resulting in varieties of visual or vestibular illusions (hence disorientation) [3].

2. Background of study

2.1 Study of spatial orientation and wayfinding process

The human ability to maintain body orientation and posture relative to his surrounding environment (in the physical space), whether at rest or when in motion is regarded as Spatial orientation [4]. Naturally, all living creatures rely on spatial orientation for navigation. In the case of humans, everyday activities depend on spatial orientation for navigating accustomed routes from outside locations to our homes etc. Likewise, the action of positioning oneself within an environment as well as the representation of the position of environmental features and objects relative to one another and the process of continuous updating of this assimilated knowledge are regarded as the key elements in spatial orientation.

According to Van den Brink et al. [5], there exists a general agreement (of two systems) for physical location to be represented in two fundamental forms in order to allow the attainment of a successful orientation and navigation process [6–9].

a. One of the systems involves the mental representation of object positions relative to an observer, termed egocentric coding. This system is often employed when the observer in a space is stationary or able to track movements based on mainly the optic flow, vestibular and proprioceptive signals, otherwise referred to as path integration.

b. The next is the system referred to as allocentric coding, which is independent of the observ-

er's current position and is dependent on additional externally referenced spatial coding drawn from inter-object interactions.

Studies show that these two-system models of parallel spatial-representation generated by body and environment in object-location memory are largely evident in adult humans [10–15]. Humans adopt these systems in their senses to situate themselves in their environment. Equally, the discernment of space is not always the same for everyone and often differs according to other mental factors. Conversely, the process of finding one's way in our spatially extensive environments is essential for survival and thus requires a wide range of cognitive abilities to actualize. Dominant among these abilities is the use of long-term spatial memory to guide wayfinding. Findings on human cognition abilities suggest that the configuration process of any given environment possesses distinctive cognitive consequences [16]. Invariably, the process of spatial configuration on its own could become constrained on spatial experience as its elements may improve or hinder components of human activities through the aspects of spatial cognition and behaviors. The research identified the human ability to mentally represent large-scale space through a variety of tests such as sketching maps, direction pointing and practical route descriptions [17]. Studies further suggest that several qualitatively different spatial representation types may also support wayfinding process, which may include actions such as route knowledge, i.e., the knowledge of directions to turn at locations or landmarks as well as the combined knowledge of the spatial relationships between locations and landmarks, referred to as survey-like knowledge [17–19]. This survey-like knowledge is believed to also represent the descriptions for spatial cognition and wayfinding principle referred to as cognitive maps, which provides humans with such ability to take shortcuts in familiar environments [20].

Wayfinding performance in buildings can be attributed majorly to circulation and spatial configurations. Successful wayfinding only occurred when the navigator makes correct navigation decisions that may take him/her from the present location to a final destination which must fulfill the intended purpose of movement [21]. According to studies [22], other principles that assist in successful wayfinding are listed as follows:

i. Location Distinctiveness;
ii. Landmarks and Orientation;
iii. Pathways or circulation configuration;
iv. Zoning (areas of different visual characters);
v. Signage with decision points;
vi. Sight lines for visibility.

These principles all play intrinsic roles in assisting the wayfinding process. However, the dominant element of spatial configuration must firstly be established appropriately in building design before the adoption of assisted principles like signage. This is critical as not all information is available in signage designs [23]. This dominant element (spatial configuration) is the primary tool utilized by designers principally in defining the wayfinding process at the point of design and configuration of building layouts. The study of spatial configurations for purposes of improving wayfinding in building and city designs has evolved over the years. Modern tools and concepts like Space syntax theories (from where axial analysis and isovists are generated), are amongst the most popular tools used for analyses of spaces and layout configurations. Space syntax utilizes a set of theories and techniques for the analysis of spatial and layout configurations. It incorporates both evaluation of the applications and the adoption of the analytical techniques and theoretical ideas associated with the syntactic study of architectural spaces. According to Bill Hillier, space should be translated into graphical measures. However, in order to apply graph theoretic measures, geometries of a space must be read firstly and then translated into patterns that would support the type of analysis to be executed [16]. This process encompasses the formation of spatial networks that invokes syntactic properties of global and local spatial systems with the aid of syntactic axial and convex maps. The three fundamental concepts that enable the assessment of spatial circulation effectiveness in space syntax include:

i. Axial lines; are defined as straight sightlines

and possible paths.

ii. Convex spaces; are defined as inhabitable void where no line between two of its points goes outside its perimeter.

iii. Isovists field; which is referred to as viewsheds or visibility polygons, indicating field of view from any particular point in space.

This study utilizes the first concept (axial analysis), to analyze the performance of layout configurations relative to spatial orientation and wayfinding process.

2.2 Spatial cognizance principles

The process of wayfinding in and around built environments is the first step towards efficient movements and flow in spaces. In the case of large public buildings such as institutional buildings, airports, hospitals, museums, malls and office buildings, wayfinding challenges often pose frustrating experiences resulting in mental and psychological stresses which may translate into disorientation. Studies on human behaviors in built up spaces show that orientation problems do not often originate at the front doors, rather orientation challenges starts off long before people enter a facility and may often continue long after they have arrived at their destination again. This is due to the fact that wayfinding capabilities are shared across numerous mediums including through visitors who eventually pass on their experiences (emotionally) to friends and relatives and the process continues downwards until each individual in turn develops their own expectations [24–26]. One of the most common principles for successfully navigating through the course of wayfinding is the generation of pathways. Tolman defined Pathways as routes to locations. This concept suggests that every individual employs cognitive maps for wayfinding. This concept defines 'Cognitive Maps' as mental representations that are utilized to obtain, store, memorize, code and decode spatial information about the relative locations and features of phenomena in the environment [20]. Analyses of the impact of layout organization on wayfinding performance alongside user-cognitive representation of real-time spatial information identify pathways as fundamental components of the spatial cognition process. The analogy of cognitive way-finding describes the human ability to make use of long-term spatial memory to guide way-finding. The process describes the originated mental map that resides in the head, and examined by the mind's eye, as functionally identical to the graphical map that is inspected in the physical environment [27]. Kuipers suggests that cognitive map information is likewise isomorphic to data held in a graphical map, further information added to, or retrieved from, the cognitive map is considered the same as that processes used for the adding and retrieval of information from a physical graphical map [28]. Although this characterization does not imply the existence of a region in the physical brain where the entire environment is physically mapped, nevertheless it indicates the availability of correspondence between the products of information input and output behaviors of the storage (visual data) and retrieval functions [29]. When related to wayfinding in built environments, it is believed that the layout of spaces influences the accuracy of the actual cognitive representations in real-world spatial configurations [30]. These layouts of spaces eventually form pathways or network structure used in our everyday spatial activities and they in turn develop into critical elements of the mental image of the spatial environment [31].

2.3 Challenges of spatial cognizance and disorientation in hospitals

Spatial orientation in a large space is attributed as fundamental for the organization of all meaningful behavior within the space. Since wayfinding is defined as the process of identifying locations and navigating to destination using mental environmental information, hence the ability to comprehend one's environment by way of spatial cognizance is the first principle towards successful wayfinding in spaces. Degrees of place capacity or volumes of functional spaces affect people's capabilities to mentally grasp the composition of the environment. Studies show that the ability to control space is achieved either through the process of habitual occupation, by per-

sonalization or by mere marking [32]. The composition of modern large buildings has evolved over the years resulting in complex environments comprising lengthy and confusing pathways and corridor systems with bends, turns and confusing signage systems [33]. These types of settings pose enormous challenges as well as frustrations for visitors and building users. Most significant in the classification of modern large buildings are Hospital buildings. **Figure 1** illustrates the comparative value of building space weights to wayfinding cum spatial orientation difficulty levels. As shown in the illustrations, when building spaces grow larger, the spatial orientation and wayfinding difficulty grow.

Figure 1. Building sizes relative to spatial orientation difficulty levels.

A review of the idea of modern hospital buildings across the globe indicates massive and highly sophisticated establishments with diverse functional areas located at various points where administration, medical care and treatments are carried out. Recorded experiences in these classes of large medical centers identifies a number of negative effects on patients and users resulting in stress, anxiety, wayfinding difficulties and spatial disorientation [34].

A review of the major large hospital buildings in Nigeria visited for this study identifies this same pattern of design which suggests significant intentions to create large accommodations with insignificant consideration for users and patient/visitor wayfinding complications. In Nigeria, there exist three major hospital/healthcare structures which are classified in hierarchical fashion [35] as shown in **Table 1**. These three classes of health institutions include:

i. Primary,
ii. Secondary, and
iii. Tertiary

According to the Medical and Dental Council of Nigeria, the primary health facilities are the smaller-sized category with the major function of providing health education, diagnosis, and treatment of common ailments. The other class is the comprehensive health facilities or secondary categories mostly known as the general hospitals. General Hospitals in Nigeria are known for the provision of accident and emergency services, advanced diagnosis with X-ray, scanning machines and pathological services. The general hospitals in Nigeria are mostly within the control of state governments. The third category often referred to as the tertiary health institutions is mostly specialist and teaching hospitals. These classes of hospitals handle complex health cases either as referrals from general hospitals or on direct administration. Just like the secondary class, it accommodates such facilities as accident and emergency units, diagnostic units, inpatient care/wards units, treatment units and out-patient units. The most common of this category are the Teaching hospitals [36].

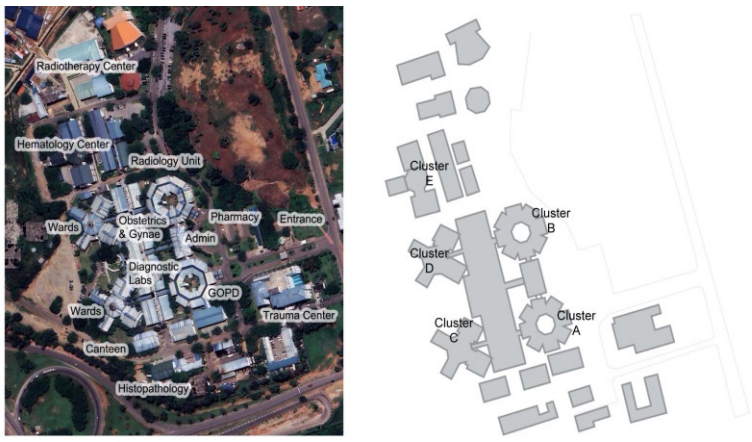
This paper intends to study the spatial orientation and wayfinding difficulties in large hospital buildings in Nigeria. As identified above in **Figure 1**, the larger the size of a building, the more complex the spatial orientation and wayfinding process within it becomes. Owing to the large sizes and spatial distribution concepts adopted in the design of these large hospital buildings, patients and visitors often find challenges in locating destination areas. A typical example is the case of the National Hospital in Abuja, Nigeria (**Figure 2**). Designed to function as both a General and Teaching hospital, the national hospital provided the service of a comprehensive training center for medical graduates in affiliation with Ahmadu Bello University Zaria as well as general healthcare services for the Abuja community. A review of the building layout indicates the presence of multiple functional units with about 28 departments, distributed in blocks and cluster pattern that

originates from the entrance gate leading through the Trauma and Emergency Center down to Radiotherapy center. The departments/units include Psychiatry, Hematology, Trauma Centre, Dietetics, Pharmacy, Chemical Pathology, Histopathology, Invitro Fertilization (IVF), Health Records, Library Services, Nuclear Medicine, Radiotherapy and Oncology, Paediatrics, Dental and MFU, Anaesthesia, Intensive Care, Family Medicine, Medical Physics, Obstetrics & Gynecology, Ophthalmology, Otorhinolaryngology/ Head and Neck Surgery, Physiotherapy, Radiology Surgery, Internal Medicine, Nursing Services, Plastic Surgery Unit, Medical Microbiology and Medical Record. With the combination of cluster layouts and combined building blocks, the complex on first view presents a visitor with a feeling of disorientation.

Study shows that the gaze bias identifies that people pay attention to structural elements in the built environment. According to Martinez-Conde et al., the study of visitors' behaviour in memorized spaces identified that tiny gaze shifts disclose people's familiar locations in a memorized space rather than that of visual space. This discovery indicates that the oculomotor system may be engaged in the process of focusing attention within the internal space of the memory [37]. These studies are in line with the suggestions for the use of axial lines and isovists fields in analyzing perception in the wayfinding process. Real-time view of the NHA environment from the entrance indicates the lack of vistas to destination points from any point of location during the process of wayfinding. Even the general directory signage (**Figure 3**) which presents a guide to users and visitors requires extensive mental mapping to acquire satisfactory spatial cognizance for recognition of destinations within the facility.

Table 1. Classification of hospitals in Nigeria.

	Healthcare classification	Function	Hospital types	Size
1	Primary	Health education, diagnosis, and treatment of common ailments	Cottage Hospitals, Clinics, Maternity homes, Dispensaries	Small
2	Secondary	Accident and emergency services, diagnosis with Radiology units and pathological services, outpatient and inpatient care/ward services	General hospitals,	Medium
3	Tertiary	Referrals from General hospitals, accident and emergency services, diagnosis with advanced Radiology units and pathological services, outpatient and inpatient care/ward services, advanced medical consultancy services, research laboratories, nursing services and critical/intensive care services.	Specialist hospitals, Teaching hospitals	Large



(a) Google map/layout National Hospital Abuja (b) Outline/layout of National Hospital Abuja

Figure 2. Google map of the National Hospital Abuja (NHA), showing the major spatial units/functions.

Figure 3. General directory of departments and units in the National Hospital Abuja.

3. Methodology

This study utilizes a descriptive methodology with a major objective centered on identifying existing cases and running case analysis using axial map analysis as an instrument. Through the case studies, the spatial layout characteristics of each case are identified and the significant impact analyzed in order to identify the performance of each configuration in the wayfinding process. Three (3) selected hospitals that make up the crux of the major (large) tertiary healthcare institutions in Nigeria are studied. The significance of this is to ascertain the effects layout configurations have on spatial orientation and wayfinding. Visual axial analysis which is a way of analyzing a spatial layout represented by an axial map (with simplified connections between spaces in urban or architectural morphology) [38], is used to ascertain the longest visibility lines between convex spaces within the selected hospitals.

Previous studies identified that the axial map is an alternative representation of spatial and urban networks for measuring the levels of accessibility across layouts. This process is defined as "spatial integration" [39]. Over the years, this method of representation has been adopted by space syntax analysis and numerous researches have been built upon this method. This analysis method is seen to function as the fundamental spatial unit through which the interaction of society and spaces are observed and interpreted. In the past, hand drawings are generally used in creating the axial map. However, the process of over-laying raster image maps is applied afterwards to complete the process. The procedure is such that the user draws the lines that represent the longest accessible and visible point, in the early years, this process is formerly completed by using tracing paper superimposed on a paper map with the axial line model. These axial lines are analyzed by visual assessment of their connectivity to identify the spatial integration and connectivity factors [40]. In this paper, however, Autocad (CAD) drawing tools are utilized to outline the building forms in order to identify the layout configurations used in design, followed by the drawing of axial lines across each node in the layout to connect visibility lines across various location/destination points. This is followed by the visual assessment of each generated axial map to identify the spatial integration and connectivity factors in each case.

4. Analysis of spatial disorientation and wayfinding in large hospital buildings using axial map analysis

4.1 Axial analysis and visual assessment procedure

For the purpose of this study, several large-scale hospitals in Nigeria were visited. It was observed that the large-sized hospital complexes were mostly the ones classified under the specialist and teaching hospital category. These classifications of hospitals are mostly government-owned and strategically located across the various geopolitical zones of Nigeria. The selection criterion for this study was intended to cut across and represent the three major geopolitical zones of Nigeria (northern, western and eastern regions).

The three selected hospitals for this study include:

i. National Hospital Abuja (NHA), located in

northern Nigeria;

ii. University of Nigeria Teaching Hospital Enugu (UNTH), located in southern Nigeria;

iii. University College Hospital Ibadan (UCH), located in western Nigeria;

The process of this analysis begins with the generation of the axial map of each hospital layout. The axial maps of each selected hospital outline the VISIBILITY context (using axial lines to indicate lines of sight) when one travels along pathways on the layouts. The connections of the red lines (lines of sight), in the analysis signify the effectiveness of each type of "Building Form" and layout in organizing the flow of visitors along these pathways.

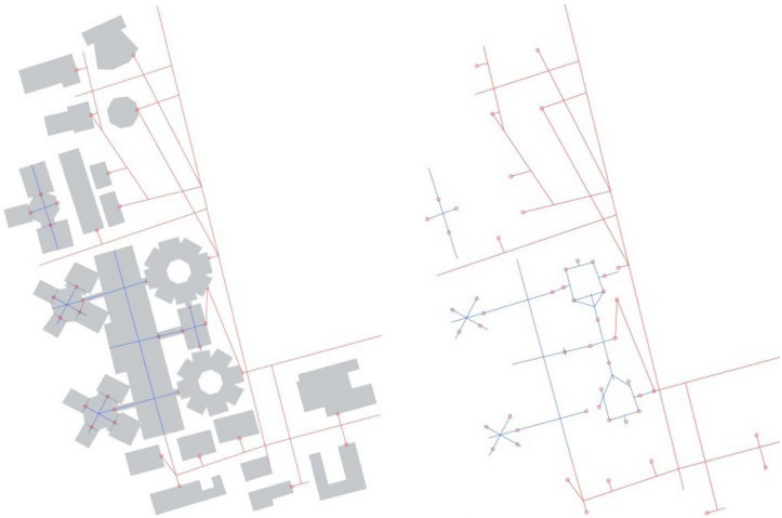
The key principle of drawing an axial map is to minimize the number of lines and the angular change between any pairs of lines. The procedure of drawing axial map is such that the number and distances of connectivity in straight/linear unobstructed lines of sight observed in each case indicate the level of difficulty visitors will face in seeing or identifying the next nodal point (functional location/destination).

Axial analysis of the National Hospital Abuja (NHA)

Figure 4 shows the axial map of the National Hospital Abuja. The significant axial lines are the external lines represented in red color, while the blue color indicated the internal axial lines. The pattern of the external axial lines indicates the level of disconnected lines of sight and dispersed connectivity between each of the blocks and cluster units in the hospital's layout. The complexity of its connectivity further signifies the challenges of connecting from one destination (node) point to another (represented in red circles).

Axial analysis of the University of Nigeria Teaching Hospital (UNTH), Enugu

To further observe the impacts of building layout configuration on spatial orientation and wayfinding, the axial map of the University of Nigeria Teaching Hospital (UNTH) was developed. **Figure 5a** shows the Google map/Layout of UNTH, while **Figures 5b and 5c** present the axial map and analysis of the layout. The significant axial lines are the external lines represented in red color, while the blue color indicates the internal axial lines. The pattern of the external axial lines indicates more linearly connected lines of sight and pathways between each of the hospital blocks. The external axial lines indicate less unobstructed (clear) direct sight connections from one destination (node) point to another with less turns than that of the NHA.

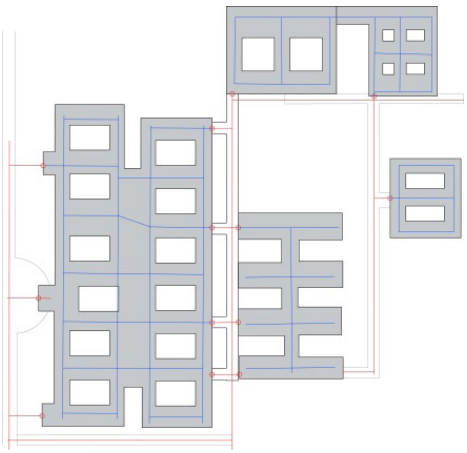


(a) Axial map of NHA layout showing the External Axial lines in Red and internal Axial lines in Blue

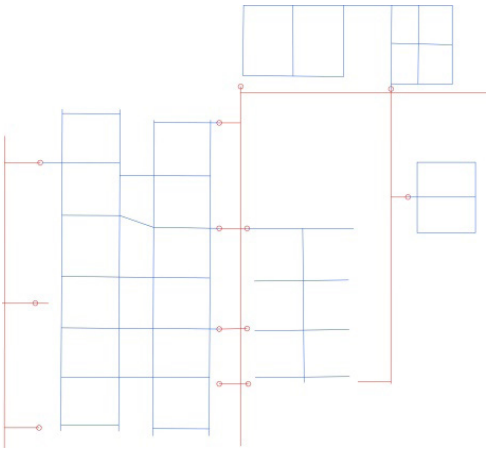
(b)Axial map of NHA showing the External Axial lines in Red and internal Axial lines in Blue

Figure 4. Axial analysis of the National Hospital Abuja.

(a) Google map/layout of UNTH.



(b) Axial map of UNTH layout showing the external axial lines in red and internal axial lines in blue.



(c) Axial map of UNTH showing the external axial lines in red and internal axial lines in blue.

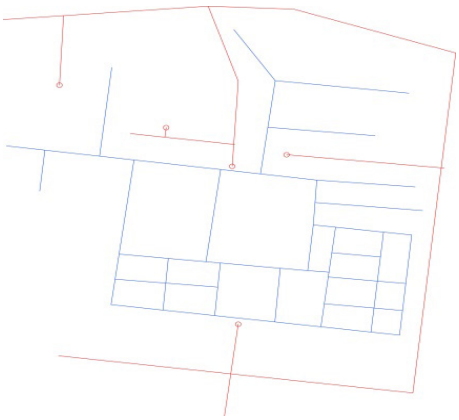
Figure 5. Axial analysis of the University of Nigeria Teaching Hospital. (a) Google map/layout of UNTH, (b) Axial map of UNTH layout, (c) Axial map of UNTH showing the external and internal axial lines.

Axial analysis of the University College Hospital (UCH), Ibadan

In the case of the analysis of the UCH layout configuration, spatial orientation and wayfinding, the axial map of the UCH was developed. **Figure 6a** shows the Google map/Layout of UCH, while **Figures 6b and 6c** present the Axial map and analysis of the layout. Likewise, the significant axial lines are the external lines represented in red color, while the blue color indicates the internal axial lines. The pattern of the external axial lines in this case indicates rather scattered lines of sight and pathways between each of the hospital blocks. The external axial lines indicate obstructed and indirect sight connections from one destination (node) point to another requiring more turns than that of the UNTH. Owing to these scattered lines, the spatial orientation course will likewise follow a cumbersome process.

(a) Google map/layout of UCH.

(b) Axial map of UCH layout showing the external axial lines in red and internal axial lines in blue.



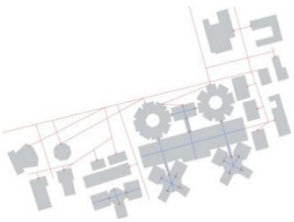
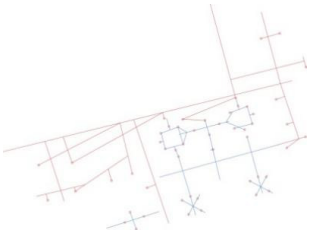
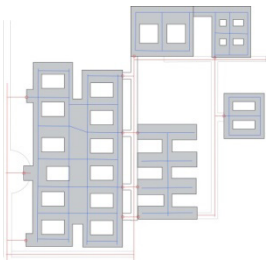
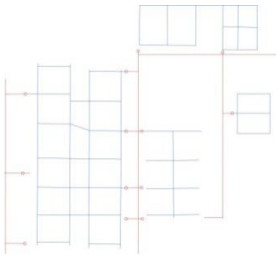
(c) Axial map of UCH showing the external axial lines in red and internal axial lines in blue.

Figure 6. Axial analysis of the University College Hospital. (a) Google map/layout of UCH, (b) Axial map of UCH layout, (c) Axial map of UCH showing the external and internal axial lines.

4.2 Results and discussion

A comparative summary of the three hospitals in the study as presented in **Table 2**, suggests that the less complex hospital layout presents lesser spatial disorientation outlook. While the NHA is made up of dispersed sightlines and connection to access points of the numerous blocks and clusters, thereby making wayfinding more challenging, the UNTH presents a less complex layout and more linear sightlines with fewer turns that enable visual connectivity to destination points thus indicating lesser challenges for wayfinding. The UCH layout on the other hand presents limited sightlines to the scattered access points to various blocks in the hospital. This presents a medium challenge to spatial orientation on the external axis, with even more challenges envisaged in the internal pathways as the building exists as a massive unit with integrated blocks. While the experience of spatial orientation may be minimal from the external axis, the internal wayfinding process in the UCH is expected to be highly disorienting.

Table 2. Analysis of disorientation levels in the three selected hospitals.

Hospital	Axial map	External axial connection to pathways and access points (nodes)	Connectivity level	Disorientation level
National Hospital Abuja (NHA)			Dispersed connection to numerous access points (nodes) owing to multiple building units	High
University of Nigeria Teaching Hospital (UNTH)			Lineal sightlines as indicated by external axial lines, ensuring ease of connection from locations	Low
University College Hospital (UCH)			Scattered connection to controlled access points (nodes), limited sightlines from external axial lines	Medium

From the comparative analysis of the three hospital buildings in **Table 2** above, it could be asserted that simplified architectural morphology (building forms) and layout/arrangement of building units if adopted in the organization and composition of the hospital building layout would improve the connectivity of axial lines (sight lines), which in turn will increase the potential of spatial orientation and wayfinding process for visitors and users. Architectural designs that consider the problems of spatial disorientation often adopt simplified patterns of hospital building layouts for the benefit of patients and users. Previous study confirms that the quality of patients care and wellbeing are linked with the physical attributes of the healthcare environment [41]. Also spatial configuration has been identified as significant in influencing human movements and this impacts the performances of the users within the space and the quality of decisions they make. For hospital buildings, spatial configuration and easy of wayfinding play major roles in determining the efficiency of hospital services and thus, in order to understand the concept of wayfinding in hospital buildings, the process of spatial orientation, flow and visual connectivity must be comprehended [42].

5. Conclusions

Building layouts, forms and spatial configuration have been identified as significant in influencing human movements, performances of users and efficiency of services especially in hospitals. This paper analyzed the layout configurations of selected large hospital buildings in Nigeria using Axial maps and relates the analysis with spatial orientation and wayfinding process. The aim of the study was to identify the extent of the impact of building layout configuration on spatial orientation and wayfinding process. The three selected hospitals (National Hospital Abuja, University of Nigeria Teaching Hospital and the University College Hospital) all represent the basic standard larger scale hospital buildings in the country. Through the axial map analysis of these selected hospitals, different scenarios were observed whereas the more complex layout configurations presented more disconnected axial lines (limited sightlines), on the other hand, the simpler building layout configurations presented better axial line connectivity with linear sightlines which ensured easier wayfinding process for visitors and users. The findings from this study provide insight into the potentials of building layout configurations in influencing wayfinding. With this insight, further studies and analysis of various building forms, layouts and configurations may be undertaken in order to discover better options for adoption in both hospital and general building designs in order to reduce the challenges of spatial disorientation for patients and building users.

Studies in the past identified significant relationships between architectural design parameters, circulation designs, spatial and layout configurations, circulation efficiency and wayfinding. Since building and urban environment designers are often challenged with the tasks of producing functional spaces, the success of which depends largely on the design implications, this study is thus tailored towards showcasing the values and importance of adopting fundamental concepts/principles of circulation design for generating appropriate building layouts focused towards optimizing wayfinding and spatial orientation right from the conceptualization stages of design. The impacts of spatial orientation in buildings and ease of wayfinding can be attributed to general building safety and post occupancy experiences of users. The values of wayfinding play key roles in problem solving practices mostly associated with emergency evacuations, or with simple spatial cognitive attitudes that impact on user orientation. Finally, since spatial disorientation in built environments is attributed mostly to layout configurations that originate from the building conceptualization and design stages, architects and designers of spaces like large hospitals may reduce these negative impacts by adopting measures like:

i. Establishing spatial configuration as the dominant element in the design for eliminating spatial disorientation and improving the wayfinding process.

ii. Application of pre-design axial analysis of conceptual building layouts prior to design development.

iii. Adoption of more linear building forms (configurations) that provides visitors and users with extended lines of sight and networks for ease of visual connectivity to destination points in large buildings, especially large hospitals where the effects of spatial disorientation may impact the mental well-being of users.

iv. Employment of the additional principles of effective wayfinding like location distinctiveness, visual characterization, adaptive sightlines and signage with decision points.

v. Adoption of spatial configurations that provide easy user-cognitive representation of spatial information with components intended to improve indoor spatial cognition process such as colors and textures.

Author Contributions

In this study, the main author Akubue Jideofor Anselm, composed the structure of the work as well as formulated the research methods and analysis. His contributions include:

a. developed the background of study and built literature review section of the work,

b. identified and structured the methodology for the research

c. developed the layouts for each of the cases studied and analysed the Axial maps generated from the layouts

d. developed the results and discussion of findings in the study

The second and third authors (Abdul-One Salman & Usman Tyabo Salihu) carried out the hospital surveys and generated the graphical data used for the analysis.

The fourth author (Abdulkadir Mohammed) organized the tables and review of the research format.

Conflict of Interest

There are no conflicts of interest to disclose.

Data Availability Statement

The hospitals used for the study are major state owned hospitals in Nigeria. Details of the hospitals layouts used in the Axial map analysis and studies are available on the directories within the hospital locations and their websites. There locations and websites are as follows:

a. National Hospital Abuja (NHA), located in northern Nigeria - Plot 132 Central Business Districts PMB 425 Garki Abuja (https://nationalhospital.gov.ng/)

b. University of Nigeria Teaching Hospital Enugu (UNTH), located in southern Nigeria – University of Nigeria Teaching Hospital, Ituku Ozalla, Enugu state (https://unth.edu.ng/)

c. University College Hospital Ibadan (UCH), located in western Nigeria – Queen Elizabeth Road, Ibadan, Oyo State. (https://uch-ibadan.org.ng/)

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Ethics Statement

No human or animal subjects were used in this study.

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