DEVELOPMENT OF PERCEPTUAL WAYFINDING FRAMEWORK FOR HOSPITAL ENVIRONMENT IN NORTH CENTRAL NIGERIA

Wayfinding refers to the task of a person navigating unfamiliar environment from a known location to an unknown location for a purpose with the goal to reach a desired destination. In large complex buildings such as teaching hospitals, wayfinding becomes a challenge to unfamiliar users which results to miss of medical appointments, anxiety, stress, getting lost, frustration, and even death in emergency situations. Hence, the study becomes pertinent in view of the paucity of study of the phenomenon in the study area. The purpose of this study was to investigate wayfinding in teaching hospitals in north central Nigeria with a view to develop a perceptual wayfinding framework. The study was carried out to determine the level of user-friendliness the hospital environment had to unfamiliar users for wayfinding. As such, the objectives of the research were to examine users' perception of wayfinding; establish the critical factors that influence the ease of wayfinding in hospital buildings, and the effectiveness of hospital design in relation to wayfinding performance. Mixed method approach was used as the methodology where four hospitals in the north central Nigeria were evaluated using quantitative and qualitative data. Consequently, cross sectional survey questionnaire was employed as instruments for collecting quantitative data while interview and observation techniques were used for collecting qualitative data. The sample size for the questionnaire survey was 400 participants, 56 respondents for the interview, and 16 participants were observed for wayfinding in the hospitals. The data were analysed using descriptive, inferential, content and domain analyses. The main research findings revealed that complex building configuration was a challenge to unfamiliar users in finding destinations with ease in the hospital environments. In addition, the research established seven critical factors that significantly predict wayfinding in the hospitals. These factors and their factor loadings include landmarks (0.854) clearly defined circulation spaces (0.812), route intersection (0.739), visual accessibility (0.655), verbal direction (0.533) building layout complexity (0.468), and signage (0.412) which are above the standard recommended threshold of 0.4. This implies that professionals (architects, urban designers and wayfinding designers) and policy makers should consider these factors that influence the environmental legibility of the hospitals in the designs of wayfinding systems. Based on the research findings, the study developed a perceptual wayfinding framework for hospitals in north central Nigeria. In the framework, the concepts of affordance and information needs were used to describe the visual perception of environmental cues. Accordingly, visual perception is important to cue-searching in the built environment, suggesting that visual ergonomics should be a significant feature to consider in spatial wayfinding designs. Finally, it was recommended that government policy on hospital designs should be of simple building layout, each zone should have clearly defined circulation space, and with each space differently identified. In that way, cue searching and selection becomes easy for successful wayfinding.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Wayfinding is the movement of persons from an origin to find a desired destination in an unfamiliar setting which is an essential ingredient of life to move from one location to another (Mandel & LeMeur, 2018). The search for ways by people to reach a destination could be within the school, cities, airports, hospitals, across the markets, and through large buildings (Ekstrom *et al.*, 2018). Also, different means are used by people to navigate their ways within a building or environment which includes the use of vehicle, and pedestrian movement in an urban setting or hospitals (Dalton *et al.*, 2019). However, in multifaceted public buildings such as airports and hospitals, point of reference is quite a difficult task for visitors and outpatients unfamiliar with the environment and has to seek for destination without prior understanding of route to the place (Ruotolo *et al.*, 2018). In spite of the challenges in wayfinding in complex environment, people must navigate from one place to another for a purpose, in the right direction, with aim to reach a desired destination (Denis, 2018).

Wayfinding involves the use of cognitive process (memory), visual ability, and perception to guide and recall the path of travel between locations and retraces the path back from memory to the origin (Haghani & Sarvi, 2017). In wayfinding, the starting point is known, but the path to follow to destination or identifying the destination is unknown (Skorupka, 2008). However, wayfinding is different from exploratory travel, which entails surveying, lacking any meticulous spatial purpose (Weisman, 1981; Zacharias, 2006). Generally, the setting to find the way is unknown to the users which cause wayfinding difficulties.

Wayfinding problems are common in hospital environments (Dalton *et al.*, 2019) and cause patients and visitors that are unfamiliar with the hospital environment stress and monetary cost (Ulrich *et al,* 2008). Zimring & Bosch (2008) established that the man hours lost by hospital staff in giving directions to visitors and patients amounted to $220,000 per annum. This amount gives N78,758,000 per annum at an exchange rate of $1 to N360 as at 2019 in Nigeria. Salmi (2008) affirmed that uncertainty in wayfinding could be a trying experience for patients with consequences of raised blood pressure due to nervousness, and causes headaches due to exhaustion. Furthermore, it was declared that the time of a travel is a significant consideration when navigating hospitals to find a destinatioin. As such, the need to determine an optional pathway for a spatial decision- making could be expensive if time is wasted in taking the shortest correct path becomes (Ekstrom *et al.*, 2018). In addition, the most stressed and vulnerable group of users that experience wayfinding difficulties in hospitals are the physically challenged, the elderly, and newcomers (Carvalho & Nolfi, 2016).

In Nigeria, the situation is not better where there have been reported occurrences of wayfinding challenges in composite hospital buildings, especially during emergency situations when there is the need to rapidly evacuate people (Babatunde *et al*., 2014). In a related development, Kahnge's (2011) studies on signage revealed that the first visit to hospital by users and visitors had difficulty in locating the various destinations in the hospital in Kaduna State of Nigeria. It was established that inadequate signage systems and awful design of hospital buildings could cause threat for people already tensed up in intricate environments (Ruotolo *et al.,* 2018). Building configuration with well-organized wayfinding in a setting enhances patient contentment and efficiency with good feeling that makes patients wish to visit the facility another time (Ekstrom *et al.,* 2018). Therefore, the development of perceptual wayfinding framework for hospital environment in North Central Nigera is appropriate and justifiable.

1.2 Statement of the Research Problem

In large hospital environment, users often get lost in finding direction to the desired destination due to the complexity of the setting as observed in teaching hospitals in north central Nigeria (Babatunde *et al.,* 2014). This problem has negatively impacted on the users (patients, visitors and staff) in the form of frustration, anger, discomfort, anxiety, stress, missed appointments, and the distraction of staff time to give directions to users (Rooke, 2012; Carvalho & Nolfi, 2016; Palmiero & Piccardi, 2017).

Previous studies tried to examine the possible causes of wayfinding difficulties in hospitals (Hughes *et al.,* 2015; Kuliga 2016; Mustikawati *et al.,* 2017). These studies found that layout complexity, evolving spaces over time, which were being regularly reconfigured and extended due to operational needs and change, often resulted in non systematic layout, thereby confusing patients. Kahnge's (2011) studies on signage revealed that unfamiliar patients had complexities in locating the various destinations in the hospital in Kaduna State of Nigeria. However, there are limited studies on the legibility and the ease of navigation in hospital environment in Nigeria. Therefore, the big question is how friendly is the hospital buildings to the users for wayfinding in an unfamiliar environment in north central Nigeria? In other words, does the hospital building support the execution of navigational tasks in an effective, efficient and satisfactory manner? Are hospitals designed to be legible, pleasant and learnable? As a result, the paucity of studies on the evaluation of navigation problems in the teaching hospitals in the north central Nigeria necessitates this study.

1.3 Aim and Objectives of the Study

The aim of the study is to develop a perceptual wayfinding framework for hospital environment in North Central Nigeria.

The objectives of the study are to;

(i) survey users' perceptions of wayfinding in the hospital environment.

(ii) determine the critical factors influencing wayfinding in the teaching hospital buildings.

(iii) evaluate the effectiveness of teaching hospital designs in relation to wayfinding.

(iv) develop a perceptual wayfinding framework for effective navigation in teaching hospitals in North Central Nigeria.

1.4 Research Questions

The following questions were answered by the study:

(i) What are the users' perceptions of wayfinding in the teaching hospital setting?

(ii) What are the critical factors influencing wayfinding in the teaching hospital buildings?

(iii) How effective is the hospital building in communicating wayfinding performance to users in the teaching hospital environment?

(iv) How can perceptual wayfinding framework be developed for effective navigation in teaching hospitals in North Central Nigeria?

1.5 Research Justification

There are paucity of research that emphasise the relationship between architectural characristics and wayfinding in hospitals particularly in the Nigerian (Maina & Umar, 2015). Kahnge (2011) worked on signage as a wayfinding tool in a teaching hospital while Maina and Umar (2015) explored the relation between physical properties and coded information in wayfinding in public building. However, there is dearth of study that evaluates the users' ease of wayfinding in teaching hospital buildings in Nigeria. Hence, this study seeks to establish the critical architectural characteristics that assist movement pattern, ease of access, contentment and security of the environment.

Beyond the philosophical basis of investigating wayfinding, there is the issue of environmental setting of research. The evidence from previous studies shows that a larger percentage of the researches on wayfinding in hospital settings were from Europe, United States of America (U.S.A), and China (Rooke, *et al.*, 2009). Thus, it could be stated that their results on wayfinding in developed countries would differ in application to hospitals in developing countries such as Nigeria based on socio-cultural differences. In fact, the factor was shown to have influenced architectural design of space considerably in the study of Lu & Bozovic-Stamenovic (2009) which explored the cultural influence of wayfinding on hospital buildings in China.

Apart from the environmental setting of the research, there is also the factor of testing the effectiveness of wayfinding structure in hospitals environment. In the United States of America (USA), Arthur & Passini (1992) employed prescriptive wayfinding structure in hospitals while Rooke (2012) used conceptual framework in the United Kingdom. In addition, Castell (2017) used wayfinding feature framework to measure the influence of building characteristics on achieving wayfinding efficiency. Accordingly, more studies with frameworks are needed in order to further test and validate these frameworks and develop new ones in other settings by extending the knowledge on wayfinding performance. Ekstrom *et al.* (2018) affirmed that it is likely that the existing hypothesis with frameworks on spatial information did not sufficiently explain the knowledge and comprehension of users' behaviour and perception of wayfinding in hospitals.

Based on the preceding, there was a knowledge gap in wayfinding perception with respect to evidence based design in hospitals particularly in Nigeria. Hence, it is important that a study hinged on the advancement of perceptual wayfinding framework, to direct prospective hospital designers (particularly architects and planners), and policy makers in wayfinding design systems in Nigeria be conducted. Furthermore, this research can add to education and knowledge, and create the basis for a hospital setting to be more accessible and inclusive in wayfinding which justified the need for this study.

1.6 Scope of the Study

The users considered for this research were the out-patients and their family care-givers of the hospitals in north central Nigeria in order to develop perception wayfinding framework. Consequently, the user's response about their experiences of the physical setting concerning wayfinding was important in the research. The study also assessed the physical properties of the buildings to understand the extent it communicate the ease of readability of the hospital setting in the sampled teaching hospitals to the users in the north central Nigeria. This involves the assessment of the spatial structure and design characteristics in the teaching hospital buildings of similar category in the research area. However, the study did not include the physically challenged and children due to ease of access, consent protocol and time required to complete the research. This study recommends these categories of particpants in further research.

1.7 Study Area

The study was conducted in the teaching hospitals in the north central geopolitical zone of Nigeria. The zone lies along River Niger and River Benue between Latitude $8^0 – 10^0$ N and Longitude 2^0 -10^0 E (Balogun, 2001). The north central Nigeria consists of six States and the Federal Capital Territory (FCT). The States are Kogi, Kwara, Nasarawa, Niger, Benue, and Plateau States (See Figure 1.1).

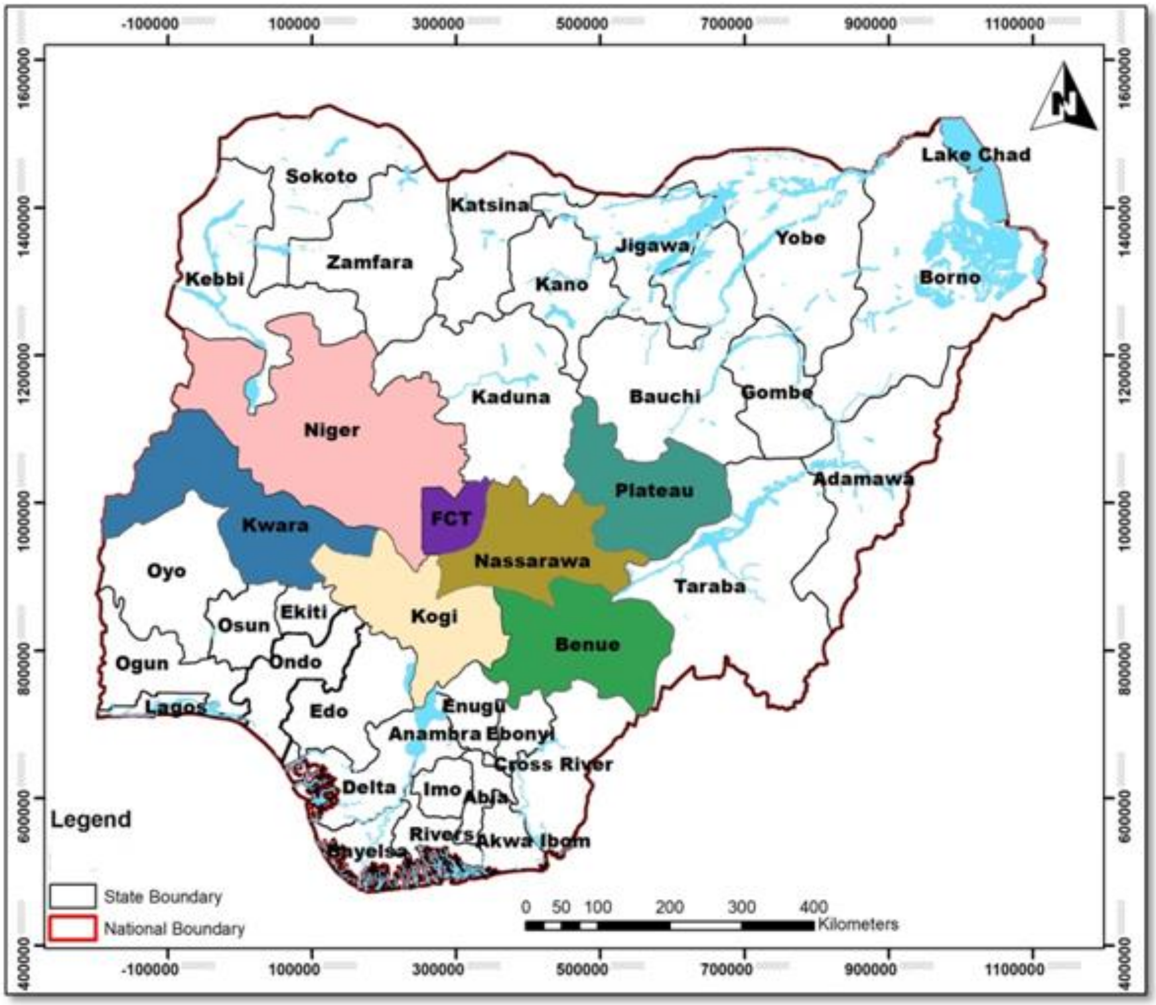

Figure 1.1: Map of Nigeria showing North Central States
Source: Niger State Ministry of Lands & Survey Dept., Minna, 2017.

Accordingly, four teaching hospitals were selected for the study based on size. These hospitals include University of Abuja Teaching Hospital (AUTH), Gwagwalada, Abuja and Benue State University Teaching Hospital (BSUTH), Makurdi. The other hospitals are University of Ilorin Teaching Hospital (UITH), Ilorin, Kwara State; and Jos University Teaching Hospital (JUTH), Jos, Plateau State. The teaching hospitals were selected based on the size and the density of the buildings that exacerbate wayfinding difficulties. Secondly, the wide coverage of services and the specialised nature of the healthcare facilities make the buildings more complex to navigate which makes wayfinding a challenge than other hospital types. Finally, teaching hospitals have a large number of patients than other hospital types because of referral cases handled by the specialist in these hospitals.

The study area was selected based on the diverse cultural makeup of the region, which could be basis for wayfinding intricacy and in reading of architectural cue of the setting to the users. For instance, in the north central Nigeria, the predominant tribes are Hausa, Yoruba, Nupe, Tiv, and Berom. It was affirmed that cultural differences affect the use of space and comprehension of signage in wayfinding (Lu & Bozovic-Stamenovic, 2009). It was asserted that wayfinding entails the communication between the user and the setting, the distinction and relations affects the manner path choices were made based on perceived environmental information (Zhao, 2012).

From the 2017 education statistics bureau in Nigeria, about 65.1% of the adult populace is illiterate. This implies that it could be difficult to use and understand the hospital signs and cues for wayfinding which affects the ease of navigation. In addition, the study area shares boundaries with the northern and southern part of the country where the three major cultures of the country (Hausa, Igbo and Yoruba) are found due to social interactions. Thus, Lu and Bozovic-Stamenovic (2009) stated that the connection between setting and behaviour is considered as solely spatial-physical associations. As such, the socio-spatial associations between the setting and direction-finder are important for the absolute admiration of wayfinding crosswise cultures. Therefore, cultural distinctiveness affects wayfinding.

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CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Historical Development in Wayfinding

Lynch (1960) initially conceived the phrase wayfinding in the *Image of the City*. Lynch investigated the link between a spectator and the setting, and affirmed that image was developed during the cognitive formation which causes information processing and wayfinding (Rooke, 2012). Wayfinding was elucidated in the expressions of spatial orientation and cognitive maps. Lynch (1960) avowed that the legibility of a city depends on the simplicity with which the city components can be acknowledged and structured into a logical pattern. Lynch recognised five constituents (paths, edges, nodes such as junctions, districts, and landmarks) that persons had a tendency for cognitive mapping from the setting. Allen (1999) elucidated that these constituents produced the design criteria for a very legible representation of the setting. Lynch's (1960) work basically made researchers to understand environments and was extensively used in urban planning and architecture.

The subsequent wayfinding era was in 1970's to 1980's where the theory of wayfinding was articulated as a problem solving process (Downs & Stea, 1973; Weisman, 1981; Kaplan & Kaplan, 1982; Carpman *et al.,* 1984; Passini, 1984). The study of Weisman (1981) documented four spatial variables (visual access, the degree of architectural differentiation, signage used to give recognition and or directional information, and plan configuration) that influence wayfinding performance within the built environment. In addition, the research of Seigel (1981) furthered people's familiarity with the setting such as rate of recurrence of previous use, to have brunt and consequence on wayfinding performance in order to effectively find the way through a new setting.

The work of Lynch, Weisman and Passini generally laid the foundation and impact on wayfinding design and hypothesis (Rooke *et al.*, 2009). The majority of the existing literature on wayfinding in multifaceted settings is plagued with numerous values and had shown a lot of remarkable advancement.

2.2 Factors Influencing Wayfinding

Nik *et al*. (2019) states that there are factors that influence navigation in hospital environment which includes environmental cues (signage, landmarks, maps, colour and lighting), human factors (age, gender, language and colour) and profound insight (familiarity and complexity). However, along the route some factors such as route strategy and route choices may change the plan of action and affect decisions made along the route. In decision execution, information from the environment is processed by trying to understand the spatial information in the environment and been competent to use it to arrive at the wanted target in a facility (Health Guideline Summary, 2014). The ability to process the spatial information could pose a problem to the hospital users when one is to locate a destination in a new large complex building. The qualities of a person which are internal factors, and the spatial features which are external features, mutually predict the users' ease of navigation (Prestopnik & Roskos-Ewoldsen, 2000).

Hence, wayfinding difficulty has been linked with fatigue, aggression, anxiety, and discomfort in patients with staff lost time in giving verbal directions (Pati *et al.*, 2015). To eradicate these difficulties, it is essential to comprehend the likey effects of the building layout in the location and the quality of the spatial information (Dogu & Erkip, 2000). For instance, the layout consist of spatial content such as the form, organisation, and its circulation network while the spatial data is the architectural and graphic expression used to resolve wayfinding difficulty (Passini *et al*., 1998). This explains the significance of understanding the factors that influence successful wayfinding.

The research on human neurophysiology affirmed that the following factors were found to influence wayfinding performance (Xia *et al*., 2008). These factors include age, gender, level of education, and language; familiarity with the environment, physical circumstances, and cognitive capacity. These factors were established to impinge on the manner people discover their way in the environment and the ones relied upon by other people vary from one person to another (Dogu & Erkip, 2000).

When people enter a complex setting, they try to understand the information contain in it and how it is organised by selecting important environmental cues they could recognise and remember to find their way in the setting (Kuliga, 2016). Consequently, different studies have documented a number of the spatial attributes that influence wayfinding. The spatial attributes include complexity of building (size or density), landmarks, architectural differentiation (distinctiveness), visual access to familiar cues, signage (use of signs and room numbers), visual configuration of space, and symmetry of the layout (Hund & Gill, 2014). Other spatial factors are edges, nodes, pathways, districts, use of finishes, colour, luminosity (lighting), utilisation, structure, flow pattern and junctions (Lynch, 1960; Weisman, 1981; Pati *et al.*, 2015).

The legibility of main architectural rudiments is a condition to comprehending the spatial organisation of a building (Arthur & Passini, 1992). The design rudiments include the entrance, the horizontal and vertical circulation, and key reference points (landmarks). Therefore, it can be argued that the primary influence of wayfinding performance is associated with the floor plan configuration of a building. In addition, the intricacy of the floor plan affects the ability of the users to recall a building, and consequently, impact on the wayfinding behaviour of the users in terms of ease and accuracy of wayfinding (Dogu & Erkip, 2000).

Apart from floor plan complexity, there is the issue of the degree of architectural differentiation that influence wayfinding. This is the extent to which dissimilar parts of a setting are distinguished. The environment could be made distinct from one another in terms of size, form, colour, and architectural technique (Mandel & LeMeur, 2018). Besides, the more distinct an environment, the more memorable in supporting wayfinding (Montello, 2014). In addition, visual access is the extent to which dissimilar parts of an environment can be seen from a range of standpoint such as from start locations, the desired ends and varied landmarks along the path of movement (Arthur & Passini, 1992). As such, greater visual access makes orientation easier for the wayfinder.

Next to visual access is signage. The signages are directional and destination signs in the form of arrows, labelling and numbering of rooms or building, pictographs, and maps that represent meaning symbolically in order to aid wayfinding (Symond, 2017). The design and position of symbols in the setting obviously have an effect on point of reference (Kuliga, 2016). Accordingly, for signage to be effective, it must be legible from a distance, must be clear and simple in design with just enough information, but not too much to avoid confusion, and must be placed at decision points (Montello & Sas, 2006). However, many contextual factors influence the effectiveness of signage. For instance, a clear sign may be confusing if placed in the midst of competing visual cluster, and a well designed and placed signs cannot compensate for other poor environmental cues along the circulation space (Arthur & Passini, 1992). Accordingly, signage is an effective wayfinding cue, but cannot compensate for poor architectural design in complex buildings.

The circulation space for persons to navigate in order to find a location is the main organising force of a layout (Hund & Gill, 2014). Sometimes, the shape of circulation scheme might be unnoticeable to the user of surroundings at the onset, but as the user makes use of environmental cues and signs along the path, wayfinding decisions becomes easier (Ekstrom *et al.*, 2018). Besides, building ordered close to an open core provides the users with an ocular and at times aural access to the shape of the circulation scheme (Haghani & Sarvi, 2017). Also, the design of the circulation scheme makes a building simple to comprehend (Ruotolo et al., 2018). Similarly, the shape, height of buildings, and crowd along the circulation space could also make the user to recall a building (Dogu & Erkip, 2000). Consequently, circulation spaces and architectural differentiation are strong attributes in wayfinding.

The colour of buildings could aid to distinguish amid constituents in a location and between settings in an environment (Ekstrom *et al.,* 2018). Equally, colour strips are also used in directing patients to some destinations in hospitals. Furthermore, colours that contrast with their background could make perception of objects easier. Besides, strong contrasting colours attract the eye, but should not be too many in order not to create confusion (Harris & Wolbers, 2014). From the foregoing, it can be argued that the use of colour in buildings performs a vital function in wayfinding.

Apart from the use of colours in buildings, the knowledge procedure in wayfinding comprises learning approaches, circumstances, and knowledge capabilities are important during navigation (Denis, 2018). For instance, in a new setting like large hospital buildings, different tactics were employed by several users in wayfinding behaviour (Mustikawati *et al.,* 2017). These tactics consist of landmarks to recognise orientation for pertinent navigational option; route information links discernible landmarks; and survey information, incorporates routes and directs sophisticated choices for route selection and general direction (Holscher *et al.*, 2006). These strategies are mostly employed by patients and visitors for protection and safety to follow their way back (Hashim & Said, 2013).

The Study of Kikiras *et al.* (2006) acknowledged four features that affect the wayfinding of persons in a setting which comprises spatial capability, basic information processing abilities, acquaintance with the setting and motor capabilities. Spatial capability refers to the ability of each person to recognise the encompassing setting with its sensing plus cognitive devices (Hund & Gill, 2014). This capability comprises every cognitive process employed in erudition of the setting and understands the connection among its elements (Allen, 1999). Accordingly, this results in spatial awareness that explains the extent to which a person comprehends and responds to a setting with one's spatial ability (Pati *et al.,* 2015). Therefore, it suggests that finding the route of travel is an active and challenging cognitive process that entails several spatial and navigational capabilities that varies from each person.

2.3 Concepts in Wayfinding

Direction-finding to destination is the capability to locate one's target in a facility without getting missing (Pati *et al.,* 2015). It is also the interaction between the user and the environment that involve interrelated processes because each decision made is influenced by the previous one (Hashim & Said, 2013). There are three main wayfinding processes which include decision making, decision execution and information processing (Health Guideline Summary, 2014). The user makes a decision by developing an action plan on how to get to a destination by making a sequence of linked decisions. Also, decision execution involves a plan of action by mapping out the route to reach the destination (Farr *et al.*, 2012).

Wayfnding refers to the procedure of discovery one's way to the desired destination in a known or new setting via whichever cues disposed by the setting (Farr *et al*., 2012). Furthermore, it can be described as a focused, directed, and inspired means of moving from a precise point of origin to a particular end (Golledge, 1999). It entails choosing and following set of paths or route through an existent network (Kalia, 2009). In addition, navigation to desired target is jointly cognitive and behaviour connected responsibilities that cannot be successful unless orientation, route option, route control and route detection are obtained and been able to go back to the position (Carpman & Grant, 1993; Bechtel & Churchman, 2002). Therefore, the two main parts of wayfinding are motion and executive (Montello, 2014). Thus, flawless incorporation of motion, acuity and reminiscence are requisite for effective navigation to destination (Mandel & LeMeur, 2018). So, the cognitive procedure refers to spatial actions that entail the capability to study a route and repeated it from memory for successful direction-finding to target location (Blades *et al.*, 2002; Julian, 2010). Consequently, it requires cognitive representaion, making decision and executing the decision (Ekstrom *et al.*, 2018).

Wayfinding can occur in Virtual Settings (VS) for instance computer simulations; charts (maps), direction-finding through websites and given that circumstance the route-finder is bigger than objects (Bailenson *et al.*, 2001). Furthermore, finding path to destination could take place in bigger scale spaces (such as large hospitals, airports and cities), thus, objects are bigger than user (Xia *et al*., 2008). This makes it possible for one to experience the setting. In virtual setting the variables can be checked whereas in actual setting the participants are observed actually doing the task; however, overriding variables like light, noise, overcrowding might affects navigation during wayfinding task in an uncontrollable way in actual surroundings (Castell, 2017). This infers that added care is necessary to check the overriding variables in actual locations with regards to the sections chosen for research.

Research is needed to elucidate information from patients in real environmental setting. This was with a view to explore patients' experiences and behaviour in finding the way in hospital environment. Besides, in the virtual and real environments, studies have identified that the most commonly reliable ways used to recognise travel routes or to arrive at a destination are signs and signage (Arrowsmith *et al*., 2005). As such, signage and well articulated architectural features as environmental cues were considered most important attributes in hospital wayfinding.

2.3.1 Navigation performance techniques

Navigation involves purposeful movement and wayfinding components as an integrated system for direction-finding to destinations (Nik *et al.*, 2019). Hund & Gill (2014) recognised variables such as time, route, and sketch map, necessary for diverse wayfinding circumstances that completely count on the direction-finding task in sight. For instance, once the research is on the capability of someone to locate an unfamiliar object in a complicated space, subsequently, time will be suitable to assess in the study (Pati *et al*., 2015); Also, once the attention is on the capability of an individual to locate a familiar setting in a difficult space, then, the exploration for route assessment would be suitable (Dix, 2016); Furthermore, once the attention is on someone's capability to have in general familiarity of the formation of space, then, sketch map drawing would be suitable (Denis, 2018). As such, in this study of hospital setting, to effectively carry out and determine user's perception, route measure and observation of patients' travel behaviour will be the most appropriate. The variables that can be used for the spatial attributes of hospital users' route were the number of directional changes, the distance from GOPD entrance to the destination, number of signage on the wall from origin to destination, and the number and type of landmarks used by patients (Kuliga, 2016). Khan (2013) stated that patients' travel behaviour was based on the number of stops, number of looking around, number of asking for direction and the number of backtracking.

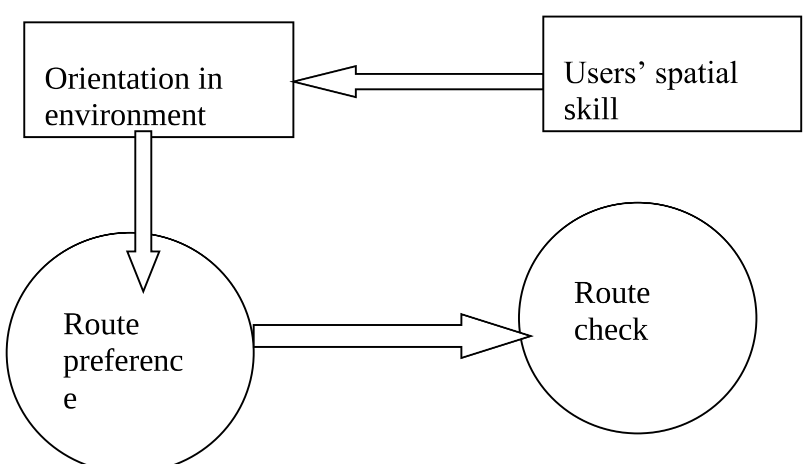
2.3.2 Human wayfinding task

Human wayfinding research examines the processes that exist in direction-finding by persons in big-scale spaces, for instance, extensive spaces like landscapes, and complex urban structures which are similar to teaching hospitals (Castell, 2017). Cooper (2010) affirmed that perception of spaces is impossible from a sole standpoint; so, persons need to find the way through a big-scale setting. Allen (1999) classified wayfinding undertakings into three kinds, which includes individual navigating to a well-known destination, another is to journey to a new destination, and lastly, investigative journey in unknown setting. This study investigates people's perception as an investigative journey in an unknown hospital complex that is within the clasified task.

The conduct of persons is diverse for every wayfinding undertakings embarked on (Xia *et al.*, 2008). Therefore, persons tend to rely mostly on emblematic spatial data and architectural characteristics conveyed during place legibility (Golledge, 1999). Place legibility is the simplicity that a structure or target is identified (Paul, 2013). The key procedures for communicating place legibility relate the abilities to harmonise real world characteristics against information and comprehending the signage usually employed to symbolise actual features (Castell, 2017).

The human features documented to be linked with wayfinding comprise spatial orientation, cognitive mapping capabilities, path (route) strategies, gender, language, and socio-cultural factors (Pati *et al*., 2015). Spatial reference point (orientation) refers to one's capability to figure a cognitive map of a setting (Arthur & Passini, 1992). Kitchin (1994) argued that cognitive mapping is the relationship between the interiorised image of space in thinking and the consciousness that persons have concerning settings. Furthermore, it is the person's inner depiction of the experienced world; also, it entails procedures that let people to obtain the symbols, amass, and remember, and try to use the information concerning their spatial setting (Dix, 2016).

Wayfinding process have been divided into a four-step procedure once carried out in the real world, and it comprises of the following (Downs & Stea, 1973): First, is the orientation, which is when users locates one's position with reference to close by landmarks and the needed destination; Secondly, route preference (choice), which involves deciding a path that could guide one to the wanted destination; Thirdly, route control which is the regular check and affirmation that one is trailling the chosen path; and finally, destination identification which involves person's capability to recognise that the most wanted destination is reached. These four processes (orientation, route selection, route control, and destination identification) are required for successful wayfinding in any large complex environment. The hospital user navigates from a known origin making a decision on the shortest route in the route selection that could guide to the required destination. Furthermore, in controlling the route, the user confirms the correctness of his or her route using the appropriate landmarks and cues along the route that could lead to the desired destination, and been able to recognise the destination. Figure 2.1 summarises the wayfinding processes in a hospital environment which is unidirectional.



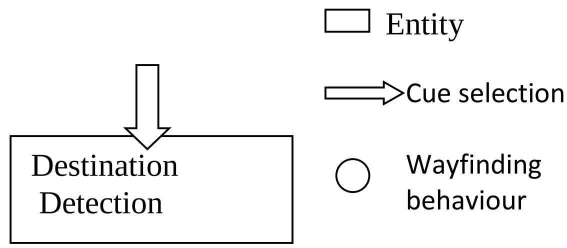


Figure 2.1 Wayfinding process (Source: Researcher’s review, 2017)

2.4 Dimensions of Wayfinding

The dimensions of wayfinding analyses involve cognitive mapping and legibility as the signal of person and physical factors of wayfinding respectively, and the connection between wayfinding and architecture. Accordingly, cognitive mapping, legibility of spatial environment, and the relationships of architecture and wayfinding are discussed in the succeeding sections.

2.4.1 Cognitive mapping

Cognitive mapping constitutes a major part of spatial information that includes the procedures a person embarks on deliberately or instinctively during direction-finding (Nik *et al.*, 2019). Cognitive map was also explained as the depiction of spatial setting created in the psyche (Xia *et al*., 2008). Therefore, the progress and use of cognitive maps are necessary components of wayfinding (Darken & Peterson, 2004). In addition, during wayfinding procedure persons understand and memorise routes by the distribution of paths into a set of distinct pathway sections, choice point (turns), and markers (landmarks) that are situated at choice points or down the way (Jackson, 1998). Hence, the depiction of spatial information is influenced by the technique utilised to obtain it. Therefore, it means that cognitive chart can be constructed during individual knowledge of the corporal world or during interpretation and erudition of route chart (Xia *et al*., 2008).

Navigation in a setting with the aid of cognitive chart needs the formation of landmark, route or survey familiarity according to the extent of facts obtainable in the location (Darken & Peterson, 2004). At this juncture, the facts acquired from the physical properties of the setting and design is utilised in decision-making, decision execution, and following reading of locational circumstances in sequence to accomplish the wayfinding undertaking (Demirbas, 2001). It is vital to remember that navigating in a setting is target focussed and so must be pre-planned. Consequently, the cognitive chart helps the explorer to plan the motion pattern in advance and registered in the mind the path to follow in the setting, while sustaining the point of reference (orientation).

Cognitive charts are range of exterior spatial features that can be represented through spoken, drawing, estimation or replicating (modeling) methods (Prestopnik & Roskos-Ewoldsen, 2000). Spoken or printed instructions were employed by Freundschuh *et al*., (1990), sketching maps of the erudite setting (Kubat *et al.*, 2012) and estimating distances (Campbell & Lyons, 2008). Nonetheless, drawings or maps contain some drawbacks due to individual disparities in capabilities of drawing sketch maps; the scale of the drawing and the kind of drawing (spatial or sequential) (Prestopnik & Roskos-Ewoldsen, 2000).

Studies have recognised gender disparities in cognitive mapping capabilities. Females are inclined to have less spatial self-confidence than males (Lawton, 2001; Lawton & Kallai, 2002; Bechtel *et al.*, 2002). It has been established that males draw whole, wide, and precise cognitive maps. Furthermore, females are inclined to concentrate on markers (landmarks) and districts whereas men tend to highlight path instructions and estimate distance (Kitchen & Freundschuh, 2000). This suggests that gender differences have significant influence in wayfinding. Accordingly, gender was considered appropriate in hospital wayfinding. The advantage of using cognitive mapping in wayfinding research is that it enables the wayfinder to comprehend and recall routes easily.

2.4.2 Legibility of spatial layout for wayfinding

Lynch's (1960) concept of legibility refers to the simplicity by which the components of urban setting can be identified and structured into a logical pattern. Again, the aptitude of one to communicate architectural rudiments and space decide one's information dispensation ability that is generally followed with little complexites in understanding the information (Paul, 2013). At times in a multifaceted setting, the information necessary to arrive at a target might be excessively big to be perceived in its whole (Kubat *et al.*, 2012). Furthermore, legibility refers to the spatial configuration of the setting that provides superior information pertinent to make an excellent wayfinding scheme in the spaces easy. Thus, a place that eases getting and comprehending of spatial information was considered to have a high legibility factor (Hund & Gill, 2014). Therefore, architectural legibility refers to the extent that the planned attributes of the setting help persons in generating an effectual cognitive chart of the spatial interactions in a building, and the ensuing simplicity of wayfinding in the setting (Dix, 2016).

The legibility of main design constituents, like entrances, horizontal and vertical circulation, visual access (the capability to view through the building) and main landmarks is a precondition to comprehending the spatial arrangement of a building (Pati *et al*., 2015). Furthermore, a low legibility factor is an unclear spatial planning, so, not implicit, and does not assist with wayfinding (Castell, 2017). Consequently, Arthur & Passini (1992) avowed that the code of the spatial planning have to be transmited to the wayfinders. Hunter (2010) asserted that the legibility of an architectural setting affects the value of extensive building categories beyond simplicity of use although comprises further variables like individual comfort, safety, stress and satisfaction. Moreover, the enunciation of pathways is an essential feature of wayfinding message (Arthur & Passini 1992). Accordingly, suitable enunciation shows the direction of a motion, enhances perceptive circulation system, and permits access to the user.

The extent of architectural legibility can influence the scale of activity, sense of control, and protection in urgent situations, for example, housing for the elderly (Weisman, 1989). For wayfinding at the building level, it is significant to recognise the associations between places, since this fact is essential for choosing successful routes from start to desired end (O'Neill, 1991a). There are several of design attributes considered to influence legibility, like signage, visual access to the exterior, architectural differentiation, and floor plan configuration (Weisman, 1981). Garling *et al*. (1983) affirmed that visual accessibility makes point of reference inside a structure a lot easier.

2.4.3 Wayfinding in architecture

Wayfinding in architecture generally refers to user's point of reference and the choice of a route to journey (Abrams, 2010). Thus, direction-finding in the context of hospital setting is the interaction between the patients and the environmental cues in being able to read and interpret the cues to get to desired target (Hashim & Said, 2013). Arthur & Passini (2002) affirmed that architects appear to conclude that assisting people's wayfinding desires in terms of being able to detect environmental cues in a facility is more significant than the addition of more symbols (signs), since nearly all the time signage cannot conquer design malfunction. Accordingly, wayfinding values are usually well thought-out during the design procedure both for the general spatial formation and the attributes of designed form. This suggests that destination paths should be able to guide users to the intended target locations. Consequently, the alignments of related functions into a cluster within buildings must be obviously recognised into zones to improve wayfinding (Hund & Gill, 2014).

In order to ease navigation to desired target regions, the circulation scheme must be of a type that persons can effortlessly comprehend. For instance, creating an easy wayfinding system for people in the specific space and formation of the setting (Rapoport, 2005). It was avowed that the most excellent method to enhance ease of wayfinding is to make a straight line of travel and less choice points down the ways in architectural design (Paul, 2013). Consequently, it suggests that floor plan configurations have a great impact on the patients' perception in hospital wayfinding.

Additionlly, the best wayfinding design in architecture is the efficient feature of buildings that permits simple and error–free direction-finding (Wermer & Schindler, 2004). In fact, the effeiency of building cues is important to general design since it aids visitor access, enhances contentment, and decreases humiliation, anxiety, uncertainty of users (Hunter, 2010). Therefore, building layout is mainly the prominent feature in wayfinding performance in spite of of signage (O'Neill, 1991b).

2.5 Users' Perception of Wayfinding

Theories of perception explain the way user acquires and recall information which might be articulated in oral type if not in similes and cognitive charts that expresses perception, and the ability to process the information (Dalton *et al*., 2019). The perception of the environment is expressed based on the previous experience of the user in relation to the needs of the wayfinder. Spatial facts are acquired during perceptual procedures which are influenced through representation and inspired by the desires (Chen, 2012). In addition, the schemata shape the connection among perception and cognition; lead perceptual processes, including the poignant reactions and accomplishments that in consequence impinge on the representation as the result of conducts that are perceived (Gibson, 2015). Furthermore, person thoughts and events are restricted by the affordances of the cultural setting, the natural and built environments, and the emotional states of the users (Goldstein, 2010). Cosequently, the explanation of these processes of behaviour is directed by the whole idea of spatial perception and conduct approach (Dalton *et al.*, 2011). Based on this approach, there exist three major hypotheses of perception and the readings of the procedures of perception which includes Gestalt, Transactional, and Ecological Theory (Gibson, 2015).

Similarly, Gestalt Theory had a profound influence on most of the thoughts of ecological designers over all earlier perception theory. Gestalt psychologists listed some factors that control the perception of shape, which includes the rule of similarity, nearness (proximity), good continuance, end (closure), region (area), symmetry as well as closeness. Gestalt Theory affirmed that the laws of similarity will be relevant if objects contain features that are alike in characters such as size, texture and colour. Next is the law of proximity which states that objects which are closely packed are likely to be gathered jointly and visually. Also, the rule of good continuance affirms that persons have a tendency to observe uninterrupted rudiments as lone entities. Moreover, the rule of closure states that visual entities are inclined to be formed into bunged completely. Furthermore, the law of the region implies that the lesser a bunged region, the further it predisposes to be observed as a shape. The rule of regularity (similarity) asserts that the further proportional a bunged region, the further it is likely to be visualised as a shape. Besides, the rule of closeness implies that regions with bunged shape predisposed to be observed as entities further usually than persons devoid of them (Chen, 2012).

However, the transactional theory makes a number of assumptions about the processes of perception. Goldstein (2010) affirmed that the assumptions include the fact that visual perception is subjective, and that perception is a dynamic procedure. Also, that perception cannot be elucidated by the extrication of conduct into the observer and the sensed. It was further stated that intuition cannot be clarified in conditions of learned answers to motivations, and that the relationship between someone and the setting is an active one. Besides, there is the assumption that the picture of the setting that a spectator holds counts on preceding knowledge and on the current intention and mind-set. Again, those preceding knowledge are anticipated onto the current circumstances in correlation to one's needs. Finally, that perception is administered by anticipations and tendencies. The significant input of transaction hypothesis to ecological design theory is the acknowledgment that knowledge forms what people give notice to, based on their needs in the environment (Nike *et al*., 2019).

The ecological approach to perception negates with Gestalt theory and the transaction clarification of the function of knowledge in perception (Hajibabai *et al.,* 2006). However, it considers the sanities as perceptual systems instead of regarding the sanities as a means of sensation (Demirbras, 2001). In hospital wayfinding, people move their body systems such as the eyes, the head and bodies to discover the surroundings in order to observe the better facts of the cues. Once the finer facts of the environment are identified by the users and finds a broader relationship within it based on experience, it is only then the user can concentrate to the other facts of the environment that were not initially noticed (Ruotolo *et al.*, 2018). Gibson (2015) affirmed that once an individual goes through the setting to perceive the structure, such as from room to room in a building, it is pertinent to note that some surfaces of the environment hide others as one vista is seen after another. The main contribution of Gibson's ecological perception theory is the psychological analysis of the role of movement in an environment (Dalton *et al*., 2019).

The capability to observe a few of the affordances of the setting seem to be intrinsic or a role of physiological development of persons while others are educated in the course of knowledge or by having one's awareness brought to them (Chen, 2012). Besides, to discover the connotation in environmental cues, a viewer does not have to deal with all variable enclosed in the visual range because notice is discerning, inhabitants focus on what they know about and what they are inspired to identify (Gibson, 2015). Consequently, this depends on previous experiences of the user. However, the relationships of the perceptual processes to cognition are indistinct in the transactional theory of perception (Demirbras, 2001). It is understood that the cognitive makeups that is vital for perception are preventative schemata (Hajibabai *et al.*, 2006). This implies that persons can merely detect what people know how to find.

Individual conduct is extremely synthetic because people have a great ability to adjust to novel built surroundings, to adjust the built settings to their desires, and to study novel visual principles (Borges & Silva, 2015). The procedures vital to these adaptive capabilities are knowledge, recalling, and generalizing (Gibson, 2015). In other words, erudition is acquired when a person relates novel reaction to a specified motivation which results in an enduring alter in conduct (Emo *et al.,* 2012). This implies that what is acquired might involve either internal or external fortification which is applied to environmental attitudes that influence future behaviour and activity patterns in the environment. Consequently, in the perception process some cues are elapsed whereas others bear in recollection.

However, recalling and not remembering are grave anxieties in perception with regards to the way buildings and cities are used which partially depends on how fine their configurations are memorised since previous trips (Passini, 1984a). Golledge (1999) assert that in route learning, the use of path regularly facilitates recalling the pathway parts and remembering them for afterward use. In other words, the relationship between pathways and landmarks along the routes with other spatial characteristics of places, usually structure the recalled layout of a knowledgeable setting. Concerning spatial familiarity, the ability to recall elements of the constructed surroundings depends on the plan values well thought-out in the location along with the person’s capability to study, remember, classify, and oversimplify based on previous experience (Hashim & Said, 2013). Consequently, the experience of an individual in an environment is the functional relationship between the user and the environmental cues (Maina & Umar, 2015).

2.5.1 Affordances and wayfinding

Affordance is a theory based on ecological approaches to psychology, which was first introduced by Gibson (1979) that examined how persons visually observe their surroundings and the proponents that have been knowledgeable is a straight procedure. In affordance, there is no learning ability or map symbol of the surroundings concerned in the user's decision and action, but rather their choices and conducts are supported on a wayfinding tactic and common sense logic, directed by the user's surveillance schema (Schrom-Feiertag *et al.*, 2016). In other words, a surveillance representation is the structure and situation such as spatial and sequential position at which surveillance is carried out (Emo *et al.*, 2012). This implies that as a result of the information in the world the user obtain a series of measures until the navigation undertaking is accomplished. Hence, affordance has to be explained comparative to the individual. For instance, a seat's affordance is to be seated which comes with a lot of features like surface (hard with flat) and tallness, comparative to the dimension of a person (Raubal, 2001).

Affordances can be measured as assessable features of the surroundings, but merely to be calculated relative to the person (Hajibabai *et al.*, 2006). It is principally imperative to comprehend the deed pertinent to the possessions of the setting in conditions of principles essential to the user (Hashim & Said, 2013). For instance, people observe cues such as signs, paths, doors, shops, and their affordance whereas discovery their way through a built environment; besides, action or undertaking in exact circumstances should be considered (Borges & Silva, 2015). Several studies have alleged that Gibson's Theory is inadequate to elucidate perception since it ignores procedures of cognition. This is because Gibson's explanation only deals with each phenomena, but neglects types of phenomena (Lakoff, 1987). Norman (1988) examined affordances of objects, for instance, doors, telephones, and radios, and avowed that they give sturdy clues to their functioning. However, Norman (1988) modified affordances as the consequence of the intellectual reading of objects, found on people's previous information and experiences that are related to the perception of the objects.

It was asserted that a person's social location, culture, knowledge, and purposes also decide the perception of affordances (Gaver, 1991). Consequently, affordance plays a main function in an empirical observation of space, as these factors proffer a user centred viewpoint. Likewise, Borges & Silva (2015) stated that for the successful modelling of the physical aspects of the environment, the framework must consist of psychological strategies, the capability of the users, the tasks concerned, and the substance possessions of the setting. Schrom-Feiertag *et al.* (2016) offered an expanded hypothesis of affordances and opined that affordances fit into three dissimilar domains such as corporal, social-institutional, and mind symbol. Similarly, the structure of dispersed cognition was utilised to depict and clarify the idea of affordance (Denis, 2018).

In the context of this research, the focal point is not on the perception procedure itself, but rather on the user's cognising sensors which is the observation schema. The observation schema is anchored in Neisser's (1976) meaning as inner to the user and guiding the user's intuition of affordance and facts from the surroundings. Therefore, the user's cognising sensors are assumed not to be limited, and consequently, lead to accurate and absolute instances, a wayfinding concept adapted from Gaibauer & Frank (2008) and Ekstrom et al. (2018).

2.5.2 User's experience and visual environment

There are three main features that are evident in the relationship between man and environment, which are classified as orientation, position, evaluation and stimulation features and explained as follows (Schellekens, 1979): The reference features dealing with the recognition of the current environment with respect to its appearance to the known previous environment. The evaluative experience deals with the user's attitude or opinion about the current environment. In this second aspect, the user's level of satisfaction of the environment is assessed. The third feature which is stimulation deals with the way the user pay attention to the selection of objects and events in the current environment. User's experience is subjective as it differs from one person to another and conceived to comprise the whole three features earlier mentioned (Wener *et al*., 2016). This implies that experience is the reaction of the user to the environment which can be observed and measured.

Cognitive maps can be visualised as perceptual schemas which organises the observer to receive some types of information on the environment that order the searching of the observer (Neisser, 1976). Hence, it was asserted that perception is a cyclical process of restoring or recalling anticipations of possible changes in the environment which will make the observer to unceasingly set to choose the information when it turns out to be obtainable (Borges & Silva, 2015). This implies that the result of the exploration change the original schema which consequently will make modified schema to order new exploration again (Savendy, 2012).

Researchers have shown interest in recent times to the problem of perception of meaning. Steinfield & Maisel (2012) asserted that to resolve the trouble of affordance, the facts acquired from the environment is controlled by the perceptual schema of the perceiver. Therefore, the schema is expected to offer possible uses the perceiver could examine and choose from the items (Zhang & Patel, 2012). Neisser (1976) Theory of perceptual cycle was criticised on the ground of some weaknesses. According to Hampson & Morris (1978), Neisser’s Theory did not explicitly explain the subjective confusion of images and distinctness, and even the nature of the observer of mental operations, in addition to perceptual anticipation which is considered not to be a sufficient component of imaging.

Additionally, perception engages the use of sensory and mental processes to obtain ecological information (Goldstein, 2010). These processes work collectively to make sure end-users obtain pertinent information from the environment (Berdahl *et al.,* 2016). Consequently, spatial information processing is important to wayfinding task in a hospital environment.

2.5.2.1 Spatial information process

There is an enormous amount of information contain in complex spatial environments which makes it important to choose the appropriate one at the right time for navigation (Passini, 1984b). Thus, the end-users usually perceive information directly connected to the task they plan to perform during wayfinding (Passini, 1984a). For instance, the research carried out by Arthur & Passini (1992) demonstrate this assertion at a Montreal hospital where it was observed that the site had a slope and the hospital was designed to follow the topography of the site. There were two entrances, one on the second floor and the other on the fourth floor. The results showed that most of the users who were going to the upper floors used the fourth floor entrance because of the perception of a visual cue (staircase). The interpretation of this study was that the end-user perceived the information (staircase) directly connected to the task, such as going to the upper floor, (Oyelola, 2014).

Furthermore, the information obtained from the environment in route learning involves spatial knowledge processing with the existing spatial configuration and landmarks (Xia et al., 2008). Decision planning and execution process involves the wayfinding decisions that end-users will make which are expected to guide both the message and the position in the spatial environment, which is for a single decision (Emo *et al.*, 2012). Basically, it is always better for the designers to take the overall decision plan as a structural component, which contains a collection of individual decisions, strategic to solving wayfinding issues, (Borges & Silva, 2015).

There are two structural components, such as decision hierarchy and decision plan, that aid the completion of a wayfinding task in order to solve wayfinding difficulties (Arthur & Passini, 1992). Accordingly, decision hierarchy requires the hierarchical executions of tasks when the end-user has the general task of locating a desired destination within a specific environment (Arthur & Passini, 1992). The major task is the decision hierarchy while the sub task is the decision plan. However, within the decision plan, there are sub-tasks each relating a single decision, and each of these is a determining element in the successful execution of the major task.

Decision plans entail the conversion of decisions within the decision hierarchy to actionable plans, where these plans lead to behavioural actions that might either effectively complete the task, or lead to another decision task (Oyelola, 2014). Thus, the twofold probability shows the dynamic nature of the decision planning and execution process. As such, decision plans are crucial to wayfinding effectiveness during pre-occupancy development and post-occupancy evaluation of spatial design projects. Consequently, decision plans enable end-users to keep track of behaviours that direct them from their starting location to their desired destination, and this can be used as empirical data in the design process (Arthur & Passini, 1992).

Moreover, decision plans at the pre-occupancy stage of a spatial design project are pre-determined by identifying wayfinding issues using evidence-based research methods. Meanwhile, decision-making at the post-occupancy stage is normally determined by circulation systems such as walkways, stairs and elevators. However, wayfinding design problems at times result in inadequately legible circulation systems, ensuing in confusion and frustration (Passini, 1984a). Wayfinding problems are described as a function of the end-user's interpretation of a wayfinding task in relation to the spatial information available (Oyelola, 2014). This of course determines the effectiveness of wayfinding performance.

2.6 The Effectiveness of Hospital Designs in Wayfinding

The effectiveness of hospital design in wayfinding involves the ability of users to successfully utilise hospital wayfinding design systems to navigate to a desired destination (Kuliga, 2016). This is usually associated with the building usability concepts and the various constructs that describes the effectiveness of hospital design in wayfinding which are discussed in the succeeding sections.

2.6.1 Building usability in hospital spatial design

The users of hospital buildings often behave in ways that are inconsistent with the designer's intent on building performance goals in terms of usability and service delivery (Haron & Hamid, 2011) The aim of such designs are usually to have buildings that are smarter in the context of wayfinding, more orderly and better-behaved users (Kruka *et al.*, 2016). Hence, real buildings with good design need to accommodate the real user behaviour. Most studies classified hospital as service-oriented under building usability which is directly associated with the quality and direction of service design that are characterised by major building complexity (Calson et al., 2010; Wener, *et al.*, 2016). The building complexity creates wayfinding challenges to hospital users. Although, current studies reveal that usability assessment of hospital structures provide optimistic affect to hospital service that makes it user-friendly (Abran *et al.*, 2013; Ritter *et al.*, 2014; Emo & Varoudis, 2016).

Hospital is to meet the bodily, emotional and societal wants of patients (Hignett & Lu, 2009). So, there is a need to assess the effectiveness of the hospital design with regards to finding their desired destination with ease to avoid the feeling of stress and frustration in the hospital environment (Haron & Hamid, 2011). Spatial plan is concerned with the individual knowledge, their response, and transactions with space and a high-quality spatial hospital design could overcome patients' wayfinding challenges (Passini & Arthur, 1992).

Accordingly, there are three main building usability parameters to assess hospital design which includes efficiency, effectiveness, and satisfaction (Haron *et al*., 2010).

Some studies define and explain the principles and concepts of building usability parameters which vary depending on the field of research (Kuliga, 2016). The main components of usability are to understand the users, their tasks, and the environment where the interaction occurs. Thus, usability is referred to as the efficiency of the service offered to examine the amount of endeavour and the speed it takes a user to accomplish a specified task which is found on a proportion of a scheme's service labour productivity and its labour contribution (Haron & Hamid, 2011). Similarly, the effectiveness of the service given is calculated by how a user accomplishes the tasks which is understood as the capability to attain the setup goal or to get the desired effect of something. And finally, user satisfaction concerns the fulfilment of a want or a request through user's opinions, view or manner in the search for the package or artefact (ISO 9241-210, 2010).

In addition to these international usability guidelines, Abran *et al*., (2013) extended the usability components to include learn-ability and security as appropriate measures. The learn-ability is the time needed to become familiar with a building and security is the extent an environment responds to the needs of different user groups, including visual access between locations (Emo & Varoudis, 2016). Accordingly, in the context of wayfinding in the hospitals, the study focuses on the usability components of efficiency, effectiveness, satisfaction and security of hospital wayfinding.

The building usability of wayfinding performance in the context of this study is translated into measures for effectiveness to mean the best decision during wayfinding, such as number of wayfinding errors at decision points, and efficiency can be assessed as wayfinding time. In addition, satisfaction is measured in terms of architectural experience, emotional and aesthetic evaluation, perceived difficulty and frustration. These measures were adopted from the study of Kuliga (2016) as the concepts used were corresponding to the aim of this research.

2.6.2 Building usability in architectural research

The main evaluation method of building usability in architectural research for building in-use is 'post-occupancy evaluation, (POE)' (Wener *et al*., 2016; Zeisel, 2006). Most often multiple evaluation methodologies are combined with post-occupancy evaluation such that each presents their own level of effort to the evaluator (Emo & Varoudis, 2016). For instance, the exploit of qualitative data and quantitative data measures in mixed-method approach could improve the outcome of research findings (Blakstad *et al.*, 2008).

The analytical post-occupancy evaluations emphasised on cross-sectional evaluations of exact performance aspect, such as wayfinding (Kuliga, 2016). For instance, the study of Holscher *et al.*, (2006) focused on investigating building users' decision-making processes during wayfinding in relation to the building's particular characteristics. The researchers asserted that the detected challenges were related to the building's complex spatial configuration, illegible signage and users' individual difficulties with monitoring landmarks, based on their cognitive-architectural analyses. Thus, they recommended an early integration of fundamental principles of wayfinding into an architectural design stage in order to avoid costly design errors in hospital wayfinding.

However, there are some limitations in the use of post-occupancy evaluation procedures which include such issues as a focus on functional features, and less on the users' perceptions (Abran *et al.*, 2013). For instance, it is important to ensure that the wayfinders understand wayfinding design and spatial layout to be able to respond correctly to issues raised in the post-occupancy evaluation (Arthur & Passini, 1992). Besides, familiar users of buildings are usually assessed such as hospital staff instead of new patient who is visiting the hospital for the first time. These newcomers are unfamiliar with the buildings and are more prone to wayfinding difficulties. Secondly, findings are usually used to inform design guidelines for future buildings, rather than change the existing deficits (Preiser, 1995). Consequently, it was suggested that the solution could be to compare the systematic design with formal spatial analysis of early floor plans prior to building construction (Holscher *et al.*, 2006).

On the whole, the basic concepts applicable to building usability are explained in this thesis which includes effectiveness, efficiency, satisfaction, learn-ability and security. The focus of building usability evaluation in this study was on the effectiveness of hospital design and user experience on wayfinding performance because that was what the objectives of the study seek to achieve. The constructs used in describing the effectiveness of hospital design are discussed in the next section.

2.7 Constructs to Measure Wayfinding

The constructs used in the context of this study are spatial legibility, influences and usefulness of the attributes in wayfinding in the context of hospital wayfinding based on previous studies (Dehghan *et al.,* 2012; Paul, 2013). These constructs were used to assess the effectiveness of wayfinding in hospital buildings.

2.7.1 Spatial legibility

Spatial legibility is the extent that the designed characteristics of the setting are clear, simple, coherent, understandable and organisable that assists people in generating an effective picture-like perception of the spatial associations inside a structure (Koseoglu & Onder, 2011). Accordingly, spatial legibility eases wayfinding within the environment (Gocer *et al.,* 2015). However, these concepts used in describing spatial legibility are characteristics of space which are easier and faster to acquire spatial knowledge, but cannot be used to measure legibility. This is because to measure spatial legibility requires the reading of space that includes the characteristics of the observer and the characteristics of space in order to perceive and understand space (Dehghan *et al.,* 2012). In order to measure spatial legibility, some variables are used, such as the extent of spatial layout complexity and the ability to recognise an important landmark (Pati *et al.,* 2015). Accordingly, the observer's perception of spatial legibility occurs as a result of psychological processes that happen in the mind, and involves receiving sensory inputs and interpreting it into meaningful experiences.

2.7.2 Influences of designed space in wayfinding

The influence of a designed space in wayfinding is the extent to which the built environment inspires, stimulate, effect and encourage movement of the users to find destinations with ease within the facility (Marquardt, 2011). The parameters that can used to measure these concepts are distinctiveness, complexity, affordance, accuracy and visibility of the environmental cues (Paul, 2013). However, for each of this dimension, specific design elements are measured with the components that determine the simplicity of navigation so as to determine the quality of space in wayfinding (Marquardt, 2011). Accordingly, the following factors determine the ease of navigation comprises of the user's factor, the environmental factor and the information factor (NHS, 2006). In the context of this study, the parameters considered from literature to measure these components are shown in Table 2.1.

Table 2.1: Determining the ease of navigation

S/N	Factors	Measures	Sources
1	Users	• The ability of the user to comprehend the words utilised on symbols and spoken by employees.	Dalton *et al.* (2019); Lee *et al.* (2014).
		• The ability of the user to interpret and comprehend the signs, location drawings and the environmental cues.	Farr *et al.,* (2012); Frank (2009); O'Neill, 1991a; Tom & Denis (2004)
		• The ability to create an effective picture-like representation of the layout or cue.	Haq & Girotto (2003)
2	Environment feature	• Complexity of the building's site, routes and its interiors.	Golldge (1999)
		• The building site, routes and destination buildings should be recognisable and memorable from other buildings.	Brunye *et al.* (2018)
		• The building site entrance should be easily identified from directions of approach.	Pati *et al. (*2015)
		• Visual accessibility- whether the building entrance or the destination can be seen easily.	Farr *et al.* (2012)
		• How possible and simple is it to create a picture-like representation of the layout of the environment.	Montello (2014)
		• The difference in areas and buildings at the site-in the architectural method, colour, dimension and conspicuousness.	Golledge (1992)
		• The ease to identify the building entrance.	Pati *et al.* (2015).
		• The number of times that direction alters along each way, such as number of junctions.	Brunye *et al.* (2018)
		• Intensity of visual disorder detracting from, otherwise hiding, entrance and symbols.	Anacta *et al.* (2017).

	• Obviously distinct walkways, outwardly plus internally. • Outstanding landmark for persons to see, memorise, identify, inside and outwardly.	Mandel & LeMur (2018) Bala (2016); Duckham *et al.* (2010); Ishikawa *et al. (2012)*.

Source: Researcher’s literature review

Table 2.1 illustrates that the user’s spoken language, educational level attained and the cognitive mental representations of space are important attributes in wayfinding performance. In addition, the information obtained from the environment is used by the users to navigate in order to find destinations in the environment (Hashim & Said, 2013). The quality of the information in the environment and the ability of the user to use the cue appropriate at arriving at the correct destination with ease and recognising the destination are critical in wayfinding. Consequently, it can be argued that the location of information must be prominent, the signs must be legible, and the terminology used must be such that the users of the facility are familiar with. Also, environmental cues must be distinguished from one another at each decision point (NHS, 2006).

2.7.3 Usefulness of place legibility in wayfinding

The usefulness of any place legibility system is the extent to which patients and visitors see the information in the environmental cues, which may positively or negatively affect the ease of wayfinding (Ullas & Aju, 2014). For instance, architectural cues such as signs may be difficult to read if they are mounted too high, located behind another sign, and poor colour combination (Paul, 2013). Moreover, finding a particular destination in a hospital can be difficult if the typeface, colour, letter, size, and terminology printed on the signs is poor.

However, it should be noted that no matter how good, legible or clearly worded the cue or sign is, if the information is not available where it is needed, the cue's or sign's usefulness is considerably reduced (Ullas & Aju, 2014). Hence, it is imperative to give specific interest to the spacing plus placement of cues or signs, and even important landmarks in order to reduce wayfinding difficulties or ease wayfinding. Hence, cues are expected to be placed at major decision points, such as along the path or corridor and at corridor intersections to enable users to decide whether to continue in the same direction or turn to reassure the users that they are on the right path (Paul, 2013). Finally, for the effective usefulness of cues for wayfinding, the signs and numbering of such facility should be made simple, consistent, flexible and visible (Schrom-Feiertag *et al.*, 2016).

2.8 Empirical Framework on Wayfinding in Hospitals

Wayfinding is the competence to effectively find the way in the hospital setting effectively in high-quality period from start to target (Gocer *et al.,* 2015). In hospitals, finding the way is regularly multifaceted and demanding with many of impact for users (Lee *et al*., 2014). This explicates the call for research to be conducted on wayfinding in multifaceted hospital buildings.

The early research on wayfinding in hospital setting began from the studies of Carpman *et al*. (1984; 1985; and 1986). The studies were important progress in study that contrives environmental study with hospital designs (Devlin, 2014). The effort of Carpman *et al*.

(1984) highlighted several important subjects with matters like how targets are named, placement, context, density, plus visibility to successfully organise wayfinding schemes. Furthermore, Carpman *et al*. (1985) affirmed that on subjects of environmental affordance, whatever the setting communicates to the user transversely its structure and that of discrete cues, for example, signage; whereas in 1986 the simplicity of navigating in hospitals with regards to stress was examined. Nevertheless, these researches were unable do justice to human cognition on wayfinding in hospital buildings. Therefore, the study of Orphir *et al*. (2009) was a great research on wayfinding that broadly examined the capability of human reminiscence, together with the extent of information an individual is able to grasp in small period cognition. Several of the earlier studies following that of Carpman *et al*. (1984; 1985; 1986) on hospital settings were on the consequence of signage and floor plan configuration on navigation accuracy (O'Neill, 1991; Pati *et al.* 2015; Wright *et al*. 1993). Though, from the idea of plan configuration and signage, wayfinding study of any complex buildings is suitable to hospital setting (Devlin, 2014). Consequently, the related literature reviewed was ordered found on the subsequent subjects, this include plan configuration and distinctive cues, participant characteristics and technological approaches.

2.8.1 Floor plan configuration and distinct cues (signage) in wayfinding

The request for healthcare delivery has made several multifaceted buildings to grow over time and these structures are connected together in such a way that are deficient in unique form that make navigation to desired destination difficult in the setting (Emo & Varoudis, 2016). Early study on wayfinding has revealed that plan configuration correlates to wayfinding performances (Weisman, 1981; O'Neill, 1991).

Another study that corroborates the result that plan configuration correlates to wayfinding performances was the study of Haq & Girotto (2003). The study was on the ability and intelligibility with emphasis on environmental cognition in unfamiliar two complex hospital buildings in the United States. One of the hospitals was University hospital while the other was a City hospital. The philosophical basis of their work was on topological measures. The aim of that study was to compare some sketch map variables and their relationship to space syntax variables. Haq & Girotto (2003) used space syntax to analyse sketch maps and experiments in the study using 96 volunteers, 49 males and 47 females participated. Two data sets were produced, one by a person and the other by corridors. In addition, the data set by person incorporated sketch map variables, wayfinding performance indicator and cognitive tasks. The second data set by passage (corridor) integrated independent values of the corridors themselves that was copied from space syntax analysis and the use the corridors in wayfinding.

The results show that the simplicity (intelligibility) of the environments was a significant measure that was prognostic of wayfinding and ecological cognition in the environment. Also, geometric and metric associations were important in wayfinding performance in the study of Haq & Girotto (2003). However, the study did not consider other important variables like light, landmarks, surface finishes, signs and other physical attributes. Again, divergent findings emerged from the assessment of dissimilar techniques of sketch map analysis. These variables left out in the study were important environmental cues considered in the current study.

The study of Baskaya *et al*. (2004) investigated spatial orientation (point of reference) and wayfinding behaviour using architectural students as beginners in an unknown two clinics that were at discrepancy in their uniformity. In the research, Baskaya *et al*. (2004) employed survey as choice task, sketch chart task experiment and response to travel around task as techniques, using university students as participants. It reveals that 63.2% of the respondents in the normal, symmetrical buildings got misplaced during wayfinding, which was different from the 6.5% of persons in the usual, asymmetrical floor plan that found wayfinding successful, easy to remember and study landmarks in the environment. The results suggested that regularity with replication of identical elements were a constraint to wayfinding that made the spatial layout important to be considered at the initial sketch. Nevertheless, a landmark that produced distinctiveness is likely to be important in structures with symmetry. Equally, what comprise schema-like awareness and how structure schema is recognised had not been made clear and it is easier and possible to find the way if a building go with an eminent representation.

Several studies have explained that spatial layout is a type of landmark and there was a further superior explanation on how to code landmark (Epstein & Vass, 2014; Ekstrom *et al.,* 2018; Nik *et al*., 2019). The study of Vilar *et al.* (2014) stressed the significance of the landmark, floor plan and spatial differentiation in the acquirement of ecological cues. Besides, the research pointed out that ecological affordance, such as passage breadth and paths properly lighted, could contend straight with noticeable cues like signage. This suggests that together these features play a part when situations change, for example, daily position of the undertaking and its dilemmas (Vilar *et al*., 2014).

The research of Carlson *et al.* (2010) demonstrates the apprehension in architecture among visual (aesthetics) and functional elements of buildings. It focused on three causal features of reasons that persons become disoriented in buildings: (i) the spatial configuration of a building; (ii) the cognitive charts that people make in finding their ways in the building; and (iii) the strategies and spatial aptitudes of the wayfinder. Furthermore, the study argued for an integrative framework that depicts the way these factors overlap after discussing the findings on the factors. Also, the study specifically shows how without communication (correspondence), without congenial combination (compatibility), and without wholeness (completenes) could possibly be connected with complexity in wayfinding in buildings.

Concerning communication, results of Carlson *et al.* (2010) reveals that users have a preference for more one-dimensional routes with less turn. As regards harmonious grouping, the research established that it was beneficial to have unobstructed lines of view linking entry spaces and other major mid spaces in the way of vertical circulation, for instance, stairs, elevators, and escalators. In addition, about wholeness, the research shows that the extent that the architectural characteristics of buildings affect wayfinding might count on the totality of the cognitive charts that each person builds. For example, the researchers believed that after two years of a patient's trip a specific hospital, whoever is uncertain concerning finding the way out has a deficient (incomplete) cognitive chart of the building. Other people that regularly visit the building similarly and could locate the egresses, apparently have further absolute cognitive charts. Their study presents a distinctive sight into likely causes people experience complexity in wayfinding, counting the idea of a cognitive chart. The use of cognitive map requires mental thinking that was not considered appropriate in a hospital setting where patients were in urgent need of medication (Mustikawati *et al.*, 2017). The understanding of how patients could quickly perceive the environmental cues in terms of affordance to find destinations in hospital environment was lacking in the study of Carlson *et al.* (2010). Accordingly, complexity and perceptions were the main argument in this thesis rather than cognitive map in the building configuration in the context of hospital setting.

The study of Marquardt (2011) confirmed the discrepancy involving the functions of floor plan and an obvious cue to each person that have dementia, signifying which attributes support otherwise impedes with wayfinding task. Several attributes stated in the research to have unhelpfully affected orientation were repetitive features, long routes, and differences of direction in the flow schemes. Consequently, the idea of worldwide plan which emphasised that settings must be planned with diverse sequence of exploits in mind could be practicalised to people with dementia at each stage of process (Knecht, 2014). It was avowed that restraining options at nodes encourage effective wayfinding (Cubukcu & Nasar, 2005; Slone *et al.*, 2014). The method employed by the latter studies was found on virtual reality (VR). Although the locations utilised by Slone *et al.* (2014) was an academic setting, yet in numerous ways seem similar to an institutional setting such as large hospital due to the complexity of the setting.

The study of Pati *et al.* (2015) examined the character and degree of support given by diverse design features in assisting wayfinding choices by mature users in a sensitive care hospital. This research was centred on the physical environmental help in wayfinding decision-making for users, and the different wayfinding tactics compared in incidence of exploit. Furthermore, other issues addressed comprise the role of environmental cues in wayfinding process in healthcare facilities which consist of plan configuration, colour, art, discernible landmarks, charts, and visual signage (Dix, 2016). Furthermore, the basic data types included in the study of Pati *et al.* (2015) were oral procedure, taking pictures, and the participants' replies on a survey questionnaire. The study was conducted in an 866-bed, tertiary care facility in Texas.

The findings that were most helpful to the study of Pati *et al.* (2015) were those that identified the order and incidence of exploit of the various spatial features used in wayfinding. Consequently, the main findings of the authors identified five most often exploited spatial features for data during wayfinding which includes signs, architectural attributes which enlarge visual fields, charts, expected functional clusters, and artwork such as painting and sculpture (Denis, 2018). The research shows the significance of tag in the hospital location, since classification schemes get perverted over time as novel structures were added to the existing buildings in the hospital, as such, the initial tagging plan should be extended (Dix, 2016). The identified gap in this study was the use of real subjects instead of simulated ones because the use of real objects is better than simulation (Brunye *et al.,* 2018). In addition, wayfinding difficulties encountered by the newly employed staff were not addressed, and might affect staff response time in providing medication to patients, and getting equipments (Pati *et al.*, 2015).

Finally, study suggests that floor plan configuration, landmark and other architectural features (such as light, colour, horizontality and verticality of circulations) were important elements for the spatial legibility of environment to the wayfinders (Anacta *et al.*, 2017). Also, it was argued that coded information such as signage cannot be wholly relied upon for wayfinding in complex environment (Denis, 2018). Accordingly, this thesis considered plan configuration and other architectural elements on the individual observation of the hospital wayfinding.

2.8.2 Participants' Characteristics in wayfinding

Wayfinding studies that focused on participants' attributes comprise of mental tasks, for instance, dementia problems. In addition, the subject of sensory deprivations such as optical deficiency, Down syndrome, plus universal hospital symbol that several studies on wayfinding attempted to tackle (Foster & Afzalnia, 2005; Scialfa *et al*., 2008; Rousek *et al*., 2009; Courbois *et al*., 2013; Lee, 2013; Legge *et al*., 2013; Harris & Wolbers, 2014; Hashim *et al*., 2014; Karimi *et al*., 2014; Lee *et al*., 2014; Manning *et al.*, 2014; Tsai, 2014; Rodriguez-Sanchez *et al*., 2014; Yang *et al*., 2014). The study of Rousek *et al.* (2009) was on visual deficiencies to observe the workings in hospital wayfinding. Rousek *et al.* (2009) employed the application of vision replicator spectacles with usually sighted persons to reproduce the familiarity of five diverse kinds of visual deteriorations. The results confirmed that majority (65%) of the participants, still devoid of goggles, reported for wayfinding difficulties. Moreover, the respondents highlighted the expectations that people have with the use of signage in the location, like its position, size and illumination of the signage. The results suggest that designers could improve comprehension of individual anticipations (schemas) concerning spatial design and the information might be used to improve wayfinding systems.

There are studies that have explored Down syndrome participants by plotting a pathway to learn their optical-spatial aptitude, and findings have revealed restrictions in wayfinding aptitudes (Courbois *et al*. (2013); Harris & Wolbers, 2014; Lee, 2013). The research of

Courbois *et al*. (2013) highlighted the reliance on pathway erudition except for structural familiarity in persons with Down syndrome. Correspondingly, other studies have revealed that adult persons owing to usual aging have complexity varying from egocentric point of reference (viewer-dependent) of the location. For example, observer centred linked to the body changing place, to an allocentric orientation (viewer-independent), such as navigation based on an exterior organise scheme, in the hospitals (Lee, 2013; Harris & Wolbers, 2014).

The studies of Fricke & Bock (2018) observed substantial age related deficits in allocentric task (navigating independently without support) and only negligible age deficits in the egocentric task (navigating with support). Therefore, such complexity of suppleness via shorter pathways among the old adults has implications for successful wayfinding performance concerning pathway choice while major route might be clogged-up. The study suggested that in crisis circumstances there would be difficulty of security issues for the aged in rapidly choosing routes to find the way from the occurrence (Courbois *et al*. 2013). Accordingly, the age of the participants has implication for an effective and efficient wayfinding performance (Fricke & Bock, 2018).

Studies have dealt with the increasing need to express facts through symbols among a wide variety of cultures that employ hospital buildings. Though, there were contradictory views concerning the slightest level of universal comprehension of a symbol an individual must hold across every culture. Even though text could improve the comprehension of signage, it is as well language bizarre that tell the restrictions in the acuity of nonfigurative symbols (Lee *et al*., 2014). For example, studies have shown participants concern on cross-cultural understanding of symbols and especially, signs that could be comprehended to transverse every cultures (Foster & Afzalnia 2005; Scialfa *et al*., 2008; Hashim *et al*., 2014; Lee *et al*., 2014). The respondennts were selected from Turkey, US, and South Korea; the countries were selected to replicate three separate cultures. The findings indicated that several signs are quite comprehended across cultures, such as those for invoicing, GOPD treatment centre, and radiology; however, others are not, as for immunization, pharmacy, and family medicine. The recognised hole in the study is the drawback in geographical stretch. This suggests that even though prior studies made efforts to acquire universal healthcare symbol to wayfinding, the comprehension was insufficient with views to their meaning to transverse diverse cultures.

The research of Hashim *et al.* (2014) shows the need to investigate signage with participants from a diversity of cultures, age and level of education status. There were 100 participants in the rsearch ou of which 80% had Arabic culture, 6% were Africns, South Asian was 6%, and North Americans/Europeans/ others were 8%. The results shows that 53% needed help to fill out health forms and patients and visitors had further difficulty transforming precise hospital symbols separately from universal symbols. These results revealed that wayfinding is culturally precise and to every vicinity. Therefore, wayfinding desires to be contextualised according to the culture of the populace.

Table 2.2 is the synopsis of several preceding research that are purposeful on the wayfinding occurrence in hospitals. Thus, the identified gap was used in placing this research and describes its spotlight.

Table 2.2: Previous studies on wayfinding in Hospitals

Researcher	Philosophical Basis	Setting	Methodology Approach	Findings

Lu (2011)	Directed visibility analysis	Danish hospital complexes	Qualitative: 3 case studies were used	Inclusive design in way-finding
Colfelt (2012)	Ineffective signage; Inaccessibility of hospital to all users	Danish hospital complex: Hvidivre hospital in Copenhagen-600beds	Qualitative: 3 case studies were used	Shows that signage alone is an ineffective wayfinding system
Rooke (2012)	Improving methods for developing way-finding systems and strategies	Old and complex hospital environment: Salford Royal hospital, U.K (1 main case study & 5 other comparative studies).	Design Science Research Approach (Ethnographic Unique Adequacy field work)	Prescriptive and evaluative way-finding conceptual framework
Paul (2013)	'Place legibility & 'Ease of way-finding' and Gender issues	Way-finding at Central Ohio medical centre; A teaching & research medical centre, United States of America (USA).	Quantitative methods: modified previous survey research by Lawton (1994); Environmental Satisfaction Survey (ESS), Factor Analysis (FA) with Cronbach's Alfa (CA), SPSS	'Place legibility plays important role in ease of way-finding; No relationship between the level of education & the perceived complexity of way-finding among genders
Castell, L. M. (2017)	Evidence–based guidance about the influence of building features on wayfinding success for people with intellectual disability	3 hospitals at Perth, Australia	Mixed- methods research: Considered quantitative and qualitative data (Creswell, 2014).	The study shows that participants with intellectual disability travelled further and less successful in reaching the destinations.
lbrahim, M. (2019)	Effects of art and design on orientation in healthcare wayfinding and showing	3 Swedish hospital setting, Malmö, Sweden	Mixed-methods approach: Considered quantitative and qualitative data (Creswell, 2018).	Produced guide for the design of wayfinding and wayshowing in hospital environment .

Source: Researcher's review, 2019

In summary, the studies in Table 2.2 show that the development of signage as a wayfinding system in hospitals with regards to universal healthcare symbols was inadequate in terms of the understanding and meanings across different cultures. In addition, most of the previous researches on wayfinding in hospitals were mainly in the industrialised nations for example, United Kingdom, United States of America, Germany, and China. There is the need to know if the findings on wayfinding in these countries are applicable to developing countries like Nigeria because the results on wayfinding in these countries are culturally specific and to each locality. Accordingly, there is the significant environmental need to contextualise wayfinding based on the culture of the people, and the level of education in Nigeria as a developing country.

2.9 Theoretical Underpinning on Human Wayfinding

The main theories underpinning this research on human wayfinding includes spatial cognition theories, decision making theories, and user-centred theories. The theory of inquiry was properly hinged on these hypotheses.

2.9.1 Spatial cognition theories in wayfinding

Cognitive studies refer to the research on individual intellect altogether in various types, comprising intuition, deed, dialectal with rational thinking (Munzer *et al.*, 2012). Therefore, intellect is anchored in rational rules, which is the capability to accomplish tasks by means of decisions taken when confronted with barriers during wayfinding (Gunzelmann &

Anderson, 2006). The rational regulations are also rooted in hypotheses that attempt to clarify the way persons discover their path of travel in the real humanity. The theories also try to know what are those things that can help people discover their route, how do people corresponds route instructions, with how person's oral and optical capabilities result in wayfinding (Raubal & Egenhofer, 1998). Accordingly, Norman (1988) classified these wayfinding processes into 'knowledge in the world' (exterior facts from environmental cues) and 'knowledge in the head' (interior facts stored in the head) to remember routes.

The familiarity in the setting acts as its individual cue, it draws on mapping which allows human to use without learning in the unfamiliar environment. In the perspective of wayfinding in setting, the environmental signs could include doors, signage, corridors, entrances and reception desk, which people use to wayfind without learning (Garling, 1989). Also, knowledge in the head mainly depends on human memory which depends on familiar environment that have to be learnt from the experiences. In the context of wayfinding, knowledge in the head is the mental representation of the built environment, in terms of the shorter path obtained from one location to another, and relative to the origin and the desired destination during wayfinding (Allen, 1999).

Furthermore, in complex teaching hospital environment, it is necessary for people to acquire spatial and numerous cognitive capacities to achieve effective navigation, for instance, a pathway to pursue. To incorporate pathway and maintain track of one or further positions in the setting, the functioning reminiscence is main to the inner depiction of the setting (Dix, 2016). There are two major approaches employed in individual spatial familiarity of physical space of a setting which include route familiarity, and precise routes (Munzer *et al.,* 2012). The two strategies was further highlighted that route familiarity requires adopting a prominent point like an orientation structure (landmarks) in navigating through the setting, while precise routes involves orientation to sections of the routes. Hence, landmark with description of turn are often employed to describe path direction. Another strategy is the configuration experience, which gives a general idea of spatial arrangement and takes up an inherent landmark for orintation (Hajibabai *et al.,* 2006). Basic images and distances are frequently ustilised to explain a space from orientation viewpoint. Though, numerous studies have pinched concentration to the restrictions in the exploit of basic route as not supportive, for lack of knowledge of the position of the north (Schwering *et al*., 2013). The exploit of cognitive aptitudes is hinged on the assignment in sight, for example, in a city road system finding one's way utilises a diverse set of cognitive capabilities than finding the way from one space to another in a structure (Gocer *et al.,* 2015).

Besides, in wayfinding research, optical feeling of colour, form and illumination with other senses, such as smell, touch and sound all exists (Chen, 2012). As such, by looking, smelling, listening and touching individuals can perceive the kinds of designed cues in the built environment. Among all human perceptions, visual perception was considered as the most important and reliable one that individuals can greatly rely on to navigate in every imaginable environment to avoid obstacles and danger (Arthur & Passini, 1992). Consequently, in wayfinding research, visual cues are the main source of cues that can be perceived in the built environment. The visual cues act as the media between human's environment and the user's environmental behaviour and therefore supports the decision making in human behaviour in wayfinding (Sun, 2009). Accordingly, Gibson's theory (2015) of visual perception describes what the visual cues in the environment offer to the wayfinder by immediately making sense of it as affordance to be able to perform during navigation to destination.

The Neisser's theory of the perception cycle (1976) provided three cognitive constituents which comprise of the gaining of physical experience, the mental depiction of physical knowledge, and the use of experience. This theory suggests that the observer have an assured cognitive formation named mental plan (schemata) which allows the intuition and exploit of knowledge from the surroundings (Gocer *et al.,* 2015).

Spatial cognizance actually describes both the perception and intellectual processes that are connected in comprehending the real setting which includes perception, rational reasoning, solving of problems and the establishment of data and concepts (Fricke & Bock, 2018). Thus, Downs and Stea (2005) distinguished between perception and cognition; perception explians the visual field of view withn reach while cognition happens when objects and proceedings are perceived to be greater than the field of view, such as complex environment. Cognition requires that the environment should be prepared psychologically. Consequently, for a reasonable explanation of persons' knowledge, it is significant that wayfinding theories incorporate a connection flanked by perception and cognition (Allen, 1999). In the context of wayfinding in teaching hospitals research, in which the environment is a complex one, the link of integration is attained by adjusting Neisser's theory of perception (1976) and Gibson's theory of affordance (2015) in the wayfinding. Accordingly, the Neisser's theory of cognition (1976) deals with mental representation in the environment while the Gibson's theory of affordance (2015) deals with visual perception (knowledge in the world) thereby complements each other in hospital wayfinding.

2.9.2 User- Centred Theory in Hospital Environment

User-centred strategy centres on persons- wayfinding- space as a scheme and their desires relative to the anticipated design results (Fischer *et al.,* 2004). There are diverse desires, capabilities and experience echelon for dissimilar cluster of user, for instance, the sightless, wheelchair, children, the elderly and normal capable persons) who trip multifaceted setting such as hospitals (Knecht, 2014). These different users carry with them diverse difficulties that require being determined for successful wayfinding designs (Schrom-Feiertag *et al.*, 2016). Consequently, it is essential to comprehend the actions of the route-finders in order to encourage better wayfinding designs. Therefore, Carpman & Grant (2003) avowed that it is better to use person's centred methodologies to obtain information where behaviour of participants is involved.

The study of Kueh (2006) employed the four features of user-centred strategies that comprise the following:

- Direct attention on people (users);
- Emphasis on the relations among users and wayfinding in the setting, mainly how customers utilise the commodities of design actions;
- Multidisciplinary researches in the conduct persons act together with wayfinding undertaking and the environments;
- A method that unites technical (cognitive science), and social/ theoretical (building of sense and familiarity) features of persons' wayfinding actions.

Kueh (2006) recommended a technique for designing user knowledge by uniting ethnography, situation - construction and design. The technique recommended that it was significant to search the communications between performers, actions, artworks and environment (context) concerned in user knowledge. Hence, the technique underscores the use of situation – construction as an explanatory and regulatory tool that investigated the current and conjectures the future circumstances of users' knowledge (Knecht, 2014). This thesis posit that it is appropriate to assess and find out how precisely the planned physical settings strenghtens the actions and behaviours of the users. Also, to gain insight concerning the tension made in the individual psyche and body while the physical setting is inappropriate and unwilling to alter in line with the study of Vischer (2008). Consequently, it is expected that the application of an interactive schemes structure for this inquiry should yield further understanding concerning how cognitive and perceptual procedures influence the user–building association in the context of teaching hospitals.

2.9.3 Wayfinding complexity theory

The wayfinding theoretical framework underlying the study was adapted from Carlson *et al.*'s (2010) integrative framework for measuring 'wayfinding complexity' in an unfamiliar environment. In the integrative framework, it tries to fuse three factors that contribute to wayfinding and their intersections. The factors include the spatial formation of the building, the cognitive charts that people build as they find the way, with the spatial aptitudes of individuals that use the edifice. The deficiency in any of these factors in wayfinding results in people getting lost. Accordingly, it could be argued that the integrative framework uses the theories of cognition and user-centred theories to put together the three factors. This study modified the framework to merge the analyses of spatial configuration (building), the users' perception and the individual characteristics (building user and related task strategy), in order to assess wayfinding processes in the human interaction with the environment. For instance, from the study of Carlson *et al.* (2010), it was modified to include the 'correspondence' as the intersection between the building and the users' perception (See Figure 2.2). Also, the intersection of the building and the approaches (strategies), and person capabilities of the people results in the well-matched union ('compatibility'); while the totality ('completeness') of the visual perception is the function of the approaches and person ability of the patients or visitors. The intricacy (complexity) appears as the connection of all the three main features (See Figure 2.2).

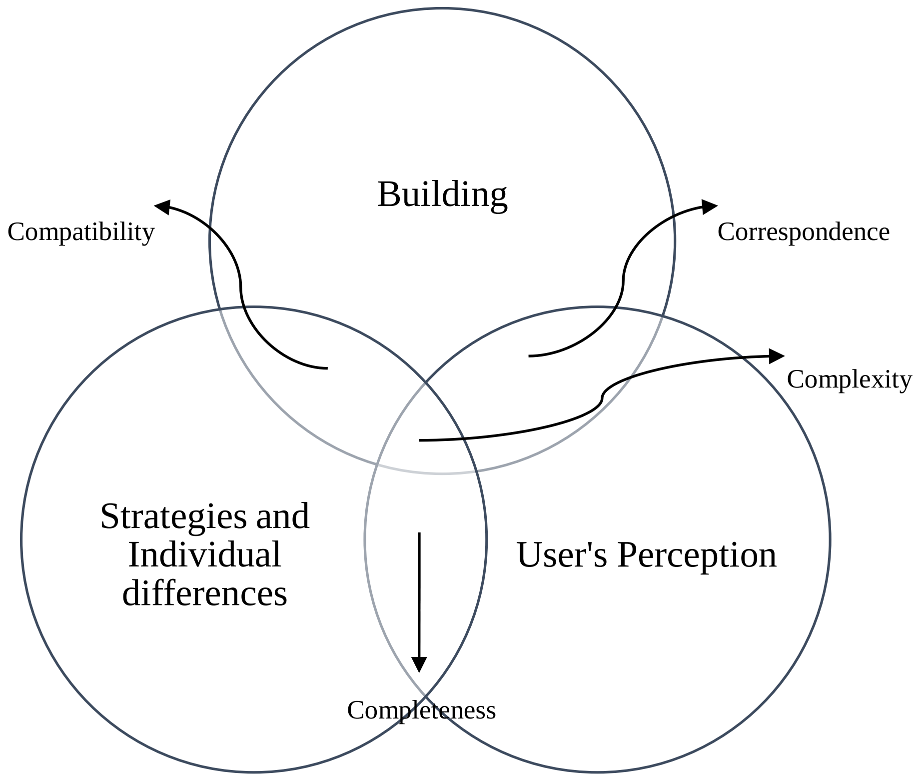


Figure 2.2: Theoretical Framework for users' perception of wayfinding complexity
Source: Adapted from Carlson *et al.*, 2010

The theoretical framework in Figure 2.2 shows that in typical wayfinding task in a specific building, wayfinding can be friendly or challenging for a particular individual with exact wayfinding approaches, and relies on a particular visual perception of space (Carlson *et al.*, 2010; Mustikawati *et al.*, 2017). To illustrate further, the wayfinding complexity in hospital buildings can occur from mismatches between the users' chosen wayfinding strategies and the most efficient strategies for the particular building, interceded by the user's individual spatial skills (Carlson *et al*., 2010). In other words, recognising the shortest route in between two locations can be more complicated for a user who employed route-based strategies, if the building impedes route-retracing, for example, through unidirectional escalators that allow ascending, but not descending (Brunye *et al.*, 2018). This can be facilitated by the user's individual spatial skills such that it can ease acquiring a coherent psychological representation of the building structure; or maintaining track of directions even with a large number of rotational turns along the way (Mustikawati *et al*., 2017). Consequently, complexity of wayfinding can be measured by assessing all together the interaction of the user, environment (building) and the strategies employed during wayfinding. As such, a wayfinding friendly building design arguably desires to be compatible with users' information needs, and the requirements of diverse wayfinding tasks, while individual spatial skills and wayfinding strategies further impact on successful navigation.

In summary, the wayfinding complexity theory is considered the most appropriate to underpin this study due to the complexity of hospital buildings. In such complex environment, the uses of visual senses are very significant in the reading of cues for wayfinding. As such, the Neisser's (1976) perception theory of affordance and information from the environment by the use of observation schema was considered important in hospital wayfinding to enable users read the environmental cues. The study carried out by Raubal (2001) also adapted this perception theory in the concept of wayfinding process. In the conceptual framework succeeding this section, it clearly describes the theoretical process in relation to the research problem.

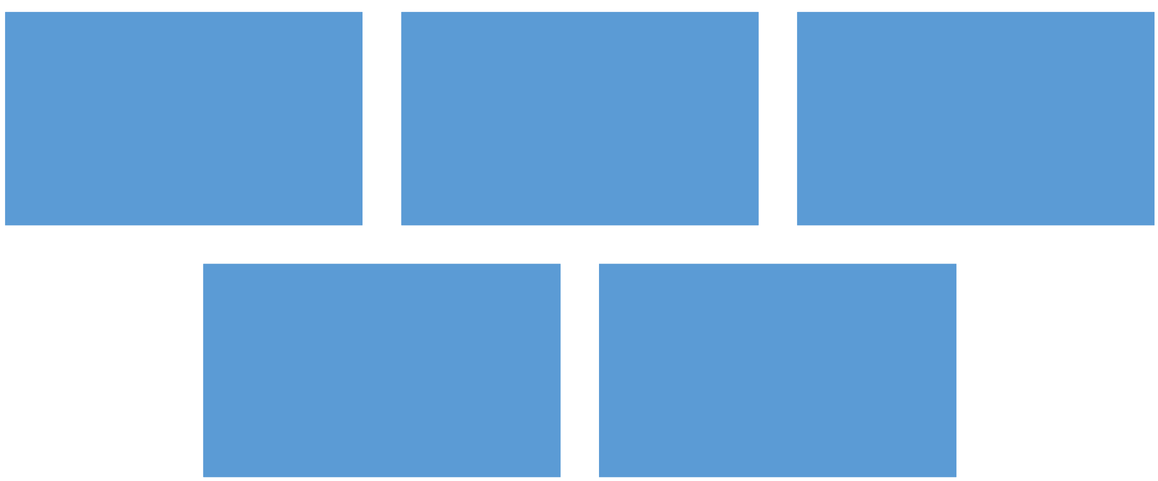
2.10 Conceptual Framework

The conceptual framework supporting the research is anchored on spatial cognitive theory and wayfinding complexity theory modified from Carlson *et al*. (2010). The Neisser's (1976) theory of intuition suggests that people have a particular cognitive formation called *schemata* (image) which allows the intuitional exploit of data required from the surroundings (Dix, 2016). This theory was employed to clarify inquiry of the objective that was to ascertain the way individuals understand intuition of direction findng to destination in hospitals. Furthermore, the theory allows the persons to obtain, symbolise and exploit information in intellectual picture to shape direction of his position that is the preliminary stage in wayfinding task in a new multifaceted location line with the study of Raubal & Egenhofer, (1998) and Paul, (2013).

The rationale for the research is to evaluate the design attributes for wayfinding that simplify legibility within the healthcare settings. Also, it was to enable the inquiry towards ascertaining user's predilections and mind-set in exploiting the corporal possessions of the setting in wayfinding task. In spatial interpretation, individuals recount subjective values instead of absolute values because of the differences in the individual spatial ability and varying strategies used during wayfinding (Brunye *et al.*, 2018; Carr, 2011; Durall & Leinonen, 2014). Thus, the incorporation of intuition (cognitive theory) and deeds resolutions (wayfinding complexity theory) underline the development of conceptual framework for wayfinding in this inquiry.

2.11 Operationalisation of Inquiry Variables

Operationalisation of Inquiry variables gives logical reasons on how and why variables are derived and used for the study. These variables were derived from literature based on the objective of the study. The wayfinding factors and the users'perception formed the parameters established from relevant previous studies in wayfinding in hospitals and their characteristics were modified into research variables. These factors



include the human characteristics, the environmental attributes, the spatial information processing capabilities such as cognitive mapping and perception, and the users' wayfinding experience which facilitates wayfinding behaviour of the users (Pati *et al.*, 2015).

Human factor and environmental attributes were discovered from previous studies to affect the way people make resolutions derived from the facts in the setting to find their way in health facilities and the variables measured include Age, gender, education, language, spatial orientation, familiarity, route strategy, culture and social situation of individual (Christenfeld, 1995; Frank, 2009; Farr *et al.,* 2012; Lawton, 2010; Seneviradne & Morall, 1985). These human variables were modified and adopted in the study. According to Farr *et al.* (2012), the efficiency and success of direction-finding to destination involves the interaction of person with spatial features.

Various studies identified environmental attributes of healthcare environment that influence navigation and the variables used as parameters in the studies includes optic arrangement of space, signage, landmark, design demarcation, as well as regularity of building arrangement (Mustikawati *et al*., 2017; Carpman *et al.*, 1985b; Pati *et al*., 2015). In addition, Huelat, (2007) in her works utilised variables that include spatial orientation, destination prediction, route selection, destination identification and return route selection. Several architectural design variables found in the literature review and used were spatial layout, entrance visibility, signage, lighting, colour, corridor intersections nodes), major landmarks, floor finishes, building layout, building configuration, visual access, circulation systems and functional cluster which were used by several studies (Weisman, 1981; O'Neill, 1991a; Carpman *et al.*, 1993; Peponis & Zimring, 1996; Dogu & Erkip, 2000; Werner, & Schindler, 2004; Montello, 2007; Turner, 2010; Rousek & Hallbeck, 2011; Khan, 2013; Maina & Umar, 2015; Ekstrom *et al.*, 2018; Dalton *et al.*, 2019).

The studies of O'Neill, (1991b) on wayfinding performance identified variables such as time taken to navigate a task, number of errors (wrong turns), number of turns, route efficiency (the shortest routes), rate of travel and backing tracking. Thus, the main factors used herein were the human, spatial, architectural and wayfinding experience factors in the research in line through the study objectives. Consequently, variables used were considered relevant for the study in accordance with the research objectives and literature happening in hospital wayfinding. The variables were defined, described, categorized into factors with codes and detail the level of measurement.

2.12 Gap in Knowledge

This thesis started with the impulse that teaching hospital is a complex environment where most users that are unfamiliar with the environment could get lost. The impact of wayfinding challenges on the users' experience can cause frustration, anger, discomfort, and anxiety linked to navigation (Kuliga, 2016; Paul, 2013). Therefore, the big question was on how friendly the hospital environment to the users with regards to their movement pattern, particularly patients and visitors, seeking health care? In other words, do the hospital buildings support the execution of navigation tasks in an effective, efficient, and satisfying manner while the building design is legible, learnable and pleasant?

In the literature reviewed, a large number of studies used semi-controlled environments such as simulation (Virtual reality) to examine and explore users' experience and behaviour (Kuliga, 2016; Mustikawati *et al.*, 2017; Slone *et al.*, 2014). Thus, there is a paucity of knowledge on verbal protocol and interview where users can actually express their feelings and opinion regarding navigation in the hospital which could not be achieved in a simulated environment. There are limited studies on the real hospital environment and in most cases 1-2 hospital setting were used in the studies. Consequently, the identified gaps that underpin the study was on users' perception or detection of environmental cues in four real hospital settings which was expected to make a valuable research and contribution to knowledge (Kuliga, 2016; Paul, 2013).

The environmental context such as culture, language, and level of education were also identified as a gap in hospital wayfinding. There were no universal symbols across culture in hospital (Lee *et al*., 2014). As such, the meanings and understanding of such symbols by different users with different cultural background becomes a challenge during wayfinding. Furthermore, the signs and symbols used in hospitals were usually not translated into the local languages that the majority of the users could understand. Accordingly, the users with no formal education could have difficulty in comprehending the signage used in hospitals.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Philosophy

Research methodology rests on the foundation of research philosophy which refers to the broad world view the researcher called a paradigm, about the phenomenon under study as affirmed by Creswell (2012). The paradigm involves the totality of the ontological (the type of veracity) and epistemological (creation of facts) assumptions that guides how a research is to be conducted and analysed as stated by Neuman (2014). The nature of the research topic, its aim and objectives, research questions and the resources available basically determine its design as acknowledged by (Creswell, 2012). These criteria mainly informed the approach to this research.

A pragmatist world view (paradigm) was used for this study which arises out of actions, situations, and consequences (Creswell & Creswell, 2018). Pragmatism is concerned with applications of what woks and solutions to problems (Patton, 1990). The researcher looks at what and how to conduct the research with emphasise on the research problem and question and use all approaches available to understand the problem (Tashakkori & Teddlie, 2010). The pragmatism world view relied on abductive reasoning (movng forth and back between inductive and deductive reasoning), intersubjectivity (creating knowledge through lines of actions) and transferability (usability of new knowledge in new set of circumstance) in the research method (Morgan, 2007). In the context of this research, Pragmatism is the philosophical underpinning for mixed methods which focused attention on the research problem and using pluralistic approaches such as quantitative and qualitative data to derive knowledge about the problem. Therefore, pragmatism unlocks the door to multiple methods, different world views, and different assumptions as well as different forms of data collection and analysis (Creswell, 2018). Consequently, both quantitative and qualitative approaches were used which effected into the mixed methods in the study.

3.2 Research Design

Based on the pragmatist paradigm that underpinned this study, the research problem and questions raised, mixed method design was considered appropriate. This research design is used because it maximises the strength drawn from both quantitative and qualitative methods and minimises the weaknesses of both approaches (Morgan, 2007). Also, the results from both quantitative and qualitative approaches can be compared from different perspectives (Hall, 2012).

3.2.1 Mixed methods design

Mixed method refers to the systematic integration of quantitative and qualitative research and the data are combined through different research designs in the study based on the research problem and question (Creswell & Creswell, 2018). Convergent mixed-method was used to combine both qualitative and quantitative data and analysis procedures in a single study in order to provide a better breadth and depth of understanding the research problem

(Leedy & Ormrod, 2014). Both forms of data were collected at the same time, analyse both datasets separately, and merge the results at the interpretation phase to determine whether the results corroborate or contradict each other (Creswell, 2014).

The main strategy used for the quantitative data was cross-sectional survey because the respondents were in different locations. Similarly, the qualitative design was used collect qualitative data through interview and observation to explore human experiences and the wayfinding situations within the entities being surveyed. As noted earlier, mixed-method was used to build on the strength of both qualitative data and quantitative data. That is, quantitative data provide for the generalisation, whereas qualitative data offer information about the context or setting, and reduce their limitations so that a complex image of the situation can be provided (Hall, 2012).

However, the researcher was mindful of some of the challenges that could be faced in implementing the convergent design as highlighted by Creswell (2012) as follows:

- The collection of data concurrently could be tasking;
- the need to consider the implication of when and how to merge the two data sets;
- Merging the two data sets in a meaningful way could be tasking; the problem of how to resolve divergent results from both qualitative and quantitative results.

The above challenges were carefully considered during the data collection, presentation and analysis stages. The problem of resolving the results from the survey and qualitative data did not arise as there was triangulation carried out in the data obtained from the two methods.

3.2.1.1 Quantitative design

The quantitative design used in the study was cross-sectonal survey. This is best used for studies that have individual people as the unit of analysis and involves the use of survey questionnaire to collect data about peoples' preferences, opinions and behaviours in a systematic manner (Bhattacherjee, 2012). Hence, the study involves individuals as the unit of analysis, to evaluate the perception of wayfinding in the hospitals using structured questionnaire. Thus, a survey questionnaire was developed based on reviewed literature which consisted of four factors, namely, the demographic characteristics of the users (patients), the environmental factors, the architectural factors and was used gather data on perception of patients' and their experiences in hospital wayfinding.

3.2.1.2 Qualitative design

The qualitative design was used to explain and increase a rich comprehension of human experiences of the participants in wayfinding as affirmed by Bhattacherjee (2012) and Yin, (2014). Similarly, wayfinding in an unfamiliar environment is a complex process that is dynamic and subjective in nature since it involves perception and human experiences in the evaluation of the phenomenon. The units of analysis were the buildings and users (patients) in the hospitals. This strategy tries to understand the viewpoint of the person being observed and interviewed, the person's thoughts or making sense out of the milieu (context), rather than the viewpoint of the observer (Bogdan & Biklen, 1998). This approach was employed in the interview and observational study in the selected hospitals.

The suppositions following this study structure espoused were owing to the fact that data are in different forms and are in different locations. In other words, the data were collected from four hospitals in north central Nigeria which serves as case studies having different respondents. The study combined the analysis of spatial (building) and non-spatial (building user and task-related) characteristics to measure wayfinding processes as human-environment interaction. The human interaction in the hospital environment could be used to determine the level of effectiveness of the hospital wayfinding performance. Therefore, the practical consequence is that the research produced a framework that could enhance the efficiency of hospital wayfinding. The sequence of the research methodology is conceptually explained in Figure 3.1.

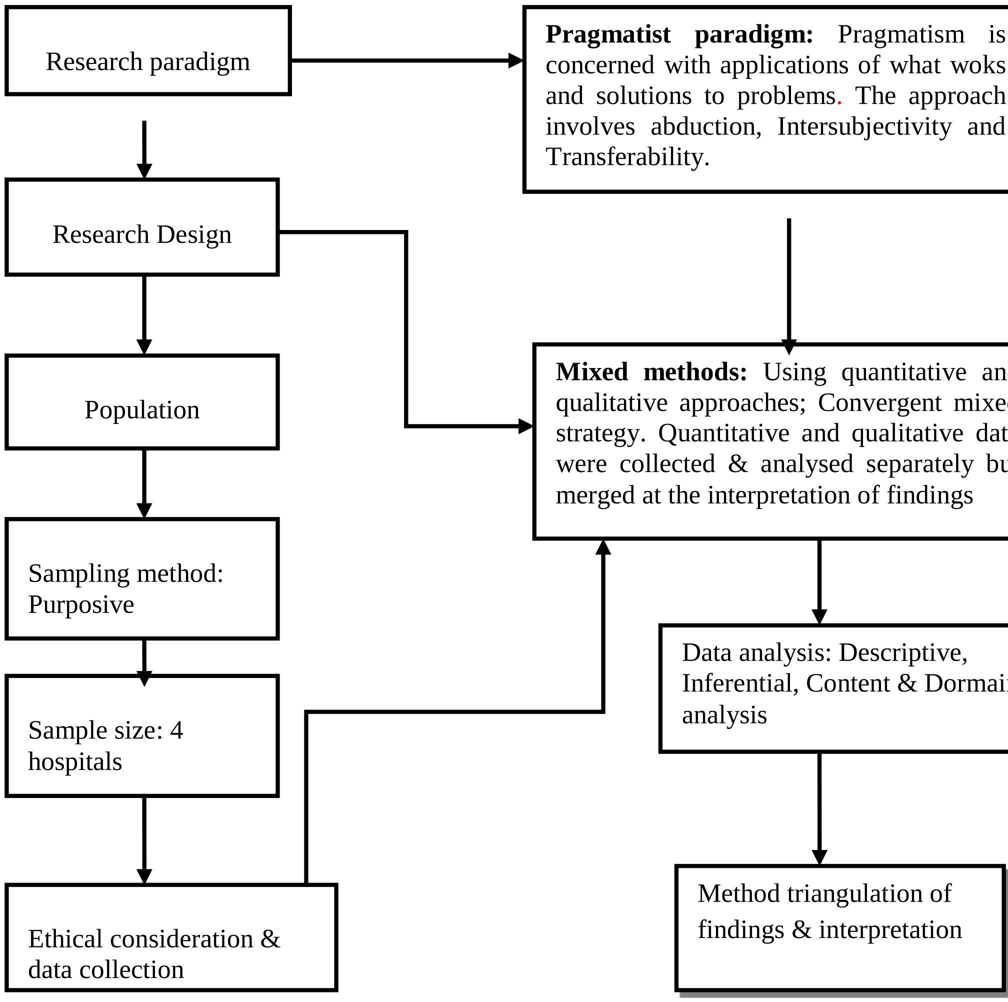


Figure 3.1 Conceptual frameworks for research methodology
(Source: Researcher's field work, 2017)

3.3 Study Population

The teaching hospitals that make up the study population in the north central Nigeria are seven (7) which include the National Hospital, Abuja (NHA) with 500 - bed-capacity, and the University of Abuja Teaching Hospital, Gwagwalada, Abuja (UATH) with 530 bed-capacities. Others are Jos University Teaching Hospital, Jos, Plateau State (JUTH) with 600

- bed capacity, and Plateau State University Teaching Hospital, Jos (PSUTH) 300 - bed-capacity. In addition, it includes University of Ilorin Teaching Hospital, Ilorin, Kwara State (UITH) with 500 - bed capacity, Kwara State University Teaching Hospital, Ilorin (KWSUTH) 300 bed capacity; and Benue State University Teaching Hospital, Makurdi, Benue State (BSUTH) with 300 bed facility.

3.4 Sampling Method

Purposeful sampling technique was used to select the hospitals and participants for qualitative data. Purposeful sampling technique involves a deliberate selection of individuals with particular experiences that was to enrich the focus of the study as affirmed by Sparkes & Smith (2014). Therefore, simple random sampling was utilised to choose respondents for the survey questionnaire. The sampling for the survey was achieved by requesting from the record officer at the GOPD the submitted cards to consult with the doctor for the day. The researcher picked the first card, drops the next one and picked every other card in that order for the survey. Consequently, the participants selected were new patients to the setting at the Outpatients in the General Out-Patients Departments (GOPDs) in the hospitals; they were selected due to ease of access to the respondents, and availability of the patient to partake in the research. Accordingly, selected participants were unfamiliar users of the hospital setting who were visiting the hospital for the first time or twice in the last one year.

The purposive sampling method was used for selection of the participants for semi-structured interview and the observational studies in order to unveil pattern and themes based on the theoretical interest of the research. A purposive sampling technique was utilised due to the context and purpose of the research as only participants willing and could give the required data that were selected. Besides, the purposive sampling procedure was considered the best choice in non-participant observation as it provides less cost, exact and more informative about the users (Bentley, *et. at.*, 1994).

3.5 Sample Size

Furthermore, the choice of sample size depends on the objectives of the study, the appropriateness of the sampling unit, the accuracy and reliability of the sampling frame within the obtainable time, cost and interest of the research (Kothari, 2004). The unit of analysis was the buildings and the outpatients as participants in the hospitals. The criteria for the choice of the hospitals in different locations were anchored in the size of the hospitals, which should be large and not having less than 250 bed capacity as minimum standard for teaching hospitals (NHS, 2006). The sample size for the study was four teaching hospitals that were purposively selected. The selection of the hospitals was based on the complexity of the hospital buildings and the population of patients. In the Federal Capital Territory (FCT), there are two teaching hospitals that comprise the National Hospital, Abuja, and University of Abuja Teaching Hospital, Gwagwalada, Abuja. The latter was selected based on size and complexity of the hospital buildings. Also, in Plateau State, there are Jos University Teaching Hospital, Jos, (JUTH), and Plateau State Teaching Hospital, Jos. The former was selected based on size and the most complex hospital. In addition, there are

University of Ilorin Teaching Hospital, Ilorin, Kwara State (UITH), and Kwara State Teaching Hospital, Ilorin and the former was selected based on size and the most complex hospital. Finally, Benue State University Teaching Hospital (BSUTH), Makurdi, was the only teaching hospital in the State and was chosen for the study.

Similarly, respondents were selected by obtaining the complete list of all the outpatients from the Record and Information unit of each hospital which formed the sample frame of the participants. The record shows that the outpatients department had the highest number of users. As such, outpatients' departments were selected for the study in each of the hospitals. In addition, the majority of the outpatients were either first or second time visitors to the hospital who were considered unfamiliar with the hospital environment. Based on the information obtained from the hospital Record and Information Units, the monthly average Outpatients that attended GOPDs was 1,976 for the teaching hospitals in the north central Nigeria which was used (See Table 3.1).

Table 3.1: Record of General Out-Patient Department Statistics for the year 2016

S/No	Name of Hospital	No. of patients / year	Average no. of patients / month	No. of administered questionnaire	% of questionnaire admnistered	No. of returned questionnaire
1	BSUTH, Makurdi	19,296	1,608	98	24.5	94
2	UATH, Abuja	32,339	2,695	112	28	98
3	UITH, Ilorin	21,151	1,763	94	23.5	86
4	JUTH, Jos	22,052	1,838	96	24	96
		Total Average	1,976	400	100	374

Source: Researchers' field work, 2017

The studies of Bartlett *et al.* (2001) published a table for sample size for questionnaire survey and recommends a sample size of 323 for 2000 population (See Appendix A3: for, ± 5 % error, where confidence level is 95% and P = 0.5; t = 1.96). Consequently, survey questionnaire was self administered on an optimum sample size of 400 participants in the hospitals based on the population to account for errors that may occur in the filling of the questionnaire (See Table 3.1). However, a total number of 374 filled questionnaires was returned representing 93.5% response rate. The sample size was considered appropriate and adequate based on the published tables from studies of Bartlett *et al.* (2001).

The sample size for both the interview and observation were based on saturation point being the point at which no new information will be obtained from further interview (Khan, 2013; Sing & Masuku, 2014). Furthermore, previous researchers recommended sample size thresholds of 10-15 interviews as adequate for theoretical data saturation for qualitative interview and observational studies (Fisher & Nasar, 1992; Morse, 2000). The total sample size for the interview was 56 while 16 participants were observed for wayfinding behaviour overall in the hospitals in the north central Nigeria.

3.6 Data collection Instrument

The research instruments used includes questionnaire survey, interview and physical observations. The questionnaire survey was used to obtain the quantitative data while the interview and observation were used for the qualitative data. The questionnaire survey was used to assess patients' perceptions on wayfinding using a structured questionnaire with four point Likert-scales to gather the information. Furthermore, semi-structured interview was used to obtain an in-depth understanding of patients' opinions and experiences in hospital wayfinding performance. In addition, observation schedule was used to physically observe the patients in hospital wayfinding and the buildings in their natural setting in order to verify or nullify the information provided in the survey and interview.

3.7 Questionnaire Development

This section detailed the procedures and guidelines utilised in the formation of the survey questionnaire (feedback form). The survey opinion poll was designed to respond to the study inquiries and the objectives one and two. The objective one was to determine users' perception of wayfinding in the hospitals while objective two was to determine the critical factors influencing wayfinding. Hence, a standardised- close- ended questionnaire (See Appendix B) was used in the descriptive research to describe and understand the perception and experiences of the users in the hospitals based on wayfinding as affirmed by Saunder *et al.* (2009). The information included in the questionnaire survey was adopted from the existing research tools of reviewed wayfinding studies of Kim *et al.* (2015) and Paul (2013) in line with the objectives of the studies. In addition, the closed questions were made clear and simple in sequential order for better comprehension by the respondents. The research instrument was made to undergo psychometric properties of reliability and validity through the supervisory teams and other senior researchers in the University who carefully went through the questions and made applicable inputs. The developed questionnaire was certified to be effective by the researcher's supervisory committee after a series of revisions, pretest and amendments.

The variables for data collection were conceptualised and each variable was operationalised with measurement details. The first part of the questions concerns attributes indicating demographic uniqueness of the hospital users that consists 6 questions. The section two of the questions were about the perception of environmental cues of the hospital buildings that consists 18 questions while the third part was on the architectural design variables with 15 questions. Finally, the last part of the questions was on the wayfinding experiences of the out-patients (15 questions). The items in the questionnaire consisted of 54 questions (See Appendix B).

Researchers have developed and used standard questionnaire survey instruments to measure variables used in the survey questionnaire in wayfinding situations which have been adapted in this research to ensure validity and reliability (Demirbas, 2001; Dogu & Erkip, 2000; Khan, 2013; Kim *et al.,* 2015; Paul, 2013; Weisman, 1981). In addition, the developed questionnaire was administered on the 20 outpatients as respondents in one of the site hospitals (UATH) as a pilot study. This was done to get their understanding of the questions and subsequently the expressions of the sentences were modified to reflect their comprehension. From the data collected, the content validity of these items was recorded and analysed for consistency.

Morenikeji (2006) asserted that scaling methods such as Likert scales could be used in structuring the questionnaire. Accordingly, a four - point Likert scale questionnaire that ranges from strongly disagree (1) to strongly agree (4) was used in all the questions, which was considered adequate in the study as espoused by Pornel & Saldana (2013). The developed survey questionnaire on a 4-point Likert Scale was used to generate an enforced choice of measure to avoid indifferent option such as 'neutral' as stated by Joshi *et al.* (2015). However, there are 5-point, 7-point and 9-point Likert-Scales with a mid-point of indecision, but was not adopted in this study. The process of validating the interview questions and observation schedule was through the help of senior researchers in the department who made useful suggestions that improved the final outcome of the questions (See Appendixes A, and C) for data collection.

3.8 Data Collection Procedure

Yin (2011) stated that when information is required from people then interview and survey questionnaire are used, however when the conduct or transaction of persons in space is necessary, in that case observation are essential. These instruments were used due to the focus of the phenomenon under investigation, which concerned the peoples' perception and experience in wayfinding performance in the hospitals, anchored in the study inquiries and objectives of the research.

3.8.1 Survey for data collection

The quantitative data was collected using survey questionnaire. In objective one, it was used to determine users' perception of wayfinding. Also, the perception survey was used to examine the significant factor that influence wayfinding in teaching hospitals in objective two. The principal researcher sought permission from the teaching hospital management to conduct research in the hospitals. To access the hospital for data collection, the principal researcher was invited for interaction with the Ethical Research Committee of the hospitals after passing an online test on health research ethics organized by the World Health Organisation (WHO) (See Appendix T). Consequently, approvals of access to conduct the research with the hospitals and units were granted.

The questionnaire contained clear instructions on how to mark the responses. In addition, the list of outpatients who submitted their cards for consultion for the day was obtained from the medical information unit. As stated earlier, a simple random sampling was utilised to administer the survey questionnaire to the sample size of 374 for the four teaching hospitals in the north central Nigeria. Each respondent was assigned an identification number and the number was written on the questionnaire to avoid error in storing and inputting of data. After obtaining the necessary ethical approvals, the survey questionnaire was administered on the spot in three of the hospitals and collected back on the same day with three research assistants. The research assistants had either Bachelors or Masters Degree. However, some patients declined filling the questionnaire on health ground that they were not emotionally stable to respond to the questions. In one of the teaching hospitals, the nurses were used as research assistants through SERVICOM unit of the hospital to help in administering the questionnaire to the out-patients. The use of the staff nurses as research assistant that administered the questionnaire enhanced response rate and build confidence on the respondents. The principal researcher finally collected the completed forms from these research assistants through SERVICOM unit of the hospital.

After two weeks of delivery to the staff nurse, the completed questionnaire were mailed and delivered to the principal investigator for only UITH. The date of delivery and collection were duly recorded. Consequently, the returned questionnaire was used to determine the response rate, 400 questionnaires were sent out to account for omissions and errors during filling. Finally, 374 were returned which gave 93.5% response rate. Saunders *et al.* (2009) affirmed that 30% response rate was considered reasonable and appropriate for mail or person to person administered questionnaire. The information on the survey was sorted and entered on a computer system using SPSS 23 version for statistical analysis.

3.8.2 Interview data collection procedure

The interview was used to determine the users' perception of hospital wayfinding and is a technique of gathering information in case study empirical research as affirmed by Bhattacherjee (2012) and Leedy & Ormrod (2014). A structured interview is more consistent in terms of questions and responses such as survey questionnaire while semi-structured interview is not consistent, but involves series of open ended questions on wayfinding. As such, semi-structured interview was employed to investigate the understanding of people's perception, experience and wayfinding behaviour in hospital environments. The exploit of semi-structured interview was regarded suitable because there were pre-determined themes the interviewer wanted to explore further particular responses on the subjects as espoused by Blandford (2013). In addition, the interviewer had only one chance to interview an outpatient in the hospital for a particular day as such three other research assistants were involved in carrying out the interviews. Accordingly, semi-structured interview was considered the best technique to collect the interview data for quick responses as stated by Cohen & Crabtree (2006). Furthermore, semi-structured interviews permit respondents the liberty to state their opinions in their individual conditions, and provide chances equally for the interviewer and the interviewee to converse on various themes in further details (Boyce & Neale, 2006). Subsequently, interview protocol was designed to guide the conduct of the interview as highlighted by seminal researchers which include the interview preparation, constructing effective research questions, and conducting the proper interview as stated in the studies of Creswell (2012) and Yin (2011).

3.8.2.1 Interview preparation in the research

On the interview preparation, a suitable location for the meeting was chosen and the interviewee was appreciated for granting the call for access and for agreeing to the appointment. Also, the purpose of the research and the format of the interview were explained as contained in the information sheet that was given out to them. Furthermore, the duration of the interview, the participant's right to confidentiality and anonymity as earlier agreed was reiterated by stating that nothing said by the interviewee would be attributed to them without their consent. The researcher also explained to the participants that they are at liberty not to answer any inquiry and that the dialogue would be stopped if the respondents so wished. The intended nature of the research output as a focus and the use of the information elicited was explained to the participants, which was purely for academic purposes. An audio recorder was used for the interview and was stated to the respondents before being used.

Preceding the start of the main dialogue, the permission request to undertake the interview was made. The themes covered were summarized to the respondents, and the researcher appealed that the interviewee read and signed the informed consent form. All of these points were sorted within five minutes. The main respondents were the outpatients, but the nurse on duty introduced the investigator, the reason of the study and appealed for the cooperation of the patients with the interviewer during morning health talk before patients' consultations with the doctors.

Apart from seeking participant's consent and interview preparation guide, there was the need to ensure the effectiveness of the research questions for the interview. Subsequently, there was a general interview guide approach that consisted of clearly worded questions that enabled the researcher to sequentially and consistently ask the participants the same questions throughout the exercise as highlighted by Creswell (2012). Also, the respondents were asked follow-up questions where necessary, that probed into the experiences of the respondents in order to elicit full information from the interview and provoke further understanding of the phenomenon, while still maintaining a neutral tone throughout the interview session.

3.8.2.2 Interview Procedure in the research

In the execution of the interview, the categories of respondents considered for the interview were outpatients of the hospitals in order to explore their perception of wayfinding performance. The interview was conducted for 2 weeks for different days at the four hospitals from Monday to Friday on 18th December, 2017 to 5th January, 2018 excluding the 3 days public holiday. The interview took place at the General Outpatient Departments. The dialogue was carried out in the official English language; however, those that spoke in local languages were translated. The minimum time for the interview session and audio recording was an average of 30 minutes and the maximum of 40 minutes for each interview. There were twelve questions about patients' wayfinding experience covering major themes which consisted of environmental attributes, architectural design attributes, and wayfinding experience attributes during wayfinding in the hospital environment. Consequently, the nature and spread of questions were shown in the Appendix A.

The researcher ensured strict compliance with the interview guideline by intermittently consulting it to ensure the smooth conduct of the interview. Turner III (2010) highlighted the following guidelines: First, one question was asked at a time; Secondly, occasionally the researcher verified whether the tape recorder was working; Thirdly, the researcher maintained a neutral ground and observed the behaviour of the respondents; Next, the researcher encouraged the respondent with occasional nods of head; Also, the researcher ascertained not to lose control of the interview; Finally, the audio recording was to guarantee that no information was lost and the researcher transcribed immediately afterwards.

The respondents interviewed were 24 for case study one, 8 respondents for case study two, 6 respondents for case study three and 18 respondents for case study four, giving a total of 56 respondents for teaching hospitals in the north central Nigeria. The variations on the numbers interviewed in each hospital depend on the willingness of the respondent to participate in the interview. The sample size of between 10 -15 has been established to be adequate to give a saturation point for qualitative interview (Mason, 2010). The saturation point was reached when there was repetitive information on the emergence of further interview that were not expected to give additional information (Creswell, 2012). As such, saturation point was attained at 24 as subsequent interviews were repetitive and yielded no extra information. The increase in the saturation point was because the respondents were not homogeneous and due to the level of complexity of the hospital buildings for four different hospitals. The demographic profiles of the respondents were included in the Appendices F, G, H and I. The samples of the transcribed interview were also attached as Appendices J, K, L and M. Prior to the main interview there was a pilot interview, which was used to guarantee reliability and validity of the instruments.

3.8.3 Systematic observation for data collection

The observation as an instrument was used to measure objective three which was to determine the effectiveness of hospital designs in relation to wayfinding performance in the hospital buldings. This study used non-participant observation where the viewer observed and reported from an apt position, in this case following the participants during wayfinding task, but without experiencing doings which the partaker carried out as avowed by Creswell (2014). The methodical watching lets a taught individual to follow the affirmed guiding principles with the procedure to monitor, report, and analyse the transactions of the wayfinder with the environment. It was affirmed that the observation should give the guarantee that new people observing the similar series of proceedings would concur by the reported facts (Castell, 2017). As such, the observation was carried out to minimize researcher's biasness and ensure reliability of the observations which prompted the recruitment of two research assistants with the principal researcher.

The researcher and the assistants followed the participants at a distance in the observation, recording and coding of the data for the wayfinding task, such that the three researchers can agree on coding of the data. In addition, an effort was made to minimize the biases on participants' wayfinding behaviour during wayfinding task which includes subject reactivity where participants' behaviour may change due to the presence of the observers. Consequently, during wayfinding tasks, the researchers avoided interaction with participants, disruption in the wayfinding task, and ensuring that the researchers were inconspicuous in the observation. The observation was supported by verbal protocol on participants' experiences.

A framework of the theory was developed to help in the understanding and the explanation of the behaviour of participants in the setting with regards to the phenomenon being studied. The observation was carried out from 27th December, 2017 to 5th January, 2018. Observations happened from 9.00 am to 1.00 pm, and 2.00 pm to 4 pm each working day (Monday - Friday) for 6 hours over a period of 2-week. Thus, there was a prolonged engagement with participants in the setting. The observation of wayfinding performance of the hospital in the study entails the description of the spatial features of the physical setting.

In addition, the observation includes the spatial features of patient's route strategy, the wayfinding behaviour and experiences of the participants in the hospital setting in line with the study of Khan (2013). Furthermore, the setting was an outpatients' department of teaching hospitals in north central Nigeria and the site plan and building layout were obtained for assessment. The users' behaviour was measured in terms of how often the wayfinding behaviour occurs such as stopping, backtracking and the cues used in the environment as avowed by O'Neill (1991).

3.8.3.1 Observation of the physical setting

The observation of the physical setting in the hospital was addressed objective three of the study, which was to establish the effectiveness of hospital designs in relation to wayfinding in the hospital buildings. Consequently, 27 attributes of the architectural elements were used to assess the wayfinding design indicators of the hospital based on reviewed literature in the observation schedule. The assessment of the physical setting was founded on its spatial legibility, influences of the design space and usefulness of place legibility system on the effectiveness of wayfinding performance. The layouts of the teaching hospital buildings in the north central zone of Nigeria, which constitute the physical setting, are shown in the succeeding section (See Figure 3.2 to 3.6). The site layout of University of Abuja Teaching Hospital and the marked out study units were shown in Figures 3.2 and 3.3. The marked out area consisted of general outpatients' departments, radiology unit, NHIS Complex, and laboratory. There is pharmacy within NHIS building.

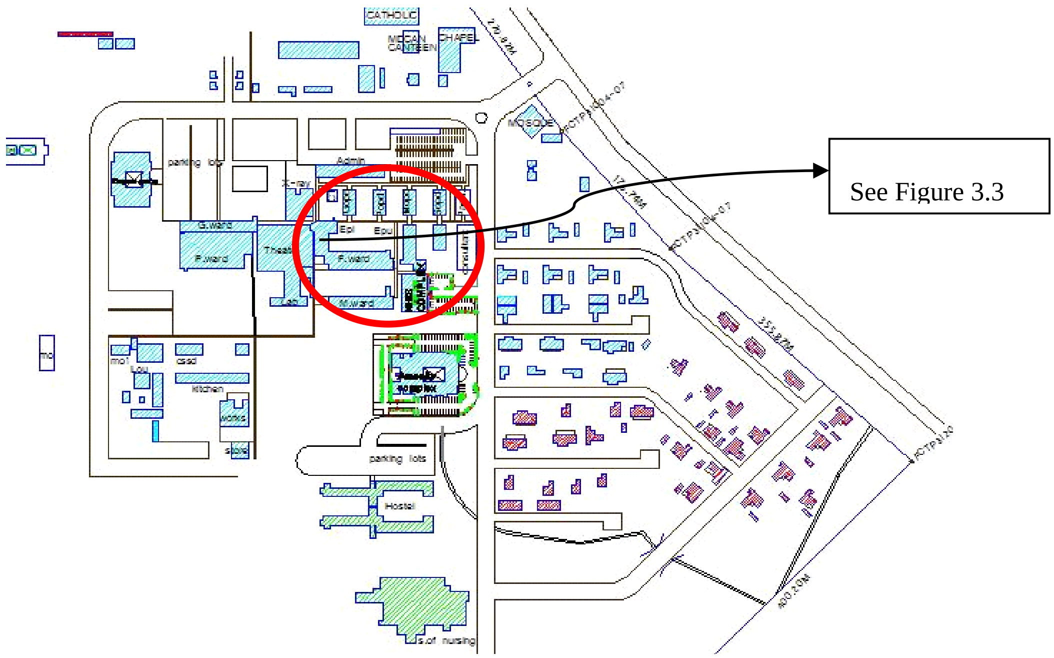


Figure 3.2: The layout of University of Abuja Teaching Hospital
(Source: Works Department, Abuja University Teaching hospital, 2017)

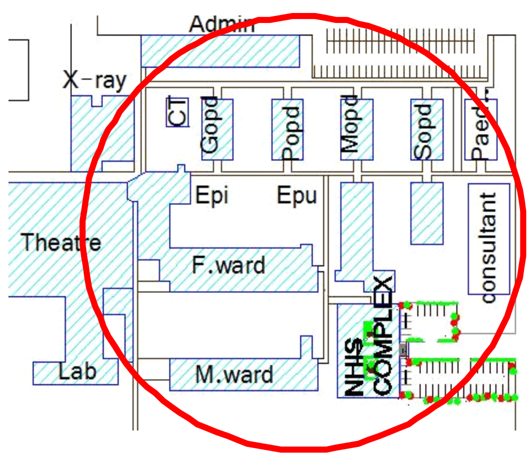


Figure 3.3: The study area within the University of Abuja Teaching Hospital

In addition, the hospital floor plans and the physical setting were observed and assessed while sketches and photograph were taken. The variables observed include circulation pattern, corridor intersections, visual accessibility, and building floor plans in terms of configuration as discussed in the literature review.

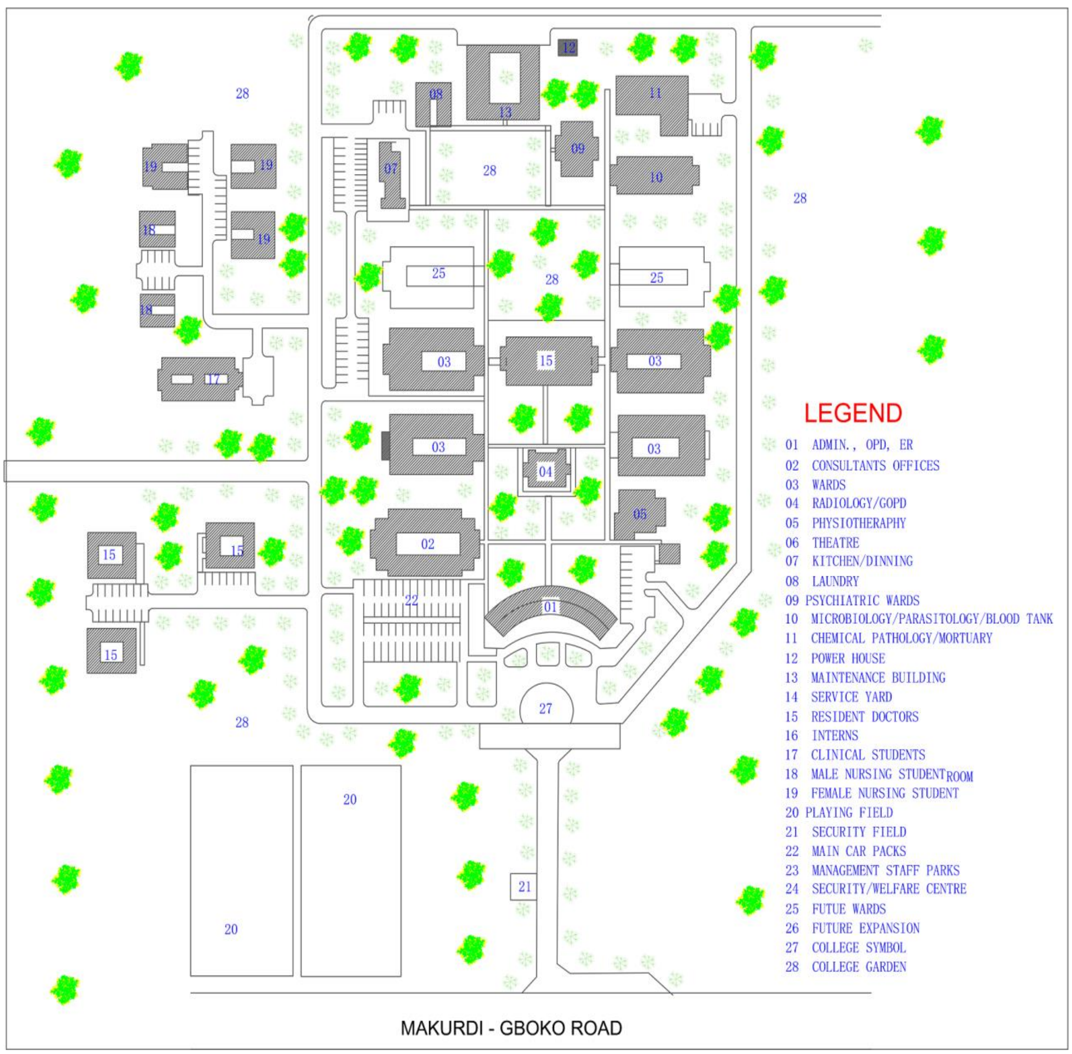


Figure 3.4: Site layout of Benue State University Teaching Hospital
Source: Works Department, Benue State University Teaching hospital, 2017

Figure 3.4 shows that 01 was the Admin/GOPD, 02 was the consultants block, 03 was the ward, and 04 was the radiology department. These were the areas where participants were observed for wayfinding task. The GOPD consists of the pharmacy unit and laboratories.

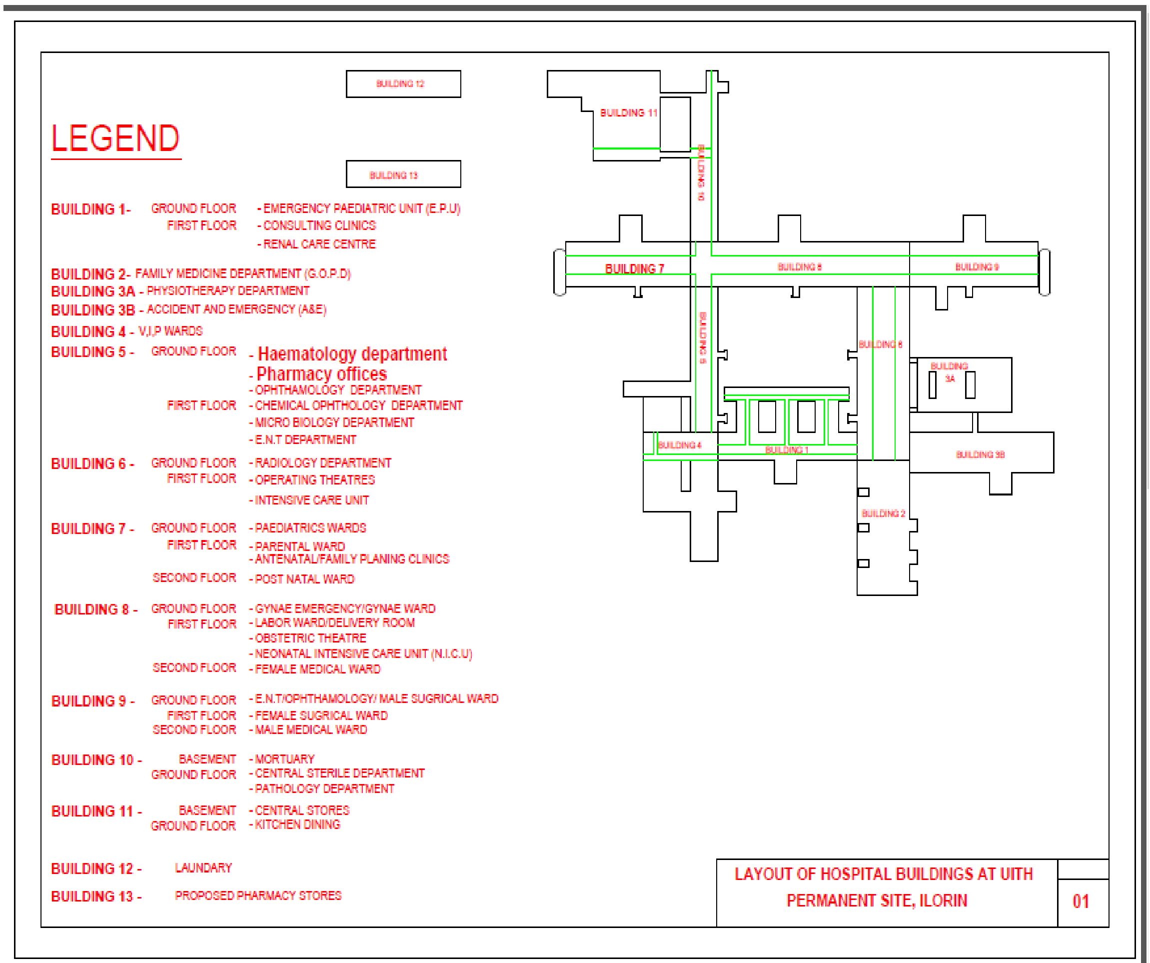


Figure 3.5: The layout of Hospital building at University of Ilorin Teaching Hospital
Source: Physical planning Dept., University of Ilorin Teaching hospital, 2017

The green lines in Figure 3.5 show the circulation spaces within the buildings. Also, the projections show the entrance and stair halls. The hospital complex has three main entrances, namely, the Emergency Pediatric Unit (EPU), Family Medicine department, and Accident and Emergency Unit (A & E). All the buildings were 1 – 2 storey building except the A & E that was bungalow. The mortuary and central stores were basements. All the wards were 2-storey (Buildings 7- 9) located behind in the hospital complex.

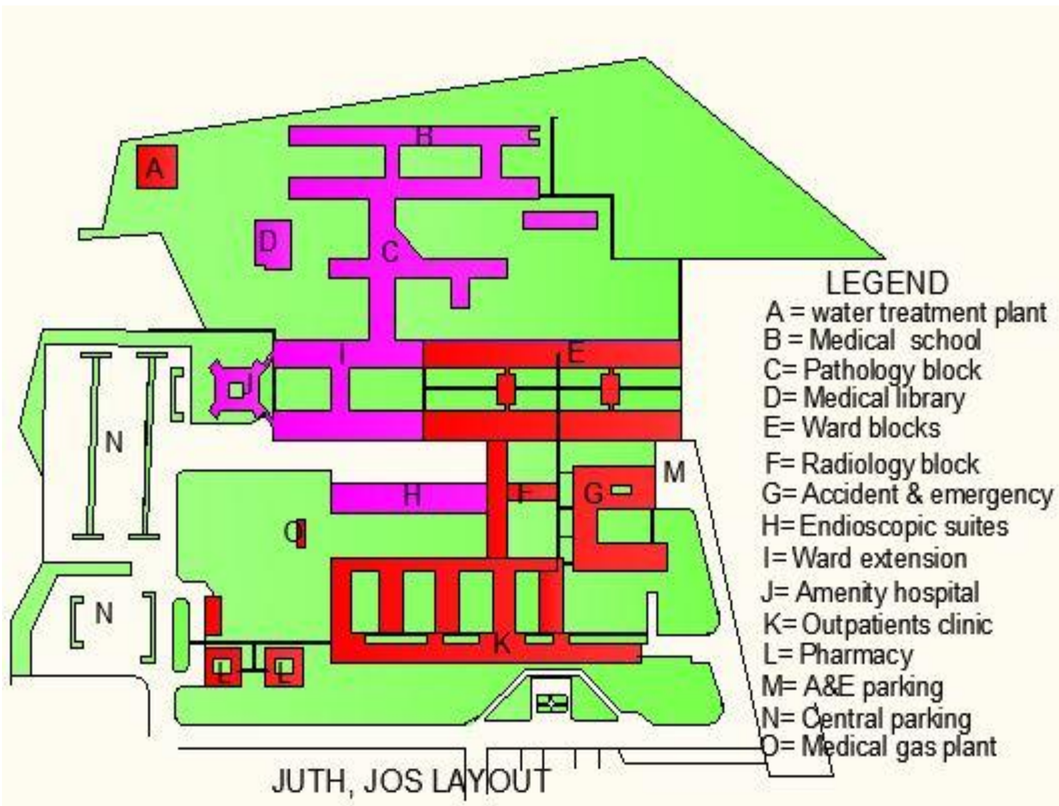


Figure 3.6: The layout of Jos University Teaching Hospital
Source: Works Dept., Jos University Teaching hospital, 2017

Figure 3.6 shows the layout of Jos University Teaching Hospital with Accident & Emergency (A & E) unit (Labelled G) with parking lot in front (M) and behind the A & E is the radiology department (F). In front of the layout is a fountain and sculpture which directly links the GOPDs, clinics and pharmacy section (K). At the left hand side of the layout are the laboratories in front row that is painted red. The blocks that are in purple colour were the various wards and other ancillary facilities (H, I, C, D & J).

3.8.3.2 Users' behaviour in wayfinding performance

In the wayfinding performance sixteen (16) respondents partook in the observation, seven males and nine females. The sample size of 16 was considered adequate as studies recommend the sample size of between 5 and 15 for observational studies (Karania, 2017; Mustikawati *et al.,* 2018; Patton, 2002). In addition, the sample size of 10 was argued to be adequate as the saturation point of an observation study by the seminal researcher (Mason, 2010). The reopndents were adults with age variety from 20 to 55 years, devoid of harsh ocular impairments. The selected respondents had not visited the hospitals over one time or twice in the last one year. As such the participants were considered unfamiliar outpatients in the hospital. However, some patients declined to participate in the observation for reasons that they were not emotionally stable for wayfinding task. Therefore, only patients willing and consented were recruited for the observations.

Each patient contacted was observed without interference during the wayfinding task as participants moved to the next destination after the consultation at the General Outpatients Department (GOPD). The selected destinations for observation from GOPD entrance were Accident and Emergency (A & E), Laboratory complex, Radiology and Pharmacy depending on where the participants choose to navigate first because they were all closely related in terms of medical procedure. These units were selected based on the medical procedural hierarchy of attending to patients for medical care. The variables used for the spatial attributes of hospital users' route were the number of directional changes, the distance from GOPD entrance to the destination, number of signage on the wall from origin to destination, and the number and type of landmarks used by patients. In addition, patients' travel behaviour was based on the number of stops, number of looking around, number of asking for direction and the number of backtracking.

Each participant was tracked from the GOPD to execute a wayfinding task to the destinations (clinical units), namely the pharmacy, laboratories, radiology (X-ray) and A & E. To evade idleness amongst respondents, the investigator identified the destination areas prior to the execution of wayfinding task. In addition, the participants were not given any hint of the location of the targets. The participants just relied on the ecological cues along the route. Accordingly, the respondents' navigation recital was subsequently experiential through walking-with watching technique where two to three participants escorted the participant's walks. The observers noted the navigation pathways and report respondents' events down the trip with video camera. Throughout the wayfinding task, the participant's actions and verbalised thoughts, what was searched and looked at were all captured with camera and audio tape. The essence of the video camera was to capture all the events and choices in the ecological milieu in which they happened, and report actions foremost able to and as a result of those events and choices without forgetting or leaving out any data. Furthermore, photographs were also taken to support the wayfinding task.

The variables observed were obtained from the previous studies on wayfinding performance task (Dehghan *et al.,* 2012; Khan, 2012; O'Neill, 1991). The variables include looking around to make path choice, the distance moved from the GOPD entrance to the desired destinations, backtracking, and wrong turns made in course of navigation. In the course of navigation, the participant route strategy and wayfinding behaviour were observed such as the number of decision making stops, the amount of times the respodents desired to gaze around to find the way, the number of times the participant backtracked, wrong turns, and the amount of times the respondents desired to ask for verbal directions on the movement route. All these observations data were collected and recorded on the observation schedule sheet (See Appendix C).

The assessment was used to determine the effectiveness of hospital designs in relation to wayfinding performance in the teaching hospital complex as set out in objective three. When the patient reached the desired destination and was waiting for medical service, the participant was asked to fill out a survey questionnaire concerning the participant's wayfinding experience. In the study, the theoretical data saturation was attained after 16 patients were observed which was considered adequate in the study of Mason (2010).

3.9 Data Analysis

The data collected in this study were both quantitative and qualitative in nature. In analysing the quantitative data statistical tools were used, while content analysis was used for the qualitative data. Accordingly, method triangulation of the findings was carried out for validity of findings and to create a solid foundation for drawing conclusions as affirmed by Yin (2011). The triangulations were in two stages. The first stage of triangulation was used in objective one where questionnaire survey and interview were utilised. Furthermore, the second stage of triangulation was done for objective one to three and was merged at the interpretation and discussion stage of the results.

3.9.1 Statistical analyses

The analyses of data obtained from the field survey questionnaire were executed with the help of Statistical Package for the Social Sciences (SPSS) version 23. The demographic and added linked facts were analysed with descriptive statistics, for instance, incidence and proportions on gender, age in years (20-34; 35-49; 50-64; 65 and above), language, and the educational level attained (primary, secondary, graduate, and none). Furthermore, descriptive statistics was carried out to elicit perception for the questionnaire survey, using a 4-point Likert's-scale (1 = Strongly Disagree to 4 = Strongly Agree) to get frequencies, and percentages. The 4-point Likert's-scale was used to generate an enforced choice of measure to avoid unresponsive option such as 'neutral' (Neither Agree nor Disagree) as affirmed by Joshi *et al.* (2015). The weighted score (WS) for each item and the weighted mean value (WMV) were obtained with the aid of SPSS version 23, and were ranked according to the mean values.

Inferential analysis was carried out to respond to objective two to establish the critical factors for wayfinding in a teaching hospital in the North Central Nigeria. As such, reliability test was carried out using Cronbach Alpha to determine the adequacy of the items. The cronbach alpha was employed to reduce arbitrary causes of mistakes to symbolize the hypothetical notion adopted as stated in the study of Ruotolo *et al.* (2018).

A Factor Analysis (FA) was utilised to reduce the factors of 54 items to manageable size. Before doing the FA, Cronbach's Alpha (CA) was determined to be 0.81 which was considered adequate because it is greater than a threshold of 0.70 CA established by Nunnally & Bernstein (1994), and Paul (2013). In the FA, Principal Components Analysis (PCA) was utilised to recognise and reduce the factors causal highly correlated variables. The PCA was employed because it is concerned with the direct reduction in the dimensionality as affirmed by Pallant (2011). In order to ensure the correctness and adequacy of the sample (data) for PCA analysis, Kaiser- Meyer-Olkin (KMO), should be $\geq$

0.6 as threshold and Bartlett's test of sphericity (BTS), should be significant at $p \leq 0.05$ were employed to identify significant correlations between items.

The (PCA) utilised Varimax rotation to check the inner construct validity of the scale. PCA analysis establishes the amount of parts, retained in the cluster of attributes, anchored in inter-association amongst the attributes. Basically, the analysis seeks to elucidate the difference in the facts from a set of dormant factors with which items can be categorised. To decide the quantity of factors from the analysis, an assessment of the Scree plot and the eigenvalues was utilised. The eigenvalue is equal to the quantity of variation in the item group elucidated with every factor, and the Scree plot was the optical plot of the eigenvalues by the quantity of factors. The standards for the amount of components to keep comprise the categorising of eigenvalues bigger than one, and break in the arc of the Scree plot. All significant associations were evaluated at alpha = 0.05. In addition, multiple regressions were used to predict the most critical variables for wayfinding performance.

3.9.2 Multiple regression analysis for wayfinding

The multiple regression analysis was carried out to further assess how well the set of variables extracted from the factor analysis (Principal Component Analysis) was able to predict wayfinding performance design indicators. The analyses were separately carried out based on variables under each factor, such as environmental, architectural, and wayfinding experience.

3.9.3 Content analysis

The inductive content analysis was utilised to analyse the interview information in response to objective one and observational studies in objective three. The content analysis entails ascertaining groups and then counting the quantity of cases while person's groups are utilised in a specific item or wording as stated by Smith & Firth (2011). The unit of analysis in this study was the interview text concerning the users' perception of wayfinding performance in the context of teaching hospital. In this context, the study described how people find their ways within a new teaching hospital setting, focusing on the architectural attributes that are most important in facilitating efficient wayfinding performance. The analysis focused attention to the manifest meaning while noting the latent meaning as supportive evidence in the interpretation.

The tape recorded interview data were transcribed verbatim and non-verbal cues were noted in the transcript. The transcribed interview was read several times to familiarise with the text to make meaning of the entire transcript. Furthermore, the transcript was sorted into content parts such as individual characteristics, the physical properties, the architectural design quality attributes, and the experiences of the wayfinder during wayfinding. The transcript was condensed into sense parts; the reduced sense components were summarised and labelled by ciphers. The diverse ciphers were contrasted in terms of their disparities and resemblance and further arranged into sub-groups and groups that constituted the obvious content.

Furthermore, a number of themes emerged from the literature which informed the pattern of the semi-structured interview. These themes were used in the content analysis in the form of framework matrix (cells and columns). The recurring themes were identified from the transcripts which represented a wide range of wayfinding experiences of all the respondents. Subsequently, indexing was carried out in the second column, which involves the coding and categorizing (grouping) the transcribed text. In the second column, similar concepts were merged and counted in the number of times it occurred. Then, it was followed by charting and abstraction in the third column, which entails abridging the information by group from the transcripts. Finally, the mapping and interpretation of the data were carried out. The mapping involves making relations among groups to discover associations as stated by Gale *et al.* (2013). In the interpretation, the information were described and explained in terms of the implicit and explicit meanings of the data by identifying the characteristics and differences. Furthermore, valid inferences were made from the data in content analysis in their situation with the aim of giving that fresh sixth sense, information, particulars and sensible lead to deed as avowed by Graneheim & Lundman (2004).

3.9.4 Use of interview content analysis

The reason of the research was to investigate and elicit users' intuitions of wayfinding in the teaching hospitals in north central Nigeria. The inquiry was to elicit information on the perception of the users and experiences regarding wayfinding in the hospitals. Therefore, the qualitative data was collected and examined for the detail comprehension of the phenomenon in order to complement the survey questionnaire as affirmed by Miles *et al.* (2014). This study used a theoretical framework approach of analysis that includes five phases, such as familiarisation, recognising a thematic framework, indexing, charting, mapping and interpretation. The interview transcripts were analysed using content analysis such that the emerging themes from the data were identified and counted for the frequency as stated by Gale *et al.* (2013).

The matrix table was used to organise the data into key issues and themes, where thematic or content analysis were used to recognise commonnesses and dissimilarities in the information as employed by Li (2016). Subsequently, the interpretation focuses on the associations between dissimilar parts of the summarised information, thereby seeking to draw descriptive or explanatory conclusion grouped in the region of the subjects (themes) as stated by Gale *et al.* (2013). Furthermore, the matrix table was used based on the content analysis of semi-structured interview transcript used. In addition, the matrix table (framework method) was used in order to manage the large data set obtained such that a holistic and descriptive synopsis of the whole data set was feasible across the table. Accordingly, the framework analysis provides focus, repeatable procedure, and obvious steps to pursue and creates extremely planned outputs of summarised data as stated by Li (2016).

In the context of wayfinding in this study, content analysis of the framework was considered an enhanced option than thematic analysis, since it emphasises how both a prioritise issue and appearing data focused subjects guided the formation of the analytical framework as affirmed by Campbell & Lyon (2008). Accordingly, the emerging themes from the questions include building layout, wayfinding aids, wayfinding information or cues in the hospitals, and landmarks. The study explained other themes such as signage, building entrance, lighting, colours, wayfinding experience, and wayfinding barriers. However, the study remained open to discovering the unexpected result. As such, the analytical framework was considered appropriate.

In addition, participants' attributes were recorded which concerns their age, gender, educational level attained, the number of times the participants visited the hospital, the type of disability of the participants (if any), and the type of visit to the hospital (See Appendices F, G, H and I). The transcribed data was organised in the framework approach according to the theme of the questions and the respondents (See Appendix J, K, L and M) as suggested by Miles *et al.* (2014). The participants were purposively selected, aged between 20-65 years for all the hospitals studied. The interviews were transcribed verbatim, listened to the audio tape record several times to get engrossed in the data. Accordingly, the researcher got familiarised with the content of data, and gained sense of the whole interviews prior to dividing them into sections. The recurring themes were identified. Consequently, the following steps in the succeeding sections were followed in the analysis.

3.9.4.1 Identifying a thematic framework

The recurring themes (subjects) were identified from the texts that emerged to symbolise a variety of wayfinding knowledge from all the respondents for each case. Codes and categories were developed by considering every row, phrases of the records in an effort to recap what respondents were describing. Comparable groups were carried jointly to structure a first theme as affirmed by Smith & Firth (2011). These subjects and groups created a coding index that was utilised to sort out the whole data. However, coding directory was continually processed all through the data analysis as fresh brainwave appeared. The frequency of similar categories was counted to determine the number of recurrences to avoid repetition and emphasise commonalities as acknowledged by Miles *et al.* (2014). The framework analysis approach was done in the matrix, in cells and columns according to the themes of the questions and responses respectively.

3.9.4.2 Indexing using the working analytical framework

Indexing refers to the methodical request of codes of the decided logical structure to the entire data set as avowed by (Gale *et al.,* 2013). After coding the text according to the response to the questions, the ciphers were then categorised jointly into groups that were obviously distinct. This shapes the operational logical structure. Each code was assigned an alphabet for easy identification, without having to write out the full sentence or names of the codes each time.

3.9.4.3 Charting data into the framework matrix

Charting data involve summarising the data by group from every text according to codes. The inquirer made effort to hit equilibrium between lessening the data and retaining the original meanings and opinion of the interviewees' word through assigning concepts to similar ideas. The chart includes references to two illustrative quotations from respondents as evidence to support the claim. The summarised data were then mapped and interpreted in order to draw conclusions on the emerging core concept.

3.9.4.4 Mapping and interpreting the data

In mapping the information, the study tried to make connection between groups to discover associations and/ or causality. The interpretation describes and explains the implicit and explicit meanings of the data by identifying the characteristics of the data, and the dissimilarities between the data recognised. In addition, where various types of data were generated, the study interrogated the hypothetical ideas, either previous ideas or the ones rising from the facts. Consequently, the succeeding sections detail the emerging themes from the interview. There were 56 respondents in the interviews conducted. The content analyses were done by creating themes and categories from the data.

3.10 Method for Triangulation of Findings

The quantitative and qualitative data of objective one were triangulated to check consistency of findings that was gotten from different methods of data collection, often referred to as findings across methods as affirmed by (Honorene, 2017). This was done for objective one where two instruments (survey questionnaire and interveiw) were used and for objective one to three in which three instruments (survey questionnaire, interveiw and observation) were used for the study.

3.11 Trustworthiness in Qualitative Research

Qualitative inquirers seek to plan and integrate procedural approaches to make certain honesty of the results as acknowledged by Mason (2010). The inquiry is to ensure rigour and integrity in which the study was carried out in sequence to enhance the credibility of the study process such that results are meaningful and acceptable as avowed by Creswell (2014). As such, the following strategies were used to make certain the credibility and honesty of the results in the study. The research paradigm was interpretative in which multiple realities exist and it was believed that the data was subjective in nature. Accordingly, the researcher's reflexivity and reflection on the previous studies on wayfinding, the methodological coherence of the study and the findings were accurately documented and ensured. In addition, an effort was made by the researcher to maintain neutrality by moving forth and back reflecting on the data, findings and critically reflecting on the meanings.

Furthermore, Peer debriefing is a strategy used to enhance credibility in qualitative research (Nguyen, 2008). Consequently, there was peer debriefing once in every two weeks with other PhD students and the research supervisory committee in the department of architecture. The conversation with the colleagues and senior researchers that was knowledgeable in the interpretive studies checked the constructs of the research instruments, the collected data, the methodology and findings in order to uncover researcher's biases taken for granted. This was to ensure openness, sensitivity and insight in the whole research process of data collection and findings.

In addition, the representativeness of the results relative to the phenomenon was ensured by using adequate sample size for questionnaire survey, the semi-structured interview and observation studies for the research. Furthermore, the researcher had a prolonged engagement with the participants for 14 working days for the participants to share their wayfinding experiences in the hospitals. Also, the use of semi-structured aural documentd dialogues let for continual reuse of the information to verify rising subjects and stay factual to respondents' narratives for outpatient's wayfinding experiences. Besides, the exploit of rich and thick verbatim extracts take out from the interview transcripts enables the researcher to make judgment about the final core concept that were true to the participants' account.

Furthermore, there was a translucent and obvious account of the study procedure from the research paradigm, to data collection process and the reporting of findings such that there was cohesion between the aim of the study, the design and method. Consequently, the same wayfinding research can be undertaken in another hospital setting following the same procedure. The emerging themes were conversed with the study supervisory committee who had provided soothing and qualitative study know-how in an open procedure where suppositions were confronted and compromise attained. The results from this wayfinding research in teaching hospitals had the rich detail of context, using outpatients as samples. It was properly documented such that it aids the assessment of research conclusions and transferability to other teaching hospitals of different settings.

Finally, there was method triangulation of findings on users' perception of wayfinding where survey questionnaire and interview were used. Subsequently, there was triangulation of findings of objective one to three to produce a more comprehensive set of findings. However, where there were divergent findings and negative cases, an effort was made to probe further to unveil the reasons, the implicit and explicit meanings.

3.12 Ethical Considerations

Ethical concerns in research refer to the suitability of the inquirers' conduct relative to the privileges of the organization with the respondents as influenced by the research as affirmed by Saunders *et al.* (2009). Accordingly, the study ensures that ethical issues in research that could arise in the course of research design, seeking access to the organization and to the rights of the individuals to collect, analyse and reporting of data were considered in the study. As a result, there are two phases of moral consent that was gotten for the research. The request to gain access to the hospitals was made in writing to each of the hospital with a processing fee paid. The principal researcher was subjected to online training and test on health research ethics and was issued an online certificate (See Appendix T). Upon the successful completion of the course, the researcher was invited for an interview with the Hospital Ethical Review Board. Upon satisfactory performance at the interaction with the ethics board of the hospital, the Ethical Board then issued approval on behalf of the Teaching Hospital to the principal researcher.

As the research was to commence, approval was also obtained from each unit concerned with the research in the hospital. Besides, prior to the dialogues, respondents were educated concerning the intents of the research, the secrecy of the data, and the footage of dialogue and their printed assent for partaking was acquired and was educated of the right to back out whichever time. Consequently, other ethical principles such as rights to privacy, confidentiality, anonymity, objectivity and honesty, risk or harm to respondents and safety of the researcher were considered in line with the principles and procedures highlighted by seminar researchers (Claudot *et al*., 2009; Richards & Schwartz, 2002).

Table 3.2 shows the research procedures adopted for the study, the reasons and the type of analysis used. This was done according to the intents of the study. Consequently, the outcome from the objectives one to three was employed to create perceptual wayfinding framework for teaching hospitals.

Table 3.2: Summary of research procedures

Objective	Procedure	Reasons	Analysis	Expected outcome
I	• Survey questionnaire;	To seek a pool of opinion on the phenomenon	Descriptive	
	• Interview: Semi-structured	To explore the purpose, context and meaning of the phenomenon (Teijlingen, 2014)	Content analysis	
	• Triangulation of results	To merge results in order to determine similarity,	Merging quantitative and qualitative results	

		differences, implicit and explicit meanings.		
II	Survey questionnaire	• To extract the most important variables from the wayfinding factors • To establish the predictors of wayfinding indicators from the extracted variables	• Factor analysis (Principal Component Analysis) • Multiple regression	
III	Observations	To understand the wayfinding situations in the environment, and examine the movement behaviour of the users and their interaction with space regarding wayfinding in the context of the hospital.	Content analysis	
IV	Triangulations of results from objective I – III	To merge results from objective I – III in order to determine similarity, differences, implicit and explicit meanings.	Merging quantitative and qualitative results	Development of perceptual wayfinding framework for teaching hospital in North Central Nigeria

Source: Researcher's work, 2017

CHAPTER FOUR

4.0. RESULTS AND DISCUSSIONS

4.1 Respondents Characteristics

The overall demographic and the familiarity related characteristics of the respondents for all the selected teaching hospitals in the North Central Nigeria are shown in Table 4.1. There were 374 respondents for all the teaching hospitals of which more than half were male (56%)

and less than half (44%) were female. Similarly, almost half of the respondents (49%) were aged between 20 to 34 years were classified as youth, 49% were aged between 35 to 65 years middle aged, and the remaining 2% were classified as elderly (senior citizens).

For the educational status, 30% had secondary education, 47% were graduates, while 21% of the respondents had primary education, and 2% had no formal education. Furthermore, over half of the respondents (60%) could speak English language fluently while the other 40% of the respondents speak other languages.

On familiarity with the environment, 20% of the respondents had visited the hospital more than 3 times; suggesting that they were familiar with the hospital environment. Also 40% had either visited the hospital once or none at all, suggesting that they were not familiar with the hospital environment. The remaining 40% of the respondents that had visited the hospital 2 to 3 times suggesting that they had fair understanding of the hospital environment. Furthermore, majority of the respondents (72%) with these demographic characteristics asked for verbal direction which suggests that a large percentage of the respondents were unfamiliar with the environment which by implication the environment was complex for cognitive mapping.

Table 4.1 Summary of Respondents Demographic Data for North Central Nigeria

Respondents' data	BSUTH, Makurdi	UATH, Abuja	UITH, Ilorin	JUTH, Jos	Summary
	%	%	%	%	%

Gender	Male	59.6	59.2	43.0	61.5	55
	Female	40.4	40.8	57.0	38.5	45
Age	20-34	52.1	44.9	32.6	64.6	49
	35-39	31.9	45.9	54.7	31.2	41
	50-64	8.5	6.1	12.8	4.2	8
	65+	7.4	3.1	0	0	2
Educ. Level	Primary	11.7	3.1	1.2	1.0	21
	Secondary	28.7	27.6	33.7	20.8	30
	Graduate	54.3	67.3	65.1	77.1	47
	None	5.3	2.0	0	1.0	2
Language	English	48.9	73.5	33.7	82.3	60
Spoken	Hausa	7.4	5.1	8.1	6.2	7
	Yoruba	7.4	10.2	55.8	3.1	18
	Igbo	10.6	6.1	1.2	1.0	5
	Others	25.5	5.1	1.2	7.3	10
No of visit to	1 time	28.7	37.8	40.7	36.5	36
hospital	2-3 times	26.6	42.9	40.7	50.0	40
	>3 times	36.2	17.3	17.4	8.3	20
	Never before	8.5	2.0	1.2	4.2	4
Ask for	Yes	57	72.4	81.4	79.2	72
direction	No	43	27.5	18.6	20.8	28

Source: Researcher’s work, 2018

4.1.2 Reliability test for the attributes

The Cronbach’s alpha coefficient was used to evaluate the reliability of each attribute of the sub-scale in the items of the survey (See Appendix E). The overall reliability estimates were employed to ensure the internal uniformity of the 48 items for all the hospitals in the North Central Nigeria. This was done based on factors which had Cronbach’s Alpha of 0.701 representing a good internal reliability amongst items with the similar attributes (See Table 4.2) and was considered adequate basd on the threshold of CA ≥ 0.70. Paul (2013) had similar reliability properties of the wayfinding scale of Cronbach’s alpha to be 0.78.

Reliability scores between 0.70 and 0.80 are interpreted as good, while scores above 0.80 reflect very good reliability (DeVellis, 1991).

Table 4.2: Reliability Statistics and Case Summary

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items		N	%
			Cases valid	374	100
			Excluded [a]	0	0
.701	.728	48	Total	374	100

a. Listwise deletion based on all variables in the procedure. Source: Researcher's work, 2018

4.2 Users' Perception of Wayfinding

There were two parts of the questionnaire for determining the users' perception of wayfinding performance in the hospitals in response to objective one. The questionnaire consists of the respondents' characteristics and factors such as spatial, architectural and wayfinding experience on a 4-point Likert scale (strongly disagree = 1 to strongly agree = 4). These were analysed for the hospitals to obtain the overall users' perception of wayfinding in the hospitals in North Central Nigeria.

4.2.1 Use of survey questionnaire

The analysis of the survey questionnaire for users' perception of hospital wayfinding in the North Central Nigeria was based on the opinion of the respondents. There were three factors which include spatial, architectural and wayfinding experience considered for the analysis in line with the subscale of the questionnaire and each factor was assessed separately. The responses for each item in the questionnaire were combined to make a compound score for all the items to ascertain the participants' degree of agreement around the phenomenon as affirmed by Joshi (2015). As such, an interpretation scheme of a 4-point Likert scale was adopted to measure attitude, opinion and perception quantitatively as devised by Pornel & Saldana, (2013) which states as follows:

Mean interval		responses of opinion
1.00 -1.49	=	Strongly Disagree
1.50 - 2.49	=	Disagree
2.50 - 3.49	=	Agree
3.50 - 4.00	=	Strongly Agree

The adopted cut-off point in the continuum of the mean was 2.50 as used in the study. This implies that less than 2.50 and greater than 2.50 was considered disagreed and agreed respectively in the scale continuum. Table 4.3 shows the summated or weighted response scores for each item (WS), the weighted mean value (WMV), the ranking, and the degree of agreement as the interpretation.

Table 4.3: Environmental factors influencing wayfinding

Item	WS	WMV	Ranking	Interpretation
B 11: Useful information from street signage	301	3.22	1st	Agree
B 10: Useful information from road junction	287	3.07	2nd	Agree
B 2: Use important building to find direction (Landmarks)	278	2.97	3th	Agree
B 9: Useful information from area	271	2.90	4th	Agree
B 6: See direct from entrance to important building and destination	250	2.85	5th	Agree
B 8: Useful information from path boundary	266	2.85	5th	Agree
B 5: Map to direct	262	2.80	7th	Agree
B 1: Use verbal direction within hospital envt.	256	2.74	8h	Agree
B 13: Similar buildings influence finding a location	251	2.65	9th	Agree
B 3: Use trees to recognise direction	219	2.34	10th	Disagree
B 4: Use important shrubs to identify direction	216	2.31	11th	Disagree
Aggregate	265	2.83		Agree

*WS (Weighted Sum); WMV (Weighted Mean Value) Source: Researcher's fieldwork, 2018)

Furthermore, the Weighted Mean Values (WMV) were calculated by dividing the weighted sum by the total number of respondents (sample size = 374) as shown in Table 4.3. Each of the items was further synthesised by ranking the mean and its interpretation. The composite aggregate on spatial (environmental) factor in the hospitals had a Mean value of 2.83 which suggests that the majority of the respondents agreed with most of the statements on the attributes measured. Consequently, it implies that the hospital environment was user-friendly for wayfinding performance. In the preceding sections of interpretation, highly ranked attributes and lowly ranked attributes are discussed.

4.2.1.1 Use of signage in hospitals

Table 4.3 revealed that the majority of the respondents' ranked signage as the first influential attributes to wayfinding performance and agreed relative to the statement that signage and room number can greatly lead one to the desired destination in the hospital. The data suggest that signage and room numbers were highly used by the respondents in directing users to the desired destination in the hospital with a mean value of 3.22. The reason for the high use of signage could be because the majority (81%) of the respondents had formal education and could read the signs. This supports the findings of other studies that the signs were noticed and read by the majority of the users (Mollerup, 2005; Lewis, 2010; Brunye *et al.*, 2018). Consequently, it implies that the signs were placed in a good location and the information was perceived at, or just before, a decision point.

4.2.1.2 Use of important buildings as landmarks for wayfinding

Table 4.3 shows that the use of important buildings as landmarks was ranked the second significantly influential variable for wayfinding performance in the hospital environment. The majority of the respondents (79%), relative to the mean score of 3.16, agreed that the data such as cues derived from buildings as landmark were used to find direction to the desired location in the hospital. This suggests that some buildings were conspicuous in terms of size, shape or height, and colour that differentiate the building from other surrounding buildings. These buildngs serve as landmarks to identify and remember locations or confirm direction to destinations. This supports the findings from previous studies, that landmarks improve wayfinding when used as reference points, to confirm route decision and destination points (Gangaputa, 2017; Sharma *et al.*, 2017).

4.2.1.3 Grouping of related functions by zones for wayfinding

The grouping of related functions (departments) by zones in the hospital design was agreed upon and ranked the third influential critical variable for wayfinding performance in the hospital environment (See Table 4.3). This support the findings of Martins & Melo (2014) that, proper zoning of related functions according to the resemblances in desires and stipulates from patients resulted in ease of wayfinding performance in hospitals, because it follows the hierarchy of importance. The implication was that, users were not likely to have difficulties in locating the desired destination within the zone and the sector could be used as landmarks. Consequently, the hospital environment was user-friendly.

4.2.1.4 Circulation spaces and nodes in hospitals

Table 4.3 revealed that the use of directional information at corridor intersections (nodes) and paths was agreed upon and ranked the fourth and fifth respectively as influential variable for effective wayfinding. This supports the findings that navigation experience in hospital building is affected by the way spaces are linked, the changes of direction forced by the circulatory system, and the way branching points is disseminated (Peponis & Zimring, 1996; Khan 2013). Accordingly, Baskaya (2004) established that signage located at choice positions in hospitals enhanced wayfinding recital. This implies that the number of changes in the direction needed to access a destination, the signage placed at such decision points, and the clear visibility of the destination from the main entrance affects the ease of wayfinding performance.

4.2.1.5 Visual access from building entrance in hospitals

The visual access of the users from the building entrance to the destination was agreed upon by the majority of the respondents (71%) and was ranked the ninth influential variable for wayfinding in the hospitals (See Table 4.3). This upholds the results of Carpman *et al.* (1985) that wayfinding behaviour of users at first entering a hospital was manipulated further by visual access to the target than by obtainable signage. Accordingly, it implies that users' wayfinding behaviour was influenced by the visual access from the building entrance to the desired destination.

4.2.1.6 Spatial layout in wayfinding

Table 4.3 shows that building layout was difficult for wayfinding as it was ranked 14th and agreed upon by the majority (67%) of the respondents. This was because of the complexity of the hospital buildings. Accordingly, it implies that the unfamiliar patients found the buildings complex to navigate which affects the ease of wayfinding in the hospital. As such, building layout should be made simple to understand and navigate.

4.2.1.7 Use of trees and shrubs as landmarks in hospital

The usages of trees and shrubs as landmarks to recognise destination in the hospital wayfinding were least ranked as the 17th and 18th, and with the weighted mean value of 2.34 and 2.31 respectively (See Table 4.3). Accordingly, the use of landscape elements such as trees and shrubs were disagreed upon by the the majority (58.5%) of the respondents. This suggests that trees and shrubs did not influence wayfinding in hospital, because the fullness of their leaves respond to climatic conditions in different seasons. This implies that during the wet season when the leaves are full, the users could visually perceive the trees and shrubs as cues for a wayfinding. However, during the dry seasons, they wither their leaves which could not be visible as environmental cues to the user.

Table 4.4: Users' responses on architectural factors for wayfinding

Item	WS	WMV	Ranking	Interpretation
A15: Designed signage system makes destination easy to identify	290	3.10	1st	Agree
A1: Easy identification of building entrance	284	3.04	2nd	Agree

A8: Lighting up circulation space play role in wayfinding	276	2.95	3rd	Agree
A4: Legible pathway identification	266	2.85	4th	Agree
A2: Floor plan arrangement was not difficult	264	2.82	5th	Agree
A3: Easy direction finding in circulation space	264	2.82	5th	Agree
A6: Too many patients around circulation space disturb wayfinding	260	2.78	7th	Agree
A7: Visible environmental picture	258	2.76	8th	Agree
A5: Easy identification of stairway	256	2.74	9th	Agree
A10: Wall colour strips are useful to wayfinding	255	2.73	10th	Agree
A12: Corridor intersection makes wayfinding difficult	254	2.72	11th	Agree
A11: Similarity of building shape influences wayfinding	250	2.67	12th	Agree
A14: Use of plants and water influences wayfinding	245	2.62	13th	Agree
A13: Seats in circulation influences wayfinding	244	2.61	14th	Agree
A9: Floor finishes make wayfinding easier	236	2.55	15th	Agree
Aggregate	261	2.79		Agree

*WS (Weighted Sum); WMV (Weighted Mean Value) Source: Researcher's work, 2018

Table 4.4 Shows that the aggregate Mean value of 2.79 (69.8%) relative to the use of architectural features as cues in hospital environment was generally agreed on. This indicates that the various architectural design attributes contributes significantly to hospital wayfinding. Consequently, it implies that the hospitals had user-friendly environments for wayfinding. The contribution of each attribute to wayfinding is detailed in the succeeding section.

4.2.1.8 Influences of signage in hospital wayfinding

The use of the designed signage system was ranked first, the highest variable that influences the ease of wayfinding in the hospitals (See Table 4.4). This was because the clarity and legibility of the information of signs (text and symbols) were provided where users need the information to find direction to destinations in the hospitals. Consequently, signage influences ease of wayfinding. This supports the findings of O'Neill (1991); Sadek (2015); and Potter (2017) that signage was an important and the main effectual attributes in plummeting wayfinding mistakes, such as incorrect turns and backtracking. Accordingly, emphasis should be given to signage and floor plan complexity because floor plan configuration exerts a significant manipulate to wayfinding recital regardless of signage.

4.2.1.9 Visual access from building entrance to landmark

The visual access from building entrance and its easy identification was ranked the second critical influential variable to wayfinding performance in the hospitals (See Table 4.4). This was because the majority of the respondents agreed relative to the declaration that the building entrance was conspicuous, the buildings were organised with open core with wide corridor systems. This supports the findings of Weisman (1981) that visual access impacts spatial legibility; and the findings of Montello (2014) that visual access have the capacity to reduce uncertainty and stress during wayfinding. The implication is that, visually salient landmarks such as artwork and visible main staircases from the main entrance area can enable wayfinder to immediately identify navigation choices available during wayfinding.

4.2.1.10 Use of lighting and wall colour strips in wayfinding

The use of lighting in the circulation space in the hospitals was ranked the third variable that influences the ease of wayfinding (See Table 4.4). This was because the circulation spaces were adequately lighted with open courtyard for natural lighting for users to clearly see signs and cues during navigation. However, this is contrary to the findings that lighting was not taken into consideration by users of space in the hospital and that it was negatively perceived (Hidayetoglu *et al.*, 2012).

The use of wall colour strips in wayfinding was ranked the tenth variable that influences wayfinding (See Table 4.4). This was because the majority (90%) of the users were aged between 20-39 years, an active age, without visual impairments. This implies that individual characteristics affect the users' perception of colour in wayfinding. Although, strong contrasting colours draw the eye of the user, however, excessively numerous eye catchers also make perplexity during wayfinding (Hidayetoglu *et al*., 2012). In addition, colour is a function of light.

4.2.1.11 Legible pathways and corridor intersection (nodes) in hospitals

The majority of the respondents (71.3%) and (68.5%) ranked circulation space and nodes as fourth and eleventh, respectively, as variables that were legible and influence the ease of wayfinding (See Table 4.4). However, the respondents perceived corridor intersections difficult where there were no directional signs. This implies that the majority agreed that there were sufficient signs and landmarks at decision points which decrease the complexity of route directions. Where users have more suboptimal wayfinding decision points available for path selection, the more complex they can experience an environment (Kuliga, 2016).

4.2.1.12 Spatial configuration (layout) of the hospitals

The floor plan configuration and similarity (symmetry) of building shape were ranked 5th and the 12th (twelfth), constituting the majority, respectively as the variables that influence the ease of wayfinding in the hospital (See Table 4.4). This suggests that majority (71% and 66.3%) of the respondent could navigate the hospital without difficulty. However, few patients could not comprehend functional spaces and their relation to one another during wayfinding due to similarity in shapes of the building layout of the setting. This implies that building layout was complex to the few patients for effective wayfinding in the hospitals.

4.2.1.13 Crowdedness in hospital wayfinding

The majority of the respondents (70%) ranked too many people around the circulation space as the seventh influential variable that constitute barrier in hospital wayfinding (See Table 4.4). This was because patients that could not read signage tend to follow the crowd in finding destinations in the hospital, particularly in emergency and outpatient departments. This implies that signage was not legible to such patients and the width of corridors might not be wide enough for the inflow of patients at peak period in the hospitals.

Table 4.5 Users' response on wayfinding experience factors

Item	WS	MWV	Ranking	Remark

WFE 1: Stressful wayfinding experience	1282	3.43	1st	Agree
WFE 2: Get lost on the way	1128	3.02	2nd	Agree
WFE 4: Stopped to ask for direction	1090	2.91	3rd	Agree
WFE 5: Stopped to read the signs	1089	2.91	3rd	Agree
WFE 6: Looked around in finding the way	1080	2.89	5th	Agree
WFE 3: Have difficulty in finding the way	1064	2.85	6th	Agree
WFE 11: Directional signs are easy to identify	1055	2.82	7th	Agree
WFE 8: Missed the way	1012	2.71	8th	Agree
WFE 12: Destination signs are easy to identify	1000	2.67	9th	Agree
WFE 7:Used shortest routes to destinations	969	2.59	10th	Agree
WFE 9: Too many turns in the circulation	962	2.57	11th	Agree
WFE13: No confusion in circulation to destination	942	2.52	12th	Agree
WFE 15:State of mind affect wayfinding	937	2.51	13th	Agree
WFE 10:Directional signs at decision points	927	2.48	14th	Disagree
WFE14:Navigating to destination with confidence	870	2.33	15th	Disagree
Aggregate	1021	2.73		Agree

*WS (Weighted Sum); WMV (Weighted Mean Value) Source: Researcher's work, 2018

The majority (68.3%) of the respondents with MWV of 2.73 agreed that the wayfinding experience was a critical factor for navigation in the hospitals as most of the variables had a mean cut-off point of ≥ 2.50 (See Table 4.5). The result implied that 13 out of 15 variables were agreed upon which accounted for 86.67%. However, the majority of the respondents disagreed on the attributes such as the placement of directional signs at the decision points (WFE 10), and the confidence level in moving from the hospital entrance to the desired destination (WFE 14) in wayfinding experience in the North Central Nigeria.

4.2.1.14 Stressful wayfinding experience

Stressful wayfinding experience was ranked the first significant influential variable that accounts for wayfinding experience by the respondents in the hospitals (See Table 4.5). This was because of the way spaces were connected, the changes of direction, the long distances and complicated routes imposed by the circulation system could cause stress to users during wayfinding to desired destinations. This implies that simple and regular spatial system can make building easy to understand and improve the wayfinding experience.

4.2.1.15 Got lost during navigation

The majority of the respondents (76%) ranked getting lost as the second significantly influential variable on the way to find desired destination during hospital wayfinding (See Table 4.5). The spatial complexity exacerbates getting lost in most of the hospitals. This upholds the results of Carlson *et al.* (2010) that the building layout complexity accounts for users getting lost in the hospital. This implies that designing efficient spatial layout and signage system significantly improve users' perception and wayfinding experience of hospital buildings.

4.2.1.16 Stopping and looking around during wayfinding

The attributes such as to stop to ask for direction and to read the signs, and looking around were ranked as the third and fourth influential variables respectively during wayfinding experience in the hospitals (See Table 4.5). This suggests that stopping and looking around by wayfinder during wayfinding were executed to confirm the correctness of the decision and the path taken by the users' during navigation. This implies that verbal direction and signage were significant in assisting the users when they encounter wayfinding difficulties during navigation.

4.2.2: Interview Results

The results of the interview are presented in matrix, using cells and columns. Similar concepts were merged in order to obtain the core concept of the theme.

4.2.2.1 Understanding building arrangement in the hospital wayfinding

The respondents were asked about how they understand the building arrangement in getting to the desired destination in the hospitals. The responses and experiences of the respondents were considered, analysed and interpreted (See Table 4.6). The alphabets in capital letters indicate the coding of themes while the numbers were the count of themes recurring in all the responses.

Table 4.6: Opinion on building arrangement

Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation
Theme: Building layout ***Simple to understand (**11**)*** ***Stressful (**1**)*** ***Complex (**14**)*** ***Confusing (**11**)*** ***Difficult to**	(A) Simple to understand /not complex (**12**)* (B)Complex/difficult to understand (**15**)* (C) Confusing (**11**)* (D) Stressful (**1**)* (E) Very easy to understand /access /Ok (**14**)* (F) Well planned /functional buildings (**1**)*	Simple to understand : A, E, F, **(27)*** (R24, R46) Complex to understand, confusing and stressful : B, C, D, G & H = **(29)*** (R10, R19)	More than half of the respondent agreed that the building layout was complex to understand, confusing and stressful to unfamiliar. **Core concept:** Complexity

understand (1**)** ***Arranged according to function (1)*** ***Very easy to understand (**6**)*** ***Very easy to access (3)*** ***Very big and one can get lost (**1**)*** ***Not as complex (**1**)*** ***Well planned buildings (**1**)*** ***Long corridor distance (1)*** ***Very ok (**5**)*** ***Sparse layout (**3**)***	(G) Very big and one can get lost (**1**)* (H) Long corridor distance (**1**)* (I) Sparse layout (**3**)*

*Frequency of count of concepts in bracket & bold; Alphabets in capitals indicate coding (A, B, C ...H)

Source: Researcher's work, 2018

The main trend of opinion in Table 4.6 in column three shows that 51.8% revealed that the complexity of the building layout made wayfinding difficult to understand, causes confusion and stress on the patients in the hospitals. In the interview the respondents mentioned complexity of building layout. For example, this was buttressed by some respondents as shown in the following quotes: *''the building arrangement was complex to understand''* *(R10);* ''*Hospital buildings were complex'' (R19).* This shows that the majority of the patients had wayfinding difficulty in the hospitals because the respondents were unfamiliar with the hospital environment. Most of the respondents were one or two time visitor in 12 months to the hospitals. However, some users' opined that the building layout was simple to understand for easy wayfinding fairly less than half mentioned simplicity. The quotes from some of the respondents buttressed the point which was as follows: *''the building arrangement is simple and not confusing'' (R24); ''It is quite simple and accessible'' (R46)*. This suggests that the respondents were familiar with the hospital environment.

4.2.2.2 Form of available aids for wayfinding

The respondents were asked on the form of available assistance that aided wayfinding in the hospitals. Table 4.7 shows the analysis.

Table 4.7: Forms of assistance for wayfinding

Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation
Theme: Available aid ***Verbal direction from the receptionist (**20**)*** ***Personnel assisted by verbal direction (**2**)*** ***Use signs and symbols on the doors to describe destination (**5**)*** ***Verbal direction from the staff (**17**)*** ***None (**7**)*** ***No assistance noticed (**4**)***	(A) Verbal direction from the staff/personnel /receptionist (**39**)* (B) Use of signs and symbols (**5**)* (C) No assistance noticed (**11**)*	A = **(39)*** (R4, R27) B = (**5**)* (R7, R15) C = (**11**)*	Majority of the respondents used verbal direction as form of assistance. **Core concept:** Verbal direction

*Frequency of concept counts; Source: Researcher's work, 2018

The main forms of assistance that aided wayfinding reveal that majority of the respondents mentioned that verbal direction from staff was used in finding direction to the desired destination in the hospital (See Table 4.7). For instance, some of the respondents' quotes buttressed the findings shown in italics as follows: *‘’I received verbal direction from the staff’’ (R4)*; *‘’I used verbal direction’’ (R27).* This suggests that the majority of the respondents could not use the signage and other environmental cues properly in the hospitals. However, few respondents’ states that they used directional signs in finding destinations in the hospitals and the quotes from the respondents were as follows: ‘*‘directional signs to access all the departments’’ (R15)*. ‘*’I used description and signs’’ (R44)*. The majority of the respondents could not read and interpret the signs and other environmental cues due to the level of their educational background. As such, the respondents resulted into asking people for verbal direction. As such, the hospital stakeholders’ needs to improve on wayfinding aids in the hospital, such aids like maps, directional signs, landmarks at decision point, and mobile interactive systems could be provided to improve on wayfinding.

4.2.2.3 Kind of wayfinding information used in the hospital

The respondents were asked of the kind of wayfinding information used in the hospital. The responses were analysed and the core concept was established as shown in Table 4.8.

Table 4.8: Kind of wayfinding information

Theoretical framework: Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation

Theme: Wayfinding information ***Signs and symbols (11)*** ***Ask people (11)*** ***Verbal direction (27)*** ***Names of wards (5)*** ***Door post (2)***	(A) Ask people for verbal direction (38) (B) Signs and symbols/names of wards/door post (18)	A = **(38)*** (R17, R32) B = **(18)*** (R8, R29)	The forms of assistance were mainly verbal direction and signage. **Core concept:** Verbal direction and signage

*The numbers is the frequency of count of concepts; Source: Researcher's work, 2018

Table 4.8 reveals that majority of the respondents used verbal direction as the main kind of information for wayfinding in the hospitals. This is buttressed by some respondents' excerpts which were as follows: *''I ask people for direction'' (R17); ''I ask people for direction in the hospitals'' (R32).* This implies that the majority of respondents had challenges in obtaining information from the environmental cues for wayfinding. However, few respondents used signage in the form of directional and destination signs and symbols as wayfinding information. The quotes from the respondents were as follows: '*'Names of wards are being written on the entrance wall of each building'' (R8);* ''Names of wards encrypted on the walls of the buildings'' (R29). This implies that few of the respondents could read the signs because of the level of formal education.

4.2.2.4 Important features used in hospital wayfinding

The respondents were asked of the important features used in hospital wayfinding that serves as environmental cues. Table 4.9 revealss the analysis of their responses and the emergence of the core concept.

Table 4.9: Important features in wayfinding

Theoretical framework: Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation

Theme: Landmarks ***Signs and symbols** (19) ***ATM stand, (3)** ***The position of building in relation to another (2)** ***Names boldly written at the entrance** (1) ***Use trees as landmark (2)** ***No features apart from the buildings (4)** ***Flowers as important features (3)** *** Overhead tank** (1)	(A) Signs/names/ symbol = signage **(28)*** (B) ATM stand, **(3)*** (C) The position of building in relation to one another = **(2)*** (D) Use trees as landmark **(1)*** (E) Flowers as important features **(3)*** (F) No features apart from the buildings **(4)*** Overhead Tank **(1)*** Parking Lot (1)	(A) Signage **(39)*** (R1, R16) (B) ATM stand, overhead tank **(3)*** (C) Trees and flowers **(4)*** (R2, R7) (D) Staircase **(8)***	The major landmarks used were signage. **Core concept:** Signage

***Signpost & stairways (**16**)**
***Sculpture, fountains & sign post** (1)
***Height of the building (1)**
Parking Lot (1**)**

Source: Researcher's Field Work, 2018

Table 4.9 reveals that the majority of the respondents agreed that signage were a prominent feature in hospital wayfinding. The quotes from some of the respondents support the claim which states as follows: *''the important features that aid my movement in the hospital were signs and symbols'' (R1); ''Pictographs and signpost on the wall and the door post'' (R36).* This implies that the signage were legible as landmarks. However, some patients identified ATM stand, trees, flowers and overhead tank as landmarks for wayfinding. For instance, '*'I used the ATM stand at the entrance for landmarks'' (R27); ''Signs and symbols, but I used the tree in front of the GOPD building to direct me'' (R22).* This implies that features such as ATM stand and trees were prominent as landmark for wayfinding.

4.2.2.5 Use of signage in hospital wayfinding

The respondents were asked how signage has been used in hospital wayfinding. Table 4.10 shows the content analysis and the emergent core concept. Similar concepts were merged and interpreted.

Table 4.10: Use of signage in destination location

Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation
Theme: Signage ***Reading signs and symbols for direction (28)**	(A) Reading signs/ symbols for direction **(28)***	A, B, D, and E = **(41)*** (R8, R9) C = (**1**)*	The main trend was to look, read and use the signage. **Core concept:**

***Looking / observing the directional signage (6)** ***I was directed (1)** ***Following the signs (4)** ***Some building names were abbreviated (1)** ***I did not use signage / cannot read (6)** ***I see, read and look at the signage, very useful (2)**	(B) Looking / observing the directional signage **(6)** (C) I was directed (1) (D) Following the signs (**4**) (E) Some building names were abbreviated (**1**) (F) I did not use signage **(4)** (G) I cannot read (2) (H) I see, read and look at the signage, very useful (**2**)	F = (**2**)* G = (**2**)* H = (**2**)* Look and read both directional and destination signs	Look and read the signage

*Frequency of count of concepts; Source: Researcher's work, 2018

The main trend in Table 4.10 reveals that the majority of the respondents look at the signs, read it and uses the signage to locate destinations. For instance, the excerpts from some of the respondents buttressed the claim as follows: ''*I see, read and look at the signage, very useful, the ward M has the picture of a pregnant woman drawn, I could locate it'' (R8);* ''*I follow the directional signs, the labels on the doors are small to notice'' (R20).* This infers that the wayfinding behaviour of the respondents on how they use signage was by looking and reading the signs and follow directions. However, some respondents did not use signage. This was because they could not read it or the signage was not properly placed in the right position. For example, the quotes from the respondents support the claim as follows: ''*I did not use the signage really, because when I entered the first time I did not see anything like signage. The signage was not seen because they were not placed where they can be seen easily'' (R14).* This implies that the legibility and the correct placement of the signage in the right position are significant for its use.

4.2.2.6 Influence of building entrance on wayfinding

The respondents were asked concerning the influence of building entrance on wayfinding in conditions of accessibility and visibility. Table 4.11 reveals the analysis and the emerging core theme.

Table 4.11: Influence of Building entrance on wayfinding

Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation
Theme**:** **Building entrance** **Help to direct me to destination (4)** **Makes wayfinding easy (6)** **It does not help (2)** **Good/strategic location for easy movement /access (8)** **Easily noticed (9)** **Centrally placed for easy accessibility (9)** **Linked directly to the receptionist (4)** **Difficult to notice (1)**	(A) Help to direct me to destination / makes wayfinding easy (**10)*** (B) It does not help (**2**)* (C)Good/strategic/Central location for easy_movement /access **(26)*** (D) Entrance gives a wider vision/visibility to destination (**7**)* (E) Linked directly to the receptionist (**4**)* (F) Difficult to notice (**1**)* (G) Confusing entrance **(1)*** (H) Do not know (**1**)* (I) A lot of people at the entrance (**4**)* (J) Visibility of destination from entrance (**5)***	A, C = **(36)*** (R2, R7) B = **(2)*** D, J = **(12)*** E = **(4)***	The main trend was the easy accessibility of the building entrance. **Core concept:** Easy accessibility

Confusing entrance (1)

Do not know (1)

A lot of people at the entrance (4)

Visibility of destination from entrance (5)

*The bold numbers indicate the frequency of count of concepts; Source: Researcher's work, 2018

The majority of the respondents' stated that the building entrance was easily accessible as shown in Table 4.11. The easy accessibility of the building entrance was due to its central location to the desired destination. For example, this is buttressed by the quotes from some of the respondents as follows: *''the entrance of the building is placed for easy accessibility, so, it really helped me to find my destination.'' (R14); ''the building entrance is located such that I could access almost everywhere I want to reach as destination'' (R44)*. This suggests that the central location of the building entrance influences the visual visibility and access to various destinations in the hospitals. In addition, a well designed layout needs to allow users who embark on wayfinding to have an obvious optical understanding on entering a setting, towards viewing numerous features and their relations.

4.2.2.7 Influence of lighting on wayfinding

Table 4.12 shows the emerging themes and concepts from the transcript of responses from the participants when the question was raised on the influence of lighting on wayfinding. The use of content analysis was employed to establish the core concept. The alphabets in capital letters indicate the coding of themes while the numbers were the count of themes recurring in all the responses. The emerging similar themes were merged in column three of the table.

Table 4.12: Influence of lighting on wayfinding

Theoretical framework: Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation
Theme: Lighting ***All corridors/pathways are well lit** (3) ***Adequate lighting aid me to see the writings on**	(A) All corridors are well lit **(3)** (B) Adequate lighting aid me to	A, E, G = **(11)*** B, D, F, H **= (32)*** C = (**7**)* (R5, R6)	The main trend was that lighting enhances visibility and ease access to destinations.

the walls and doors /easy access to destinations (9**)** *** Lighting does not influence my movement** (7) ***Lighting helps me to see sign post better (**21**)*** ***Very okay (**6) ***Help enhance visibility (**1**)** ***Lighting ease movement (**2**)** ***Lighting brightens the corridor (**1**)**	see the writings on the walls and doors and in easy access to destinations (**9**) (C) Does not influence my movement (**7**) (D) Lighting helps me to see a sign post better **(21)*** (E) Lighting was very okay (**6**) (F) Help enhance visibility (**1**) (G) Lighting ease movement (**2**)* (H) Lighting brightens the corridor **(1)**	*Lighting was okay = **11** *Enhance visibility = **32**	**Core concept:** Enhance visibility

*The bold numbers indicate the frequency count of concepts.
Source: Researcher's work, 2018

The main trend of opinion in Table 4.12 reveals that the majority of the respondents agreed that lighting influence effective wayfinding as it helps the users to see better and enhance ease access to destinations. The quotes from some of the respondents support the findings as follows: *''the lighting in the circulation space lightens up the place so I was able to access the destination without stress'' (R12); ''the lighting was helpful and aids my visibility to the destination'' (R29).* This suggests that adequate lighting in the hospital influence greatly the effectiveness of wayfinding in the hospitals.

4.2.2.8 Influence of colour in wayfinding

The respondents were asked about how the use of colour has influenced wayfinding in hospital building. The responses from the participants were analysed and core concept was established as shown in Table 4.13. All the main themes were stated in column one. In column two, the themes were coded using capital alphabets and similar themes were merged together in column three.

Table 4.13: Colour influence on wayfinding

Theoretical framework: Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation

Theme: Colour influence ***Same colour for the building does not help (27)** ***Colours are all the same (17)** ***The bright colours make movement easy (2)** ***Does not know (1)** ***Difficult to identify (1)**	(A) Does not help me **(27)*** (B) Colours are all the same (**17**)* (C) The bright colours make movement easy (**2**) (D) Does not know (**1**) (E) Difficult to identify (**1**)	A & B = **(44)*** Colours are the same and does not help (R1, R12) (C) The bright colours make movement easy (**2**)* (R8, R15)	The main opinion was that colour has no effect in wayfinding. . **Core concept:** No effect

*The bold numbers indicate the frequency of count of concepts and the alphabets in capital indicates coding
Source: Researcher's field work, 2018

The result reveals that the majority of the respondents stated that colour has no effect in wayfinding (See Table 4.13). The excerpts from some of the respondents that support the claim are as follows: *''external wall colour does not help me in moving to the desired destination'' (R1); ''Colour of buildings is the same, it has no effect in finding my destination'' (R19).* This implies that similar external wall colour for buildings in hospitals do not influence effective wayfinding to the desired destination. Accordingly, functions in the hospital be zoned and each zone be differentiated with different colour which provide a framework to the layout for effective wayfinding.

4.2.2.9 Wayfinding experience in the hospitals

Table 4.14 illustrates the content analysis of the responses from the respondents when asked about the wayfinding experiences to the desired destination in the hospital. Accordingly, core concept emerged from the analysis and was interpreted.

Table 4.14: Wayfinding experience

Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation

Theme**:** **Wayfinding experience** ***Difficult, got confused (**7**)** ***Seek for help for direction (**35**)** ***Was easy because I used signs and symbols (**4) ***Frustrating and stressful** (8) ***Was not easy , too many buildings (**1**)** ***It was complex (**1**)** ***Do not know (**1)	(A) Difficult, got confused **(7)** (B) Seek help for direction **(35)** (C) Was easy because of sign & symbols used **(4)** (D) Frustrating and stressful **(8)** (E) Was not easy, too many buildings **(1)** (F) It was complex **(1)**	A, B, D, E, F = **(52)*** Complex & stressful (R7, R12) C = **(4)*** Easy (R5, R8)	Complex and stressful, however, some users found the wayfinding experience easy due to use of signs. **Core concept:** Complex and stressful

*The bold numbers indicate the frequency of count of concepts; Source: Researcher's work, 2018

The result demonstrates that the majority of the respondents stated that wayfinding experience in the teaching hospitals were complex and stressful (See Table 4.14). This is buttressed by the quotes from some respondents as shown in the following excerpts*: ''...it was complex because at some point I could not locate the staircase I had to ask for direction to the staircase'' (R14); ''It was a bit stressful'' (R20); Yeah! For the first time, it was a little difficult to locate my destination'' (R36).* Consequently, it suggests that most of the users were first time visitors to the hospital and were unfamiliar with the hospital environment. As such, the complexity of the building layout caused wayfinding difficulties and stress to the hospital users.

4.2.2.10 Wayfinding barriers in the hospitals

The participants were asked about the wayfinding barriers encountered in the hospitals. The responses were analysed using content analysis and core concept was established as shown in Table 4.15.

Table 4.15: Wayfinding barriers

Identifying themes	Indexing: coding and merging similar issues	Charting: Data abstraction and summary	Mapping and Interpretation
Theme**:** **Wayfinding barriers** ***Far distance to walk (**6) *** Some confusing Signs and symbols (**2**)** *** Too many stairs causes confusion** (8) ***Dark lobbies (**1) ***No barriers observed (**11**)** ***Similarity of building colours confuses one. (**5)	(A) Far distance to walk **(6**)* (B) Confusing Signs and symbols (**2**) (C) Too many stairs causes confusion (**8**) (D) Dark lobbies (**1**) (E) No barriers observed (**11**)* (F) Similarity of building colours confuses one (**5**)	A = **(6)*** B = (**2**)* C = (**8**)* D = (**1**)* E = **(11)*** F = (**5**)* G = (**2**)* H = **(16)*** I **= (5)** **C & H = 24 Crowdedness**	Crowd in the hallway was the main barrier in the hospital. **Core concept:** Crowdedness

***Many junctions and turns. (**2**)**	(G) Many junctions and turns (**2**)
.Crowd in the hallway. (16**)**	(H) Crowd in the hallway **(16)***
Complexity of buildings. (5**)**	(I) Complexity of buildings (**5**)

The number shows the frequency of count of concepts; Capital letters indicate coding
Source: Researcher's work, 2018

The main trend of opinion in Table 4.15 illustrates that the majority of the respondents agreed that the crowd in the hallway was a barrier to effective wayfinding to destinations. The result shows that respondents visited the GOPD during the clinical peak period. The quotes from some of the respondents that support the claim were in italics as follows: *''there are many people in the hallways and at the corridors at peak periods which makes the hospital crowded and causes confusion in finding destinations'' (R25); ''the heavy human traffic in the corridor cause obstruction to movement on busy days'' (R56).* This suggests the width of the corridors and hallways should be wide enough and seats provided to avoid people hanging around the walkways in the hospitals. However, some respondents mentioned far distance, complexity and confusion signage as a barrier in the buildings.

4.2.2.11 Summary of findings under qualitative interview data

The summary of all the findings under qualitative data (interviews) are as follows: The building layout was found to be complex to understand which causes uncertainty and anxiety to unfamiliar users of the hospital environment. This implies that complexity in hospital environment could cause difficulty and stress during wayfinding. The result supports other findings that the complexity of the building plan has the capacity to negatively impact on wayfinding process (Devlin, 2014). The result also corroborates the findings that the complexity of the building plan decreases wayfinding performance by affecting the wayfinder's aptitude to comprehend the spatial associations and the passage systems inside a building (Passini, 1996; Abu-Ghazzeh, 1996; Baskaya *et al.,* 2004; Dogu & Erkip 2000; O'Neill 1991a, 1992; Peponis, *et al.*, 1990; Werner & Schindler, 2004).

The qualitative data (interview) found that verbal direction was the main form of wayfinding assistance in the teaching hospitals. This finding supports the study by Passini (1984b) which found that numerous visitors at the reception asked for wayfinding direction that helped people with their wayfinding. Also, the study by Huelat (2007) corroborates the findings that people in a hospital setting felt at ease enquiring staff for wayfinding guidance. This implies that hospital staff at the reception should be properly trained and encouraged to be friendly to visitors in giving verbal direction.

The interview data found that signage was used as the main landmark at decision points in hospital wayfinding. This result corroborates the findings of other researches that textual signage, directional signs, and bold graphics used as landmarks at decision points have been shown to positively improve wayfinding performance (O'Neill, 1991a; Tzeng & Huang, 2009). This infers that textual signage should be translated into local languages and pictographs for better understanding of signage, and to improve wayfinding performance in the hospital.

Also, the qualitative data of the study found the building entrance easily accessible. The result of other research in wayfinding found that visual access in hospital building entrance was capable of reducing uncertainty and stress during wayfinding (Montello, 2014). This suggests that the hospital building entrance should be conspicuous, visible and accessible to users to improve wayfinding.

Besides, the interview data found lighting to have enhanced visibility of patients in hospital pathways and cues during wayfinding. As such, lighting could improve wayfinding performance. The study of Hidayetoglu *et al* (2012) found that the rise in the brilliance echelon of space absolutely correlates with optimistic intuition of space during wayfinding.

Additionally, the interview data result shows that the use of wall colour for hospital wayfinding has no effect during navigation due to similarity of external wall colours. Also, interior wall colour strips were found to be confusing. The studies by Bennett (2009) caution the use of colour to aid wayfinding in hospital due to individual differences in understanding colour types. However, the findings of other researches revealed that colour could provide significant support for wayfinding (Salmi, 2006; Smith, 2008).

The interview data result found crowdedness as a barrier in hospital wayfinding. Similarly, the study of Dogu & Erkip (2000) found crowdedness to have impacted on an individual's aptitude to recollect a building and its position. Likewise, Salmi (2007a) argued that a crowded environment suggest complexity and could also offer a lot of visual or sensory motivation, causing complexity in giving concentration to suitable wayfinding data in the hospital. This implies that crowd control is significant in hospital wayfinding design.

4.2.3 Method triangulation of findings

The quantitative and qualitative data analysed in objective one with survey questionnaire and interviews were triangulated to check consistency of findings. In order words, the triangulation provides confirmation and completeness of findings which reveals the similarities and differences of the findings. Consequently, the implicit and explicit meanings underlining the findings were established in the succeeding sections.

4.2.3.1 Building layout in wayfinding

The major quantitative findings reveal that the building layout was ranked the fifth variable that made wayfinding difficult to navigate due to the complexity of the hospital environment (See 4.2.1.7 and 4.2.1.13). The core concept as finding from the semi- structured interview was the complexity of the building layout which made wayfinding stressful to navigate (See Table 4.6). The word complexity was mentioned by the majority (51.8%) of the respondents as the core concept for building layout relative to how the respondents understand the building arrangement. Accordingly, the findings from semi-structured interview corroborate the findings from quantitative data used to explore the opinion of the respondents on the understanding of the building layout during wayfinding. This was because the majority (80%) of the respondents' had visited the hospital either once or twice in the last 12 months and was unfamiliar with the hospital buildings. However, few respondents mentioned the theme simplicity relative to understanding of the building layout. This implies that the respondents were familiar with the hospital building layout and had visited the hospitals more than two times in 12 months.

4.2.3.2 Landmarks used for wayfinding

The quantitative findings demonstrate that majority of the respondents (79%) ranked differentiated building as landmark as the second most influential variable in wayfinding performance (See 4.2.1.2). This was because the buildings that were differentiated in height, size, shape and colour became prominent for patients and as such serves as landmarks. However, qualitative findings reveal divergent results from quantitative findings as the signage was the core concept in the interview and the most influential variable used as landmarks in hospital wayfinding (See Table 4.9). The theme signage was mentioned by the majority of the respondents as landmarks. However, some patients mentioned differentiated buildings, stairways, ATM stand, overhead tank, and trees as landmarks which accounted for 41% respondents. The users that identified signage as landmarks had formal education above secondary school and as such could read the signage. Conversely, the users that used differentiated building and other features within the hospital as landmarks had difficulty in reading the sign because they had no formal education, thus, resulted in the use of prominent building as reference point.

4.2.3.3 Use of signage for wayfinding

In quantitative findings, majority of the respondents (77%) agreed that signage was ranked first as the most influential variable for hospital wayfinding (See 4.2.1.1 and 4.2.1.8). The qualitative findings from semi-structured interview reveal that the majority of the respondents mentioned the concept of reading signs as a core concept relative to how participants use signage in hospitals (See Table 4.10 and 4.2.2.9). Accordingly, the qualitative result on signage corroborates the quantitative findings as a significant variable that influences the ease of wayfinding. This implies that signage was a significant variable to hospital wayfinding.

4.2.3.4 Visual access from building entrance for wayfinding

The quantitative findings from the survey questionnaire reveal that visual access was ranked ninth and second in environmental and architectural factors respectively in which majority (71%) of the respondents agreed that visual access was one of the most influential variables for wayfinding (See 4.2.1.5 and 4.2.1.9). The qualitative findings from the interview demonstrate that the majority of the respondents mentioned easy accessibility as the core concept for visual access from building entrance in hospital wayfinding (See Table 4.11). As such, the findings from the interview confirm the findings from the survey questionnaire.

4.2.3.5 Use of lighting and colour for wayfinding

The use of lighting for wayfinding was ranked the third influential variable by the majority (74%) of the respondent in the survey agreed that lighting influence the ease of wayfinding (See Table 4.4 and 4.2.1.10). Similarly, the qualitative result from interview shows that majority of the respondents mentioned enhanced visibility as the core concept for the use of lighting in wayfinding (See Table 4.12). Consequently, the qualitative result substantiates the quantitative finding which implies that signage and pathways were adequately illuminated.

In the quantitative findings, the majority of the respondents (68%) agreed that wall colour strips was ranked tenth influential variable for hospital wayfinding (See Table 4.4, Subsections 4.2.1.12). However, qualitative findings from the semi-structured interview contradict the findings from the survey questionnaire. This was because the theme no effect was mentioned by the majority of the respondents in the interview as the core concept due to the fact that all the buildings were painted the same colour (See Table 4.13). Also, some patients had difficulty following the wall colour strips to destinations due to turns and the vertical movement to the upper floor of the buildings.

4.2.3.6 Form of assistance in hospital wayfinding

The findings from the survey questionnaire reveal that verbal direction was ranked the thirteenth influential variable as the one of the wayfinding aids in the hospital (See Table 4.3). This demonstrates that majority (69%) of the respondents agreed that verbal direction was one of the variables used for wayfinding (See Subsection 4.2.1.16). The qualitative results from the interview reveal that majority of the respondents mentioned verbal direction as the core concept in the form of assistance used in hospital wayfinding which confirms the quantitative findings (See Table 4.7). This was because majority of the respondent has difficulty reading the directional maps and had to use verbal direction. This implies that the hospital staff needs to be trained to humbly and effectively guide users to the desired destinations.

4.2.3.7 Wayfinding experience in hospital buildings

The quantitative result from the survey questionnaire shows that stressfulness and getting lost were ranked first and second with weighted mean value of 3.43 and 3.02 respectively as influential variables in wayfinding experience factor in hospital buildings (See Table 4.5). This implies that the majority (between 76% and 86%) of the respondents agreed that hospital environment was stressful and one can get lost respectively due to its complexity (See subsection 4.2.1.14 and 4.2.1.15). Similarly, the qualitative result from interview illustrates that the majority of the respondents mentioned stressfulness as the core concept for wayfinding experience in the hospital (See Table 4.14). Accordingly, the qualitative result corroborates the quantitative finding which implies that the hospital environment was complex to navigate during wayfinding.

4.2.3.8 Barriers in hospital wayfinding

In the quantitative findings, the majority (70%) of the respondents agreed that crowdedness at circulation space impedes on hospital wayfinding (See 4.2.1.14). The qualitative result from interview shows that few of the respondents mentioned crowdedness as a barrier in hospital wayfinding as the core concept (See Table 4.15). Consequently, the interview result confirms the finding from the survey questionnaire. This implies that there is need to control crowd by giving enough width in the circulation spaces and adequate waiting areas in the hospital as unfamiliar users tend to be confused at the emergency and outpatient departments where a lot people usually gathered at clinical peak period. However, some respondents identified too many staircases, intersection of paths (nodes), confusing signs, and complexity of the buildings as barriers to hospital wayfinding. All the themes mentioned in the qualitative findings emerged from the study.

4.3 Critical Factors Influencing Wayfinding

The objective two was to examine the critical factors for wayfinding in hospital building. As such, the Principal Component Analysis (PCA) was employed to explore the degree to which the survey items on each factor were associated with the construct and the components of the construct that capture wayfinding. This was achieved by analyzing the PCA of each factor such as the spatial (environmental), architectural and wayfinding experience factors. The interpretation of which was used to extract the variables that most contribute to wayfinding, using rotation method of the loadings (the correlation between individual variables and the Principal Components) to identify clear patterns. Thereafter, multiple regression analysis was conducted to establish the attributes that most predict wayfinding performance indicators (Pallant, 2011).

4.3.1 Environmental factor in wayfinding

The PCA technique was used to transform the original variables in the environmental factor into a lesser set of linear combination that capture all the variances in the variables been used in order to produce an experiential synopsis of the data set (Pallant, 2011). There were 18 survey items on the environmental factor in wayfinding that were analysed on the PCA with the aid of SPSS version 23. The sample size of 374 was adequate for the analysis as it was above the recommended 150+ with a ratio of 17 cases for each of the variables (Constantin, 2014; Pallant, 2011). The data was assessed for its suitability for factor analysis by running correlation matrix (≥ 0.3 threshold) which revealed that there were many variables with coefficients of 0.3 and above (See Appendix N). Also, the Kaiser-Meyer-Olkin (KMO) had value of 0.710 which was greater than the threshold of 0.6 and above (Kaiser 1974 cited in Pallant, 2011) and Bartlett’s Test of Sphericity (BTS) which was statistically significant at

0.000 less than the p value criterion of < 0.05 (See Table 4.16). Hence, factor analysis was suitable.

Table 4.16: KMO and Bartlett's Test for environmental factor

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.710
Bartlett's Test of Sphericity	Approx. Chi-Square	1064.665
	Df	153
	Sig.	.000

Source: Researcher's work, 2018

Table 4.17: Principal Component Analysis (PCA) for environmental factor

	Check: KMO ≥ 0.6;	BTS ≤ 0.05	**Component Matrix: Loading ≥ 0.4**		**Total Variance Explained (Initial Eigenvalue > 1)**		**Rotated Component Matrix ≥ 0.4**	
					% of variance	Cum. %	Comp.	Loading
B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11, B12, B13, B14, B15, B16, B16, B17, B18	0.710	0.000	B11	.592	18.453		B3	.854
			B12	.587	10.035		B4	.814
			B10	.541	8.946		B13	.753
			B14	.531	7.138		B12	.718
			B13	.531	6.030		B11	.610
			B2	.523	5.736	56.34	B10	.589
							B14	.524

Source: Researcher's work, 2018

In the Total Variance Explained in Table 4.17, the PCA revealed the presence of 6 components with the Initial Eigenvalue greater than 1, explaining the percentage of variance 18.5%, 10.0%, 8.9%, 7.1%, 6.0%, and 5.8% in each component. These six components explained the variance of a total of 56.34% cumulative (See Appendix V).

In addition, the Scree plot graph (See Figure 4.1) shows a break (elbow like) after the 2nd component and a large break up to the 6th component. From the large break, the eigenvalue begin to level off by appearing horizontal and the remaining attributes were cosidered not to contribute much to wayfinding. Accordingly, two components were assumed to be meaningful and retained for rotation.

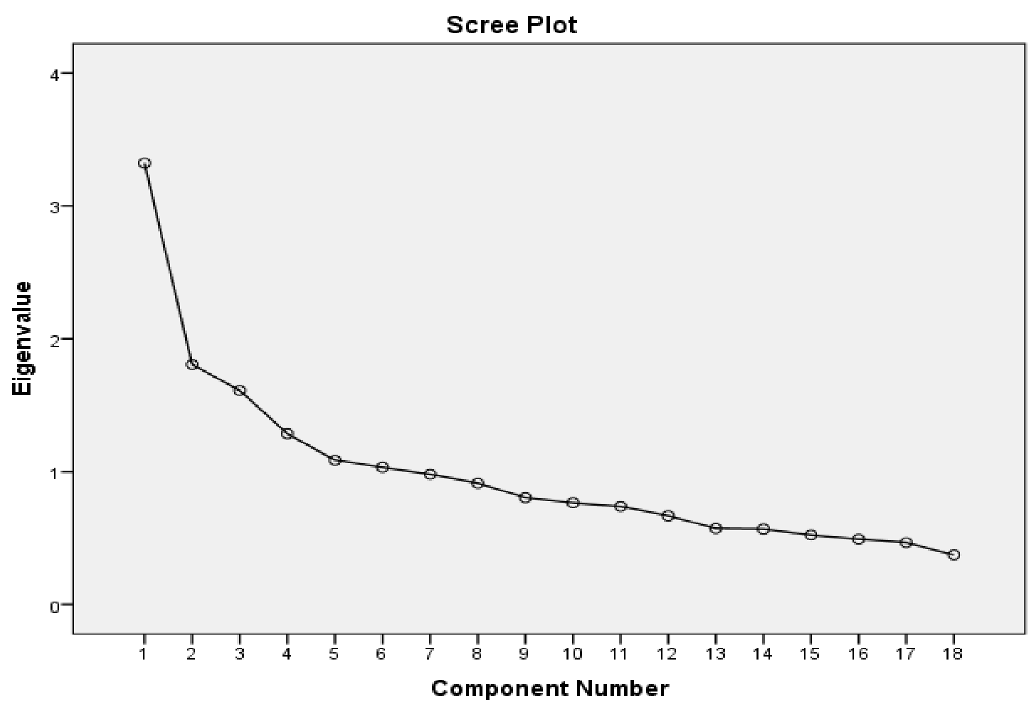


Figure 4.1 Scree plot for environmental factor

Source: Researcher's work, 2018

The Component Matrix (See Table 4.17, 3rd column) shows the unrotated loadings with six items loading quite strongly above the threshold of 0.4 in the 1st column of the component. This suggests that the six components (B11, B12, B10, B14, B13, and B2 as coded) were the wayfinding solutions extracted that were likely to be more appropriate to predict wayfinding. However, the variables were subjected to further analysis of rotation.

Subsequently, Oblimin rotation component matrix was performed which presents the Pattern Matrix and the Structure Matrix columns as shown in Appendix U the (See Table 4.17, 5th column). The components that were more strongly correlated and had a coefficient above 0.4 criteria were compared with each other in the first two columns and were extracted. Hence, the following components were retained in the first and second columns: B13, B12, B11, B10, B14, B3, and B4 (7 items). The findings of the analysis uphold the exploit of the retained attributes in environmental factor as a common solution to wayfinding in hospitals.

The rotated variable demonstrates simple structure with relatively high factor loading on only one component and near zero loading on the second component. The extracted variables from the rotation were named from the questionnaire as follows; B11 = Path for circulation, B12= Edges (path boundaries), B10 = important building (Landmark), B14 = Circulation junction (Nodes), B13 = Districts (Area), B3 = important trees, and B4 = important shrubs. The five variables in the first component were on the Lynch's (1960) 'image-ability' concept of wayfinding while the two variables of the second component were on a different concept, which was the use of landscape for wayfinding. Table 4.18 shows the extracted variable code, name and their factor loading.

Table 4.18 Extracted variables summary for environmental factor

Component	Code	Variable name	Factor loading
1	B3	Important trees (Landmark)	0.854
2	B4	Important shrubs (Landmark)	0.814
3	B13	Districts (Area)	0.753
4	B12	Edges (path boundaries)	0.718
5	B11	Path of circulation	0.610
6	B10	Important building (Landmark)	0.589
7	B14	Circulation junction (Nodes)	0.524

Source: Researcher’s work, 2018

4.3.2 Architectural factor in wayfinding

There were 15 survey items on the architectural factor in wayfinding that were analysed on the PCA with the aid of SPSS version 23 on the same sample size of 374. The data was assessed for its fitness for factor analysis by running correlation matrix (≥ 0.3 threshold) which revealed that there were many variables with coefficients of 0.3 and above (See Appendix W). Also, Table 4.19 shows that the Kaiser-Meyer-Olkin (KMO) had a value of 0.698 which was greater than the threshold of 0.6 and above (Kaiser 1974 cited in Pallant, 2011) and Bartlett's Test of Sphericity (BTS) which was statistically significant at 0.000 less than the p value criterion of < 0.05. Therefore, factor analysis was appropriate based on the values obtained for KMO and BTS.

Table 4.19: KMO and Bartlett's Test for architectural factor

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.698
Bartlett's Test of Sphericity	Approx. Chi-Square	634.727
	Df	105
	Sig.	.000

Source: Researcher's work, 2018

Table 4.20: PCA for architectural factor

Variables and Indicators	Check: KMO ≥ 0.6	BTS ≤ 0.05	Component Matrix: Loading ≥ 0.4	Total Variance Explained (Initial Eigenvalue > 1)	Rotated Component Matrix ≥ 0.4

					:% of variance	Cum. %		Loading
	0.698	0.000	A9	.588	18.848		A6	.815
			A2	.570	10.142		A12	.739
A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15,			A8	.533	8.526		A1	.655
			A10	.529	7.474		A13	.591
			A7	.494	7.030		A2	.548
			A1	.473	6.852	58.872	A3	.412
			A3	.467				
			A14	.450				
			A13	.405				
			A6	.617				
			A4	.417				

Source: Researcher’s work, 2018

Table 4.20 illustrates that the variable were adequate for the factor analysis with KMO = 0.70 (0.698) and BTS = 0.00 above the criterion. The PCA also revealed the presence of 6 components with the Initial Eigenvalue greater than 1, which had the Total Variance Explained as 18.85%, 10.14%, 8.53%, 7.47%, 7.03%, and 6.85%. These six components explain variance cumulatively as 58.87% (See Appendix W).

In addition, the Scree plot graph (Figure 4.2) shows adequacy of PCA with a break (elbow like) after the second component up to the 6th component where it level off. Accordingly, two components were retained for further investigation.

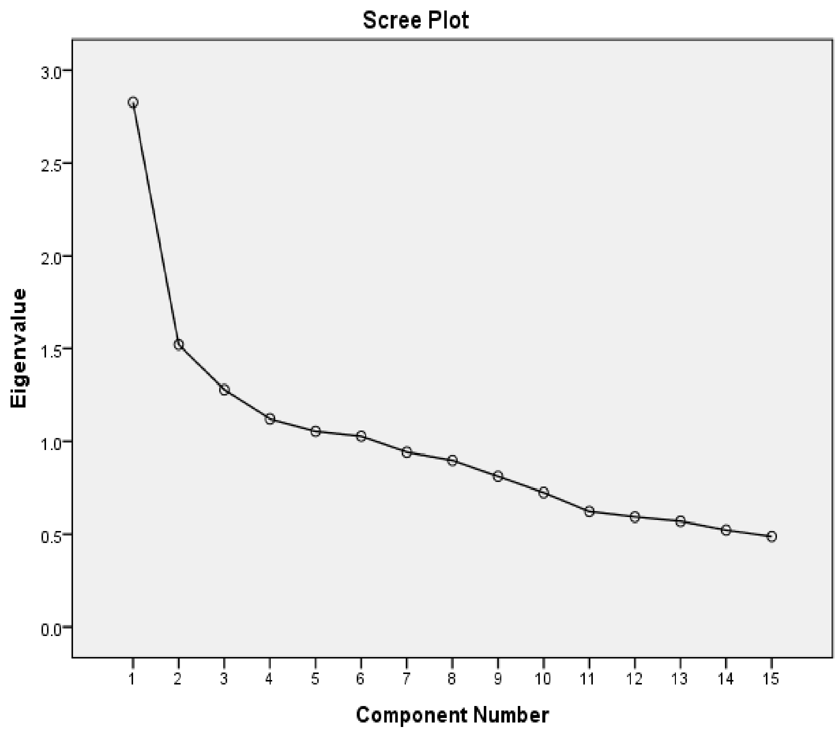


Figure 4.2: Scree plot for architectural factor
(Source: Researcher's work, 2018)

The component Matrix (See Table 4.21) shows the unrotated loadings with six items loading quite strongly above the threshold of 0.4 and another five items loaded relatively fair in the large break presented in the first and second column. This suggests that the six components (A9, A2, A8, A10, A7, A1, A3, A14, A13, A6, and A4 as coded in Appendix W) solutions were extracted and was likely to be more appropriate. Further analysis was done using rotation method.

Subsequently, Oblimin rotation was performed which presents the Pattern Matrix and the Structure Matrix columns in the Appendix X. The components that were more strongly correlated and had a coefficient above 0.4 criteria were extracted and compared with each other in the first and second components. Hence, the following components were retained: A1, A13, A2, A3, A6 and A12 (6 items). The findings of the analysis uphold the exploit of the retained attributes in architectural factor as a common solution to wayfinding in hospitals. The extracted variables coded above were named from the questionnaire as follows: A1= Building entrance, A13 = Seats in circulation (furniture), A2 = Floor plan arrangement, A3 = Circulation spaces, A6 = Patients around circulation (crowd), and A12 = Corridor intersection. Also, the extracted item solution was satisfactory as more than three items had significant loading on the first component and they shared the same conceptual meaning which is the use of circulation. The Appendix X shows the items with high factor loadings that correlate weakly near zero loading on the second component. Table 4.21 illustrates the extracted variable and their factor loading.

Table 4.21 Extracted variables summary for architectural factor

Component	Code	Variable name	Factor loading
1	A6	Patients around circulation (crowd)	0.812
2	A12	Corridor intersection	0.739
3	A1	Visual access from Building entrance	0.655
4	A13	Seats in circulation (furniture)	0.591
5	A2	Floor plan configuration	0.548
6	A3	Circulation spaces	0.412

Source: Researcher's work, 2018

4.3.3 Wayfinding experience factor in hospital

There were 15 survey items on the wayfinding experience factor that were analysed on PCA with the aid of SPSS version 23. The same respondents of sample size were 374 which were adequate for the analysis as it was above the recommended 150+ with a ratio of 15 cases for each of the variables (Constantin, 2014; Pallant, 2011). The data were assessed for its suitability for factor analysis by running correlation matrix (≥ 0.3 threshold) which revealed that there were many variables with coefficients of 0.3 and above (See Appendix P). Also, the Kaiser-Meyer-Olkin (KMO) had a value of 0.672 which was greater than the threshold of 0.6 and above (Kaiser 1974 cited in Pallant, 2011) and Bartlett's Test of Sphericity (BTS) which was statistically significant at 0.000 less than the p value criterion of < 0.05 (See Table 4.22). Therefore, factor analysis was suitable.

Table 4.22: KMO and Bartlett's Test for wayfinding experience factor

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.672
Bartlett's Test of Sphericity	Approx. Chi-Square	903.931
	Df	105
	Sig.	.000

Source: Researcher's work, 2018

Table 4.23: Principal Component Analysis (PCA) for wayfinding experience factor

Variables and Indicators	**Check:** KMO ≥ 0.6	BTS ≤ 0.05	**Component Matrix: Loading ≥ 0.4**		**Total Variance Explained (Initial Eigenvalue > 1)** :% of variance	Cum. %	**Rotated Component Matrix ≥ 0.4** Comp.	Loading
WF1, WF2, WF3, WF4, WF5, WF6, WF7, WF8, WF9, A10, WF11, WF12, WF13, WF14, WF15	**0.672**	**0.000**	WF11	.695	20.105		WF10	.866
			WF14	.590	11.342		WF5	.791
			WF3	-.587	9.952		WF8	.777
			WF10	.575	7.958		WF13	.685
			WF12	.569	7.281		WF11	.586
			WF13	.512	7.040	**63.678**	WF4	.533
			WF7	.459			WF3	.468
							WF12	.429

Source: Researcher's work, 2018

In the Total Variance Explained, Table 4.23 indicates that the PCA revealed the presence of 6 components with the Initial Eigenvalue greater than 1, explaining 20.11%, 11.34%, 9.95%, 7.96%, 7.28%, and 7.04% of variance. These six components explain variance of a total of 63.68% cumulative (See Appendix Y).

In the Communalities, the criterion of value ≥ 0.6 was used. As such, the items that were greater than or equal to 0.6 were retained (See AppendixY). This provides information on how much of the variance in each item was explained. Accordingly, nine variables were retained in the Communalities Table.

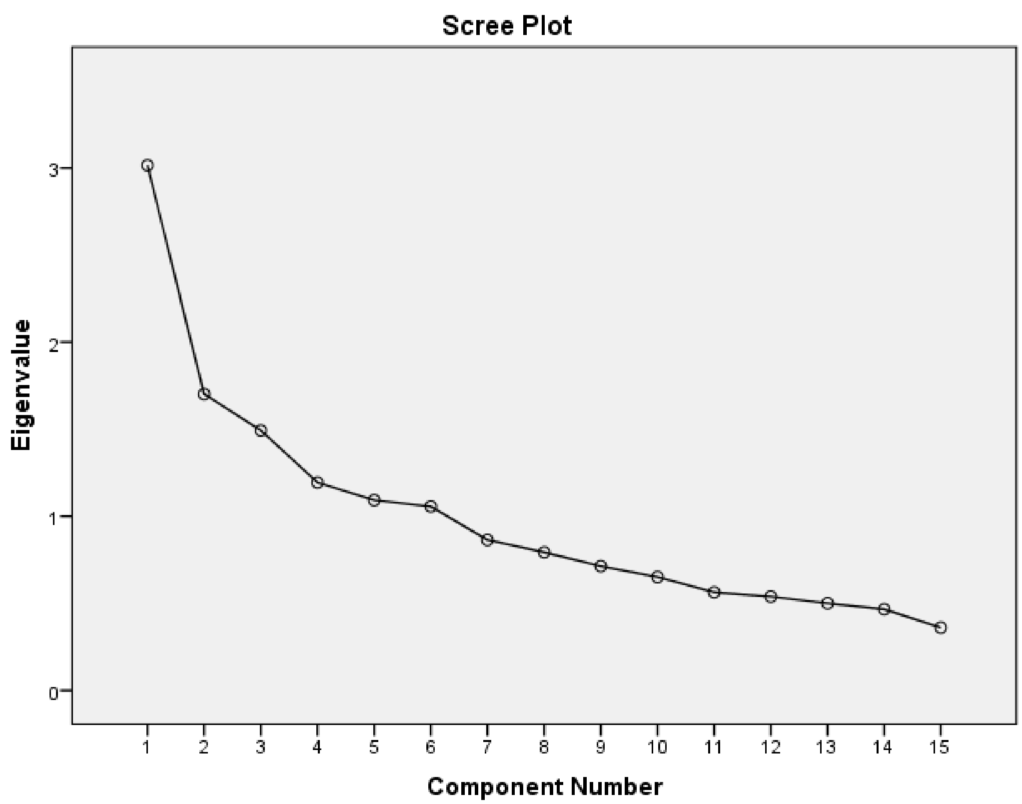


Figure 4.3 Scree plot for wayfinding experience factor

Source: Researcher's work, 2018

In addition, the Scree plot graph (Figure 4.8) shows a break (elbow like) after the second component with large break up to the sixth component until it level off. Accordingly, two components were retained for further investigation.

The Component Matrix shown in Table 4.23 illustrates the unrotated loadings with seven items loading quite strongly above the threshold of 0.4. This suggests that the seven components (WF11, WF14, WF3, WF10, WF12, WF13, and WF7 as coded) extracted provides wayfinding solutions that were more likely to be appropriate to predict wayfinding. Subsequently, Oblimin rotation was performed which presents the Pattern Matrix and the Structure Matrix columns in the Appendix Z. The components that were more strongly correlated and had a coefficient above 0.4 criteria in the Pattern matrix column were compared with each other in the first and second columns and were extracted.

Hence, the following components were retained based on their loadings: WF10, WF13, WF11, WF12, WF5, WF8, WF4, and WF3 (8 items). The findings of the analysis support the use of the retained attributes in wayfinding experience factor as a common solution to wayfinding in hospitals. The extracted variables coded above were named as follows: WF10 = Directional signs at decision points (0.866), WF5 = Stopped to read signs (0.791), WF8 = Missed your way (0.777), WF13 = Visible circulation paths (0.685), WF11 = Directional signs (0.586), WF4 = Stopped to ask for direction (0.533), WF3 = Difficulty in finding a way (0.468) and WF12 = Destination signs (0.429). Similarly, the extracted item solution was satisfactory as more than three items had significant loading on the first component and they shared the same conceptual meaning which is the use of signage. However, on the second component, the retained items were on a different conceptual meaning that deals with the wayfinding behaviour in the hospital.

The Appendix Z shows the items with high factor loadings of eigenvalue 1 correlates weakly near zero loading on the second component with negative value which was used to confirm the rotated retained items. This implies that the variables on first and second components measure different concepts which support the earlier rotated retained items. Table 4.24 illustrates the outline of the extracted variables for wayfinding experience variables with factor loading for further analysis.

Table 4.24 Extracted variables summary for wayfinding experience factor

Component	Code	Variable name	Factor loading
1	WF10	Directional signs at decision points,	0.866
2	WF5	Stopped to read signs,	0.791
3	WF8	Missed your way	0.777
4	WF13	Visible circulation paths	0.685
5	WF11	Directional signs	0.586
6	WF4	Stopped to ask for direction	0.533
7	WF3	Difficulty in finding a way	0.468

8	WF12	Destination signs,	0.429

Source: Researcher's work, 2018

4.3.4 Multiple regression results

The regression results are presented according to the wayfinding factors. Consequently, the emerging results are the critical indicators for effective wayfnding in hospital buildings in the North Cetral Nigeria.

4.3.4.1 Regression results for environmental factor

Prior to the main analysis, preliminary analyses were performed to guarantee that there was no breach of the suppositions of normality, linearity, multicollinearity and homoscedasticity. In the Appendix Q the independent variables (IV's) did not show much relationship with the dependent variable (DV) as the correlations were between 0.111 and 0.25 which were less than $r > 0.3$ threshold. In addition, the relationship between the independent variables (IV's) were between 0.013 and 0.483 less than the threshold of $r < 0.7$ recommended by Pallant (2011). Consequently, the collinear relationships between the variables were low. This implies that the IV's were measuring different constructs.

Also, the Normal P-P plot in Figure 4.4 shows that major points reasonably lie in the diagonal straight line from the base left to the apex right. In addition, the scatter plots in Figure 4. 5 revealed the residuals were fairly rectangular in distribution, with the majority of the scores intense in the centre. This implies that there was no outlier, and that all assumptions of multicollinearity, normality and linearity were not violated, suggesting that multiple regression was appropriate.

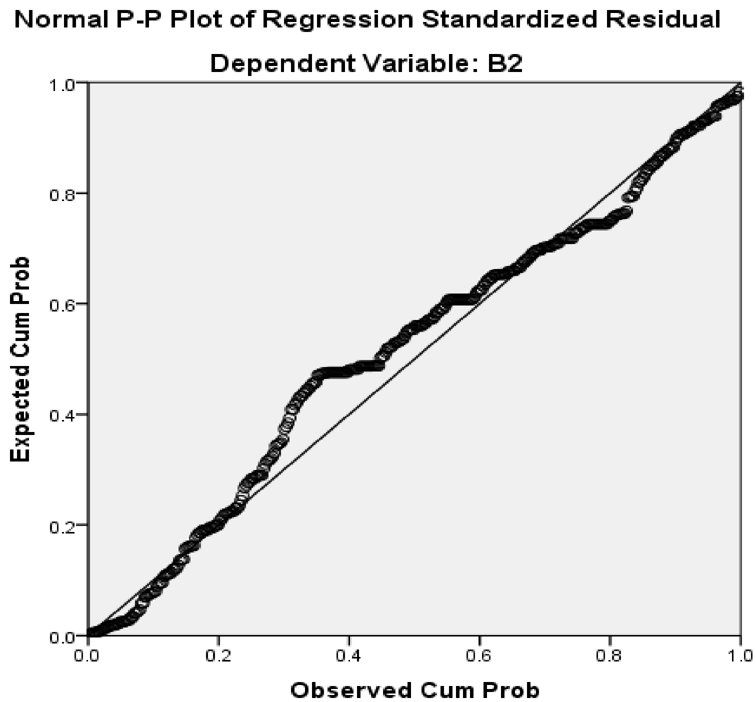


Figure 4.4 Normal P-P Plot of Regression for environmental factor

Source: Researcher's work, 2018

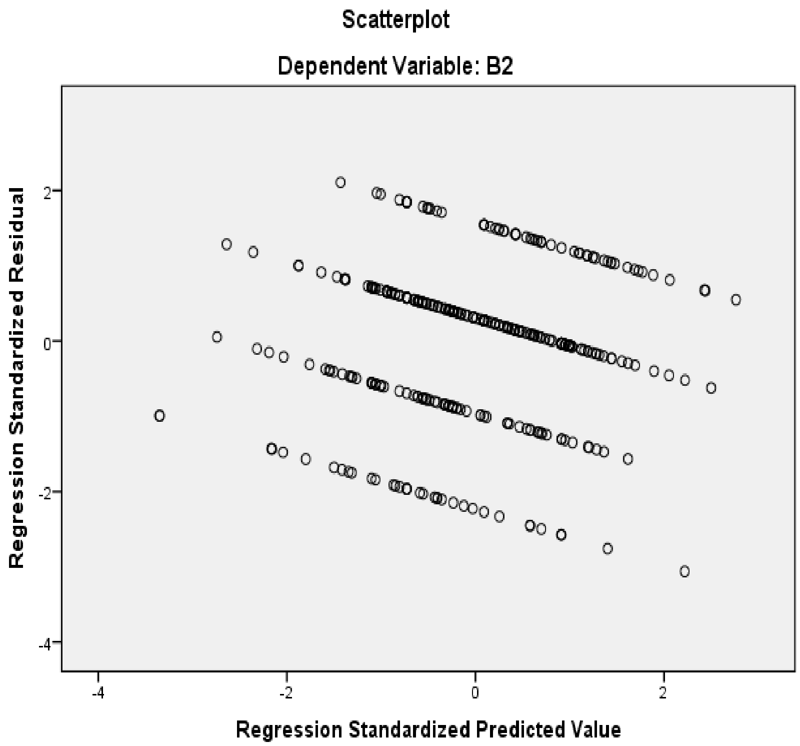


Figure 4.5: Scatter plot for environmental factor

Researcher's work, 2018

Table 4.25: ANOVA[a] for environmental factor

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	31.882	7	4.555	7.361	.000[b]
	Residual	226.460	366	.619		
	Total	258.342	373			

a. Dependent Variable: B2

b. Predictors: (Constant), B14, B4, B11, B10, B12, B3, B13; Source: Researcher's work, 2018

The findings of the regression in the Table 4.25 (ANOVA) indicates that the sig. value p = 0.000, F (7, 366) = 7.36 less than the threshold of p value of 0.05 shows the goodness of fit of the model to the data. This means that the regression shows a strong relationship that significantly predicts wayfinding performance.

Table 4.26: Model Summary[b] for environmental factor

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.351[a]	0.123	0.107	0.787

a. Predictors: (Constant), B14, B4, B11, B10, B12, B3, B13
b. Dependent Variable: B2 (Use of building as landmark)
Source: Researcher's work, 2018

In Table 4.26, the model indicated that R Square was 12.3% (R^2 = 0.123), which was the percentage of the degree of the variance in the dependent variable explained in the model. However, the R-squared was low, but the p value of 0.000 (i.e. less than the threshold of 0.05) shows the goodness of fit of the model to the data. The R-squared was low because it predicts human behaviour which is harder to predict than physical processes, but adding more data and calculating the effect size could improve the R-squared and provide a better fit for the model (Hoyt *et al.,* 2006). In addition, the researchers asserted that regardless of the R-squared, the significant coefficients still symbolise the mean change in the reaction for one part of variation in the predictor. Accordingly, it suggests that the model was relatively a good predictor of the wayfinding performance (B2). Where, B2 is the use of important buildings (landmark) for finding a desired destination in the hospital. The coefficient table (See Appendix Q) with the column labelled 'B' was the value of the dependent variable, B2 = 1.157, Std error estimates = 0.257, t = 4.494, Sign. 0.000.

In the final model as shown in the coefficient, Appendix Q, only one variable made a unique statistically significant contribution less than 0.05 in the environmental factor for wayfinding, which was B3. This variable was stated in order of Sig. (p- value) and the beta values, such as B3 = ($p < 0.000$, 0.254), as shown in the Appendix Q. The standardized (beta) value was used for application. Where, B3 = Use of trees to identify direction. Therefore, the model obtains the form of a statistical equation where: $Y = \beta_0 + \beta_1 X_1$. Thus,

Y symbolises the result variable, wayfinding performance with the use of landmark.

X_1 = B3 represents the predictor variable.

4.3.4.2 Regression results for architectural factor

The check for the assumptions of the architectural factor was carried out. The Normal P-P plot in Figure 4.6 shows that major points reasonably lie in the diagonal straight line from the base left to the apex right. In addition, the scatter plots in Figure 4. 7 revealed that the residuals were distributed fairly in rectangular, with the majority of the scores intense in the centre. This implies that there was no outlier, and that all assumptions of multicollinearity, normality and linearity were not violated, suggesting that multiple regression was appropriate.

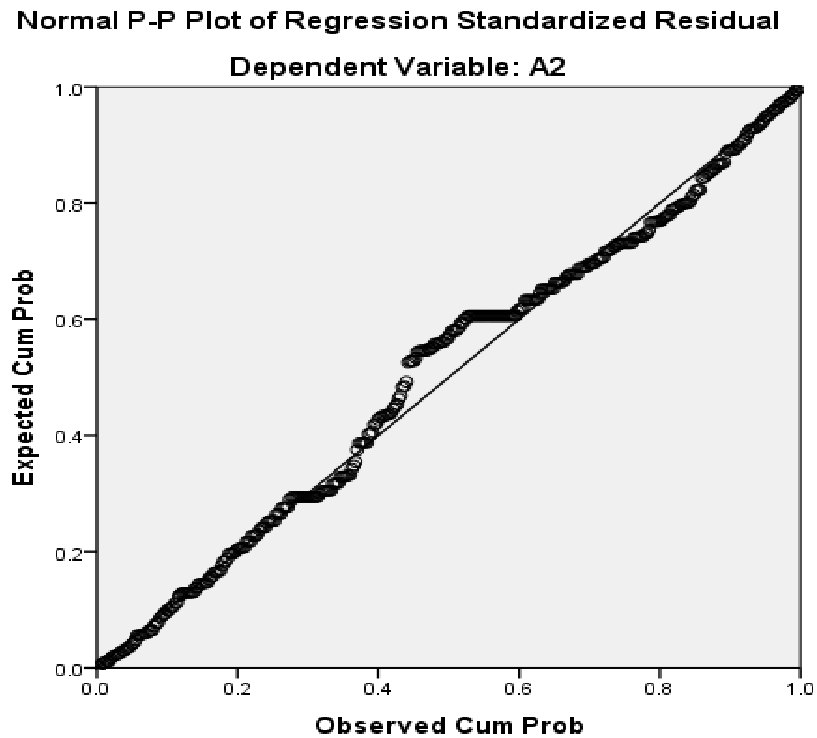


Figure 4.6: Normal P-P Plot of Regression for architectural factor

Source: Researcher's work, 2018

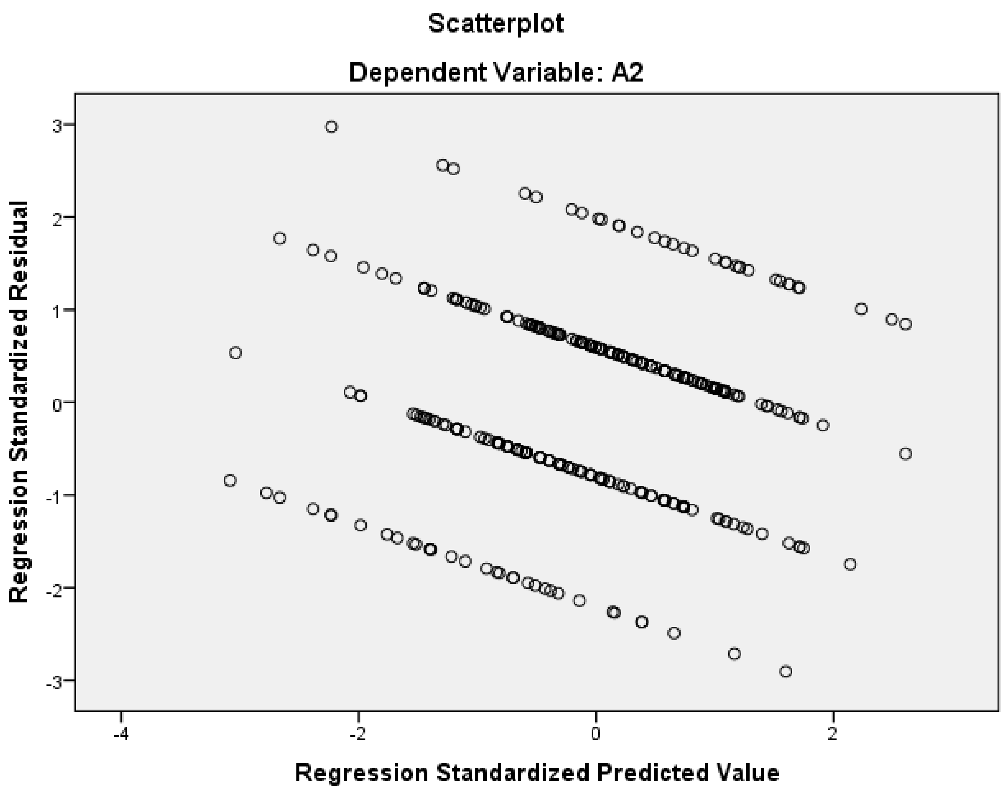


Figure 4.7: Scatter plot for architectural factor

Source: Researcher's work, 2018

Table 4.27: ANOVA[a] for architectural factor

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	37.082	5	7.416	14.492	.000[b]
	Residual	188.322	368	.512		
	Total	225.404	373			

a. Dependent Variable: A2

b. Predictors: (Constant), A13, A6, A3, A1, A12; Source: Researcher's work, 2018

The findings of the regression in the Table 4.27 (ANOVA) indicates that the sig. value p = 0.000, F (5, 368) = 14.492 less than the threshold of p value of 0.05 which shows the goodness of fit of the model to the data. This means that the regression significantly predicts wayfinding performance.

Table 4.28: Model Summary[b] for architectural factor

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.406[a]	.165	.153	.715

a. Predictors: (Constant), A13, A6, A3, A1, A12
b. Dependent Variable: A2
Source: Researcher's work, 2018

In Table 4.28, the model indicated that R Square was 16.5% ($R^2 = 0.165$), which was the percentage of variance explained in the model and illustrates a strong association. This implies that the model was relatively a good predictor of the wayfinding performance of the dependent variable (A2). Where, A2 was the floor plan configuration makes wayfinding simple to understand the desired destination in the hospital.

In the coefficient table in Appendix R, in the column labeled B, the dependent variable, A2 = 1.995, Std error estimates = 0.237, t = 8.404, Sign. 0.000. In the final model, only four variables made a unique statistically significant input less than 0.05 in the architectural factor for wayfinding, which were A1, A3, A6, and A12. These variables were stated in order of Sig. value (p- value) and the beta values, such as A1 = ($p < 0.000$, $\beta = 0.228$), A3 = 0.000; $\beta = 0.219$; A6 = ($p < 0.046$, $\beta = 0.100$), and A12 = 0.011; $\beta = 0.128$ as shown in Appendix

R. The standardized (beta) value was used for application in the development of the conceptual framework. Where, A1, was the easy identification of building entrance in the hospital; A3, was easy direction finding in the circulation space (pathways); A6, was that too many patients (crowd) around the circulation space disturb the ease of wayfinding; and A12, states that corridor intersection makes wayfinding difficult in the hospital (nodes). Therefore, the model obtains the form of a statistical equation where: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$. Thus,

Y represents the outcome variable, wayfinding performance with the use of pathways to destinations in the hospital.

X_1 = A1 symbolises the first predictor variable

X_2 = A3 symbolises the second predictor variable

X_3 = A6 symbolises the third predictor variable

X_4 = A12 symbolises the fourth predictor variable

4.3.4.3 Regression analysis for wayfinding experience factor

The check for the assumptions of the architectural factor was carried out. The Normal P-P plot in Figure 4.8 shows that major points reasonably lie in the diagonal straight line from the bottom left to the top right with little deviations from the central line. In addition, the scatter plots in Figure 4. 9 revealed that the residuals were rectangularly distributed fairly, with the majority of the scores concerted in the centre. This implies that there was no outlier, and that all assumptions of multicollinearity, normality and linearity were not violated, suggesting that multiple regression was appropriate.

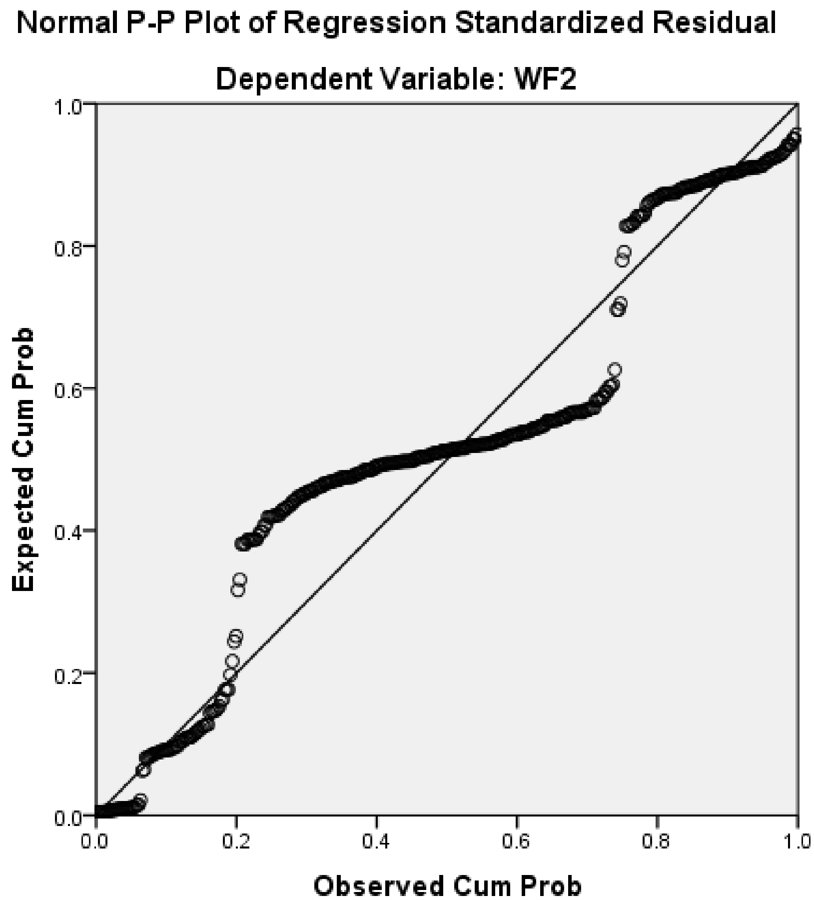


Figure 4.8: Normal P-P Plot of Regression for waayfinding experience

Source: Researcher’s work, 2018

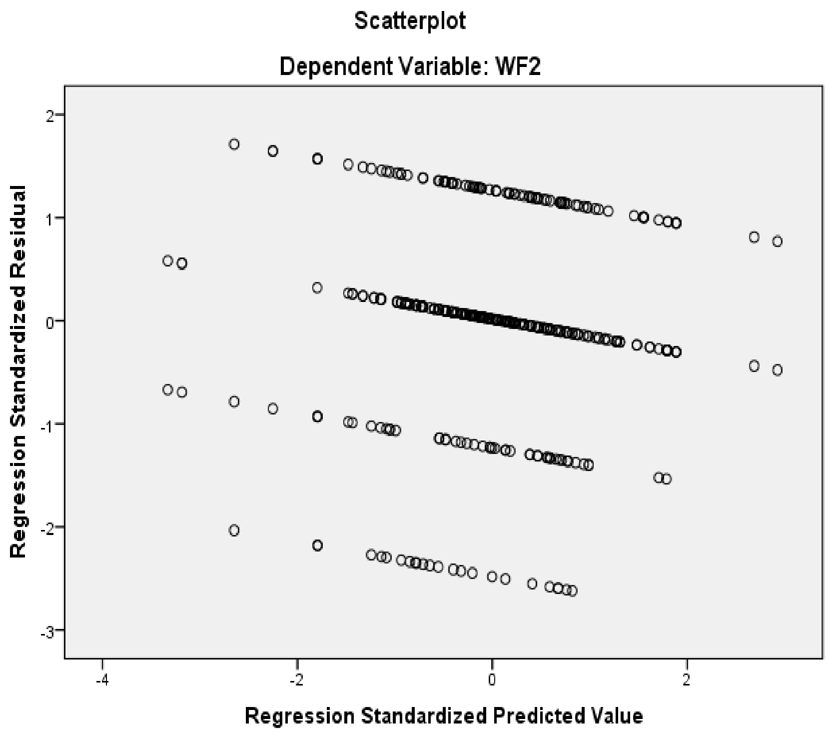


Figure 4.9: Scatter plot for waayfinding experience

Source: Researcher’s work, 2018

Table 4.29: ANOVA[a] for wayfinding experience factor

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.839	8	.855	1.333	.226[b]
	Residual	234.094	365	.641		
	Total	240.933	373			

a. Dependent Variable: WF2, Source: Author, output from SPSS

b. Predictors: (Constant), WF13, WF8, WF12, WF3, WF4, WF5, WF10, WF11

Source: Researcher’s work, 2018

The results of the regression in the Table 4.29 (ANOVA) indicates that the sig. value p = 0.226, F (8, 365) = 1.333 greater than the threshold of p value of 0.05 which illustrates that the finding was not statistically significant in the model. This means that the data for the regression did not significantly predict wayfinding performance.

In Table 4.30, the model indicated that R Square was 2.8% ($R^2 = 0.028$), which was the percentage of variance explained in the model and shows a weak relationship. As a result of the significant value of 0.226 this was above the threshold (i.e. $p \leq 0.05$). This implies that the model was relatively a bad predictor of the wayfinding performance of the dependent variable (WF 2). Where, WF 2 was to get lost on the way to the desired destination in the hospital. The coefficient in Appendix S column 'B' on the dependent variable, WF2 = 3.226, Std error estimates = 0.284, t = 11.377, Sign. 0.000.

Table 4.30: Model Summary[b] for wayfinding experience factor

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.168[a]	.028	.007	.801

a. Predictors: (Constant), WF13, WF8, WF12, WF3, WF4, WF5, WF10, WF11

b. Dependent Variable: WF2

Source: Researcher's work, 2018

In the final model, only two (2) variables completed a distinctive statistically significant input to the forecast of the dependent variable which was less than 0.05 in the wayfinding experience factor for wayfinding performance. The Appendix S (Coefficient) shows that the variables which were stated in order of importance of the beta value, this includes: WF3 = ($p < 0.018$, $\beta = -0.139$), and WF4 = ($p < 0.041$, $\beta = 0.119$). The standardized (beta) values were used for application. Where, WF3 = having difficulty in finding the way in the hospital, WF4 = Stopped more than twice to ask for direction in the hospital. Therefore, the model obtain the shape of a statistical equation where: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2$. Thus,

Y symbolises the result variable, WF2, getting lost in the hospital in wayfinding performance

X_1 = WF3 symbolises the first predictor variable
X_2 = WF4 symbolises the second predictor variable

Consequently, the established critical factors for wayfinding in the hospitals obtained from the analysis are highlighted as follows:

- B3: the use of trees as landmarks to recognize the direction in wayfinding, (0.854)
- A6: crowd in the circulation space disturbs wayfinding (0.812)
- A12: the corridor intersection (nodes) makes wayfinding difficult in the hospital (0.739)
- A1: Visual accessibility of the building entrance (0.655)
- WF4: stopped more than twice to ask for direction in the hospital (verbal direction) (0.533)

- WF3: having difficulty in finding the way within the hospital (complexity) (0.468)
- A3: easy direction finding in the circulation space (path), (0.412)

4.4 Effectiveness of Hospital Wayfinding

In response to ojective three, the effectiveness of wayfinding performance in the hospitals was concerned with task accomplishment, such as success or failure during wayfinding through systematic observation. In order to eliminate biasness in the observational studies, the principal researcher, and two research assistants were involved in the observation of the physical settings using a standardised observation schedule in all the four sites selected. The collected data were compared and harmonized for analysis. In the analysis, observation of the physical setting was carried out by taking notes of the environmental cues obtained from the literature that were present in the hospital buildings for wayfinding and were seen being used by patients. An effective wayfinding is based on human behaviour with the goal to create a comprehensive, understandable and consistent visual communication system that has a concise message by showing the relevant information at the appropriate decision points (Jibestream, 2014). The efficiency in the navigation of the hospital by the users' determines the wayfinding success. The analyses were mainly descriptive for all the observations.

Furthermore, the observation of the physical setting was analysed using domain analysis of spaces. This involves a systematic identification of the environmental cues of the observed spaces for wayfinding in the hospital (Kuliga, 2016). Hence, the researcher and the assistants used observation schedule in the assessment of the setting by ticking the observed variables used by patients in the schedule, and photographs of the setting were taken. The observation schedule was used for the spatial legibility of the variables in the setting which were assessed on being legible, not legible, and not available in the setting. Spatial legibility implies whether the variable was recognized or not by patients during navigation (Koseoglu & Onder, 2011). Also, not legible means the environmental cue was present but not recognized or used as wayfinding aid by the users. Similarly, other variables were assessed on the degree of influence and usefulness of the environmental cues on wayfinding. The influence of the cues refers to the extent to which it controls the sense of direction of the wayfinder. Also, the usefulness of a cue is the extent it helps the user in wayfinding (Paul, 2013).

To know the degree of legibility of environmental cues and route choice at path junctions, the perceived legibility scales were used for the assessment onsite. It was done for four destinations from GOPD main entrance to accident and emergency (A & E), radiology, pharmacy, and laboratories in the study area with the help of 16 subjects (four in each hospital). The legibility parameters used by Kang *et al.* (2017) in wayfinding were adopted because it measured the same variables of the study. Those parameters for the assessment of environmental cue legibility includes perceptual gaps in identifying the direction of destination, difficulty of route choice in the intersections, possibility of choosing a false path at intersections, and the recognition rate of the destination. In addition, the process of obtaining spatial information in the environment depends on the characteristics of the space and that of the observer. Therefore, the observation was done for the physical setting and the patients. As such, the spatial variables of legibility depend on recognisability of buildings and the spatial configuration in terms of its complexity (Baskaya *et al.,* 2004).

In addition, the spatial attributes of patients' route travel were observed by the researcher in the selected destination areas. The number of directional change in patient's route was counted and the distances of the route of entry to destinations were measured. Besides, the signage on the walls was described in terms of the information it provided on its legibility level (clarity and consistency for the identification of direction and destination) during wayfinding. The type of landmark provided was described. The users' travel behaviour was described in terms of the number of stops, the looking around, asking for direction, and the number of backtracking within the navigation.

4.4.1 Observation of the physical settings for Case study one (A)

The site plan or the building layout, pictures and patients wayfinding behaviour were used in the analysis of the observation of the Teaching Hospitals. The buildings and patients were the unit of analysis assessed in the hospital. The on-site physical observation of the buildings and the site plan were analysed. In case study A, the researcher observed that the floor plan configuration was symmetrically laid out with courtyards and open spaces that facilitate natural ventilation and lighting of the interior buildings (See Figure 4.10). The building plan shape and building layout were legible, with a conspicuous building entrance, which enhances visual access (See Plate I). The architectural differentiation influences the ease of wayfinding in the hospital (Researcher's observation). For instance, the consultancy block which house the family medicine clinic and the theatre with wards were three storey buildings (See Plate II & Plate IV), the General Out-patient Department, GOPD, (See Plate I), the laboratory, Accident and Emergency (Plate III), and the physiotherapy buildings were two storey buildings while the radiology department was a bungalow**.**

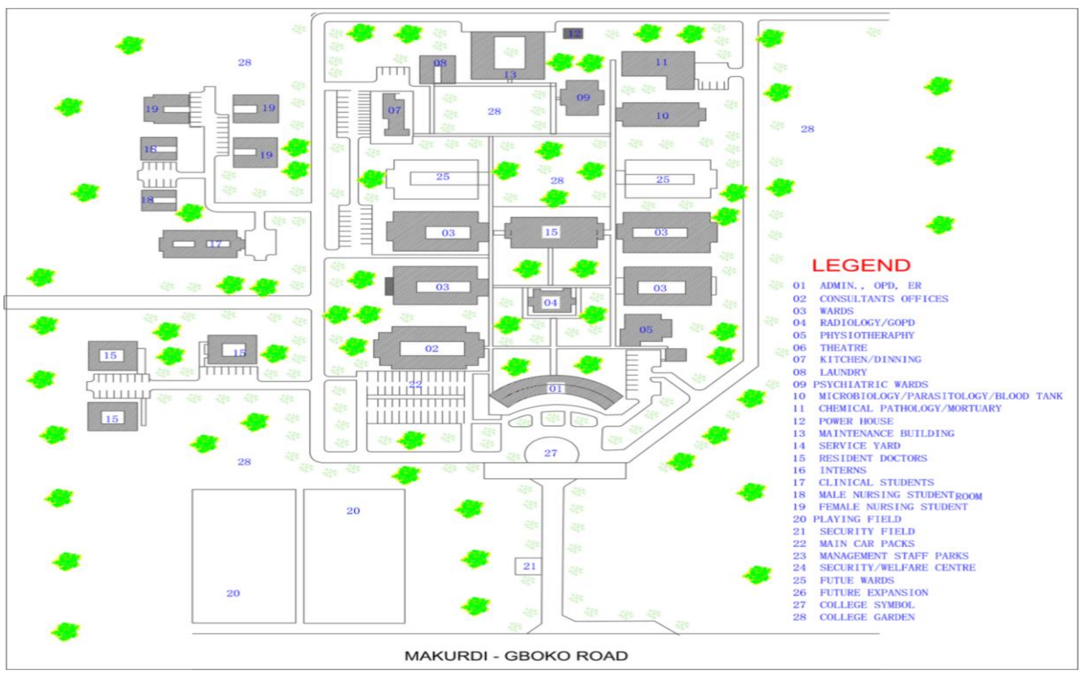


Figure 4.10: Site layout (Benue State University Teaching Hospital, Makurdi

Plate I: GOPD Main entrance (BSUTH)

Plate II: Family medicine clinic (BSUTH)

Plate III: Accident &Emergency (BSUTH)

Plate IV: Consultancy & wards (BSUTH, Makurdi)

4.4.2 Observation in case study Two (B)

The physical setting in case study two has asymmetrical floor plan configuration (See Figure 4.11). The studied area consists of the NHIS, the GOPD's, the Pharmacy, the Accident and Emergency (A & E) the X-ray and laboratory department (See Figure 4.12). The detail observation of the setting was recorded in Table 4.31. The NHIS and the wards were 1-storey building. The wards were located behind the GOPD's, X-ray and theatre in the layout (See Figure 4.12). From the approach was parking and the Administrative block of the hospital and behind it was the GOPDs'.

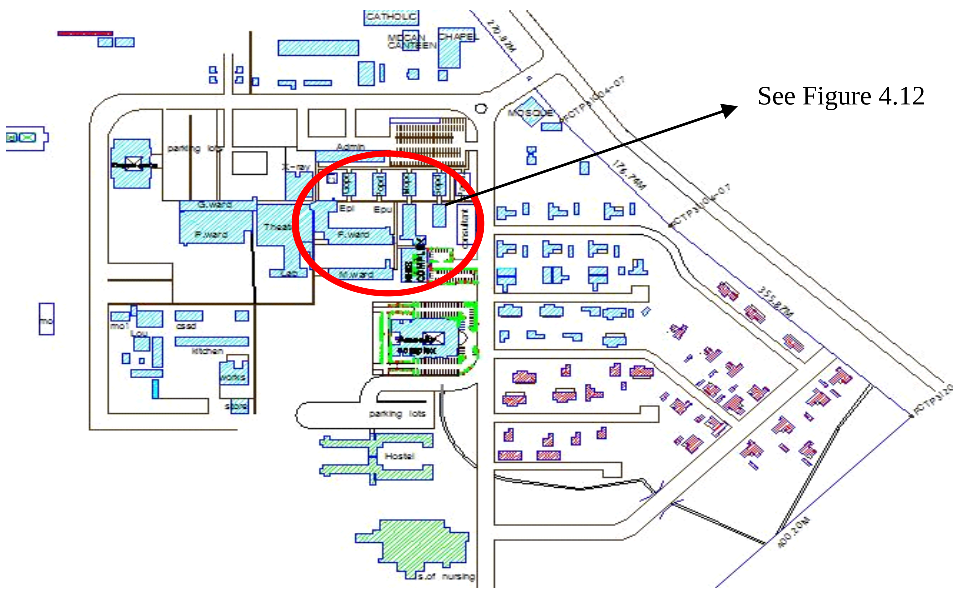


Figure 4.11: The layout of University of Abuja Teaching Hospital
Source: Researcher's field work, 2018

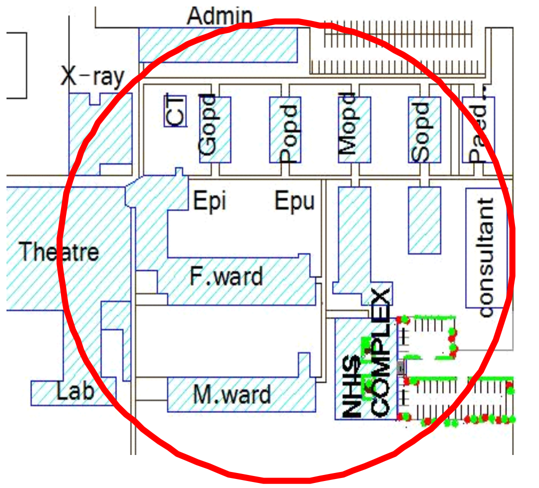


Figure 4.12: The study area within the hospital
Source: Researcher's field work, 2018

4.4.3 Observation in case study three (C)

The main approach was in the middle of the front row of blocks that house the Reception. Also, to the right were the GOPD's, the Family clinic, and Accident and Emergency (A & E) section. Behind the latter was the Radiology department. At the left hand side were 1-story buildings that house the Laboratories, Hematology and Pathology departments. The middle block was 2-story blocks that comprise the Wards. The blue line in the layout indicates the circulation paths in the hospital.

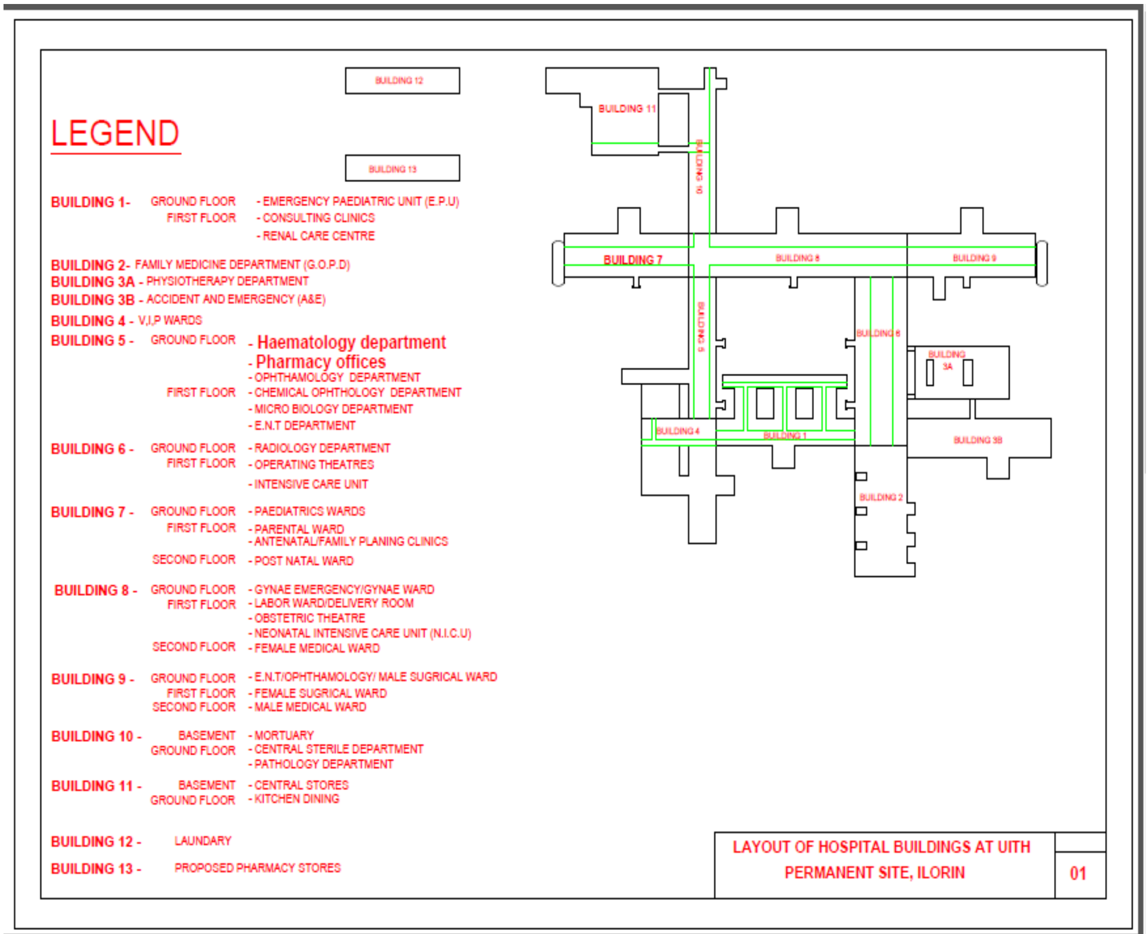


Figure 4.13: Hospital layout of UITH, Ilorin
Source: Researcher’s field work, 2018

4.4.4 Observation in case study four (D)

At the approach of the hospital was a fountain, and immediately one enters the building were the reception, ATM stand, GOPD’s, and the Family clinic (See Plate V). At the western side (right hand side) was a parking lot, Accident and Emergency (A & E). Furthermore, behind the A & E were the Radiology department and the Endoscopy suites. Behind the later were the Wards, the Amenity section, and the Pathotology Block. The details of the design attributes observed were indicated in Table 4.31.

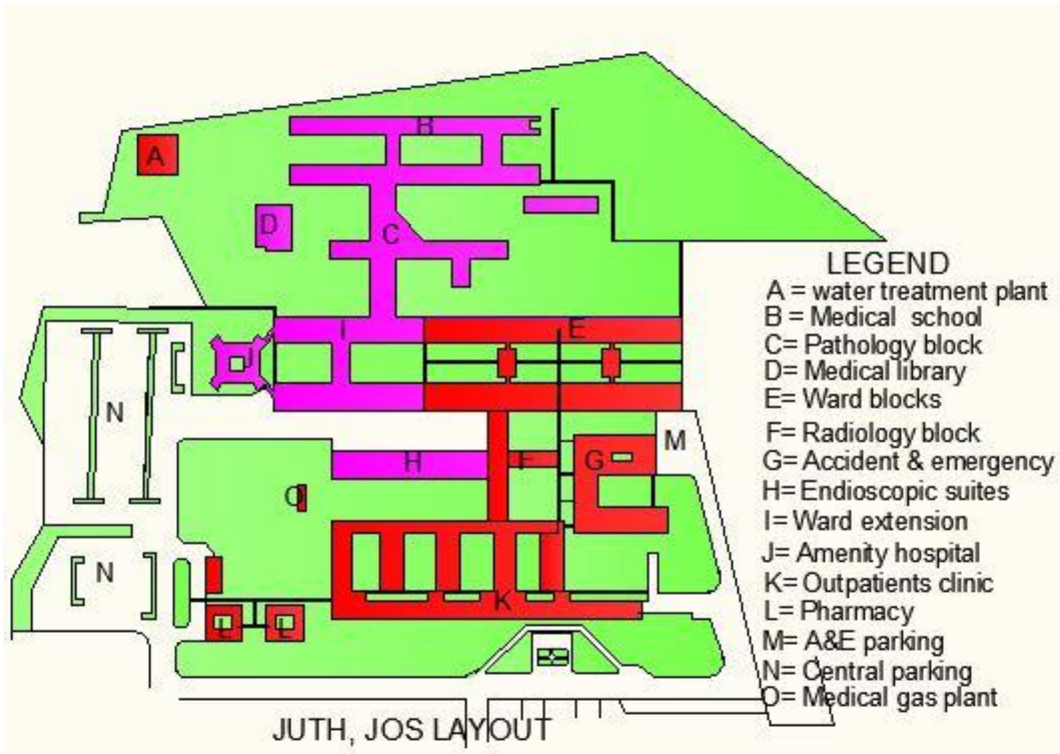


Plate V: Site layout, JUTH, Jos

Source: Researcher's field work, 2018

Table 4.31: Observation schedule on spatial legibility of hospitals

S/No	Design attributes/indicators	Case A (BSUTH)			Case B (UATH)			Case C (UITH)			Case D (JUTH)			North Central		
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1	Building Layout	*				*		*			*			*		
2	Visual access from entrance	*				*		*			*			*		
3	Maps: Accessibility of this information at entry point			*			*		*			*			*	*
4	Signs: Accessibility (directional and destination points)		*		*			*				*		*		
5	Display bill boards	*					*		*			*			*	
6	Horizontal circulation (pathways)	*			*			*			*			*		
7	Vertical circulation (stairs/elevators)	*			*			*				*		*		
8	Adequacy of lighting in the circulation space	*				*			*		*			*	*	
9	open core circulation system	*			*			*			*			*		
10	floor plan configuration	*			*			*			*			*		
11	Building shape	*			*			*			*			*		
12	Symmetry of the building layout	*			*			*			*			*		

a (Legible); b (Not legible); c (Not available)
Source: Researcher's field work, 2017

4.4.5 Spatial legibility of hospital wayfinding

The subjectivity in the assessment of spatial legibility of wayfinding in hospitals was addressed by involving two research assistants where results were compared and harmonized. Also, the data was validated with verbal protocol from the participants.

4.4.5.1 Use of maps for wayfinding

Table 4.31 shows that maps were not available for patients to use in wayfinding in case studies A and B while in case studies C and D the available maps were not legible as patient were not seen using it (See Plate VI). This implies that maps were not legible for use as wayfinding aids in the hospitals.

Plate VI: Directional map (UITH, Ilorin); Source: Researcher’s field work, 2018

4.4.5.2 Use of signage for wayfinding

The signs provided in the hospitals were not legible in case studies A and D while in case studies B and C, the signs were legible. Therefore, it means that the signage was fairly adequate for effective wayfinding in the hospitals. The excerpts from the verbal protocol in italics states: *''I read the signs and symbols'' (P1); ''I looked at the signs as I pass by, the signs actually help me to find my destinations…'' (P2).* This suggests that the participants used the signs during wayfinding by looking and reading the signs. The participants that could not read the signs relied on verbal direction. This implies that signage was a significant environmental cue in hospital wayfinding.

4.4.5.3 Building layout for wayfinding

Table 4.33 reveals that the building layout in the hospitals was legible in all the hospitals, except in the case study B that has asymmetrical configuration. In case study B, the non legibility of the building layout was due to the evolution of spaces in form of new buildings and extensions to the buildings, especially the general outpatients' departments (GOPD) and the national health insurance scheme (NHIS) buildings. The excerpts from the respondents were stated as follows: *'The building plan was easy and I did not have difficulty to find my destination'. (P6); 'the building plan was simple to understand' (P10).* The educational background of the users could be the reason why the participants committed fewer wayfinding errors such as backtracking. This implies that the hospital environment was simple to understand for the majority (three out of four cases) of the hospitals. Consequently, it was user-friendly to the patients.

4.4.5.4 Visual access for wayfinding

The visual access from the building entrance was legible in the hospitals except in case study B where the building entrance was not conspicuous enough. However, the visual visibility of destinations from the main entrance could be difficult due to the complexity of the hospital buildings. Accordingly, it implies that visual access was legible and significant in most of the hospitals for wayfinding performance.

4.4.5.5 Circulation spaces for wayfinding

Table 4.33 shows that the circulation spaces (pathways) in the hospitals were legible. Both the horizontal and vertical (stairways) circulations were easily recognised and visible to the patients. However, there were no directional signs for the stairways in case study D which made it not too legible to the patients. This implies that directional signs are important in hospitals during wayfinding to avoid error in navigation.

4.4.5.6 Use of lighting for wayfinding

The use of lighting was adequate and legible in case studies A and D, but was not adequate and legible in case studies B and C (See Table 4.33). Some of the lighting points were not working and made the circulation spaces dark. This affected the illumination of some pathways in case studies B and C. The excerpts from the participants' states as follows: '*'both natural and artificial lighting were adequate and helps me in finding my destinations''… (P5); ''Lighting helps me to see the pathway and signs better in getting to* *my destination''… (P9).* This means that provision of adequate lighting to illuminate the pathways was very important during wayfinding.

4.4.6 Influences of architectural cues for wayfinding

The influences of architectural design variables on the spatial legibility of the hospitals for effective wayfinding performance was assessed based on the extent the environmental cues persuade the patients or visitors in decision making on the navigation choices during wayfinding (Paul, 2013). The assessment criteria were on the ability of the wayfinder and or the observer to recognize the architectural cues and the complexity of the cues in decision making for wayfinding (Koseoglu & Onder, 2011).

Table 4.32: Observation schedule on influences of design space for wayfinding

a(Influence); b (Not influence); c (Not available); * marked
Source: Researcher's field work, 2017

S/No	Design attributes/indicators	Case A (BSUTH)			Case B (UATH)			Case C (UITH)			Case D (JUTH)			North Central		
		A	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1	Architectural differentiation	*			*				*			*		*	*	
2	Floor finishes		*			*			*			*			*	
3	Important visible building form	*				*		*				*		*	*	
4	Important visible plants	*			*				*		*			*		
5	Important visible water body i.e. fountain (landmark)			*			*			*	*					*
6	Number of corridor intersections (nodes) at decision points	*			*			*				*		*		
7	Door numbers for destination identification	*			*			*			*			*		
8	Edges (clear building boundaries)	*			*			*			*			*		
9	Districts (recognizable and common character of buildings as reference point)	*			*			*			*			*		

Though, the assessment was subjective, but the data were also validated through verbal protocol. In addition, biasness was minimized in the selection of the participants for observation by selecting equal number of gender, age spread, and the extent of acquaintance with the hospital setting. Also, the principal researcher and two research assistants were recruited for the assessment and the result was pharmonized as shown in Table 4.32.

4.4.6.1 Architectural differentiation for wayfinding

The result from Table 4.32 shows that buildings were architecturally differentiated in terms of height in case studies A and B which influence effective wayfinding performance. However, in case studies C and D there were no physical differentiation of the buildings. This was because all the wards and GOPD in case studies A and B were storey buildings and were also differentiated in terms of location (See Plate VII). However, in hospitals that the buildings lack physically differentiation due to high degree of uniformity, there was the feeling of being lost or disoriented by unfamiliar hospital users. This implies that the greater the physical differentiation the better the wayfinding performance because it facilitates the extraction and understanding of physical information which corroborates the findings of Abu-Obeid (1998).

Plate VII: Maternity wards (UITH, Ilorin)
Source: Researcher's field work, 2017

4.4.6.2 Landmarks for hospital wayfinding

The results in Table 4.32 show that the visual attraction of some important building forms, trees and fountain were prominent and used as landmarks by patients who are unfamiliar with the hospital environments. The researchers observed that building forms were used as a reference point in case studies A and C. Plants such as trees were used as landmark in case studies A and B while in case study D, the fountain was used as landmarks. Hence, landmarks influence the effectiveness of wayfinding performance in the hospitals. This implies that landmarks were significant factor in the effectiveness of wayfinding performance.

4.4.6.3 Circulation intersections (Nodes) for wayfinding

The number of corridor intersections in the hospitals was few which influences the ease of wayfinding in case study A, B and C (See Table 4.32). This was because there were fewer nodes in the circulation space. The more the number of nodes in the circulation space the wayfinder encounter during wafinding, the more difficulty was experienced in decision making as to the correct route to choose and follow. Such difficulty was encountered because there were no directional cue or information provided at the nodes. This implies that path intersections (nodes) are significant points for decision-making during wayfinding. Accordingly, visual cues should actively be made available towards an upcoming turn direction to enable wayfinder compare options and make decision while heading to a path intersection during wayfinding.

4.4.6.4 Signage for wayfinding

Table 4.32 shows that door label and room numbers were used to identify destinations during wayfinding which influenced the ease of wayfinding in the hospitals. This is because the patients that can read door labels and numbers had no problem in identifying destinations in the hospitals while those patients that could not read used pictures to identify destinations. This is to suggest that pictograph (See plate VIII) were also used to depict room functions and to identify destinations for those patients that could not read.

Plate VIII: Radiology department at UATH, Abuja
Source: Researcher’s field work, 2017

4.4.7 Usefulness of architectural cues for wayfinding

The usefulness of architectural cues for wayfinding is the visual content of the environmental cues for wayfinding in terms of direction, orientation, and identification (Tzeng & Huang, 2009). In other words, the usefulness of a cue is how it has assisted the wayfinder in decision making during wayfinding. In addition, the usefulness of any spatial legibility system is restricted by the ability of patients and visitors to see the information and use it effectively for wayfinding which may positively or negatively affect the ease of wayfinding (Paul, 2013). Furthermore, the assessment of usefulness of environmental cues was based on the ability of the wayfinder to gather information from the cues in terms of its simplicity, consistency, flexibility, and visibility of the architectural features or cues (Tzeng & Huang, 2009). These parameters were used in the observation and analysis as recorded in Table 4.33. The site layout in conjunction with the physical observation of the building was carried out, recorded in Tables 4.33 to 4.35, and analysed. The researcher observed that the circulation spaces in both the horizontal and vertical cues were legible. However, the building entrance was not conspicuous which makes visual access to destinations not to be legible (Author's observation, See Plate IX).

Plate IX: Blood Laboratory at UATH, Gwagwalada-Abuja (Source: Researcher's field work, 2017

Plate X: NHIS (UATH, Gwagwalada-Abuja) (Source: Researcher’s field work, 2017)

Besides, the researcher observed that the General Out- Patients Departments (GOPD) was a storey building adjacent to other out patients departments, such as the Pediatric Out-Patient Department (POPD), Medical Out-patient Department (MOPD), and the Surgical Out-Patient Department (See Plate X, NHIS). These adjoining buildings were bungalow. A participant’s quotes stated that: *‘’ the massive height of the building was used to describe the GOPD for me’’ (R 20)*. This is to suggest that the users relied more on other architectural features such as building height and destination signs to effectively navigate the hospital. This implies that the hospital environment was user- friendly. However, there were no wall colour strips and artwork, such as sculpture or pictograph to direct users to various destinations in the hospital (See XI). The patients had to use verbal direction and signage during wayfinding (See Plate XI). This is to suggest that the users relied more on functional clusters, verbal direction, and signage for effective wayfinding in the hospital.

Plate XI: SGOPD at JUTH, Jos (Source: Researcher's field work, 2017)

Table 4.33: Observation schedule on usefulness of architectural cues

S/No	Design attributes/indicators	Case A (BSUTH)			Case B (UATH)			Case C (UITH)			Case D (JUTH)			North Central		
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1	Wall colour strips			*			*	*					*			*
2	Furniture (seats) in waiting area	*			*			*			*			*		
3	Functional clusters (shops, ATM, wards)	*			*			*			*			*		
4	Artwork (sculpture or paintings)			*			*	*			*			*		
5	Directional destination signs	*			*			*			*			*		
6	Identification of destination signs	*			*			*			*			*		

a (Useful); b (Not useful); c (Not available);
Source: Researcher's field work, 2017

4.4.7.1 Use of wall colour strips for wayfinding

The use of wall colour strips was not prominently used in most of the hospitals except for case study C (See Table 4.33; See Plate XII, Plate). Despite the use of wall colour strips in the hospital C, patients still got confused with direction finding to various destinations as stated by the participant's verbal protocol (See Plate XII; Plate XIII). The excerpts from the participants' states as follows: *'Hmm! I was confused with the colours when I had to turn to find direction to hematology laboratory in the upper floors'... (P3). ''Wall colours strips did not help to direct me to the laboratory'' (P12).* This implies that wall colour strips has not been useful in the ease of wayfinding. This study argued that only the users' with formal education could interpret the label, direction of the arrow and the colour codes. Although, the label was translated to local dialect (Yoruba, See Plate XIV), the meaning and understanding was still inadequate. Consequently, some wayfinders without formal education could not interpret the direction of the arrows to mean that the patients need to follow the direction of the arrow.

Plate XII: NHIS (JUTH): Source: Researcher's field work, 2017

Plate XIII: Blood bank, UITH, Ilorin: (Source: Researcher's field work, 2017)

Plate XIV: Laboratory complex, UITH, Ilorin: (Source: Researcher's field work, 2017)

4.4.7.2 Zoning of functions for wayfinding

Table 4.33 reveals that all the teaching hospitals studied zoned important commercial activities such as snacks stands, ATM's stand at the entrance hall for easy access and as landmarks (See Plate XV). Some participants used the ATM and shops to describe their orientation as stated in the following excerpts in italics from the participants: '*I used the ATM stand to know the direction to the GOPD's from the main entrance'… (P4). ''I used the ATM stand at the entrance, sign on the walls and doors to find my way to my destination'' (P14).* This is to suggest that the zoning of functions was significantly useful in the ease of wayfinding due to the proximity of the functions to each other with short walking distance.

Plate XV: Functional cluster: ATM stand & Snack shop (UATH, Abuja);
Source: Researcher's field work, 2017)

4.4.7.3 Signage for wayfinding

The use of signage was prominent in hospital wayfinding for directional and destination identifications in all the case studies (See Table 4.33) and Plate XII. This was because signs were correctly placed at the appropriate location and useful for effective wayfinding. The excerpt statements from the participants in italics were as follows: *'I read the signs and symbols on the wall and door post to find my way'… (P11).* This suggests that signage was useful in hospital wayfinding.

4.4.7.4 Use of artwork for wayfinding

Table 4.33 shows that the use of artwork such as sculpture and pictograph were used for wayfinding in case studies C and D. Artworks were prominently used at the main entrance approach, accident and emergency section, maternity wards and radiology departments (See Plate XVI; Plate XVII). Patients were seen looking at the artworks during wayfinding.

Except statements from the participants in italics were as follows: *'I used the pictures and sign post on the wall at the Accident and Emergency section, Radiology to know my destinations'…. (P15).* This implies that artworks such as pictograph and sculptures were useful to the participants for effective wayfinding.

Plate XVI: Emergency complex (UITH) (Source: Author's field work, 2017)

Plate XVII: Radiology at UITH, Ilorin (Source: Researcher's field work, 2017)

4.4.8 Observation of spatial attributes of patients' travel route

The average number of directional turns during navigation from the main entrance to the general outpatient departments (GOPD), Accident and Emergency (A & E), laboratory, radiology and pharmacy were between one and two turns in all the hospitals (See Table 4.34).

Table 4.34: Spatial attributes of patients' travel route in the hospitals

S/No.	Spatial attributes	GOPD	(A &E)	Laboratory	Radiology	Pharmacy
1	Average number of directional turns	2	1	2	1	2
2	Average distance from entrance to destination	10m	5m	100m	40m	30m
3	Average number of signage on the walls from origin to destination	2	1	3	2	1
4	Average number & type of landmarks used	2 nos, Trees	Pictograph Signage	Pictograph Signage	Pictograph Signage	Signage

*Accident &Emergency (A & E). Source: Researcher's on-site observation, 2017

This implies that the limited number of turns to reach the aforementioned destinations reduces navigational errors committed by users. Also, the signage on the walls was clear, consistent and legible which suggests ease of navigation (Author's observation; See Plate XVIII). However, there were no directional signs where paths intersect (nodes) and that was the position where the wayfinder make decision on which path to follow. As such, patients got confused and had to ask for direction from other patients or the hospital staff. The excerpt from the participants was in italics and was stated as follows: *I read signs and* *symbols on the wall and door post to find my way'…. (P11).* Similarly, pictographs were used to identify desired destinations (See Plate XVII). This implies that the architectural differentiation in terms of height and the use of pictograph serves as landmarks. In addition, the trees used as landscape elements constitute the main landmark in the GOPD. The accident and emergency (A & E) had the least minimum travel distance of 5m while the laboratories were the farthest away with maximum distance of 100m as shown in See Table 4.34. This suggests that there is ease of navigation to (A & E) department due to its proximity than navigating to the laboratory complex with the farthest distance.

Plate XVIII: Radiology department at UATH, Abuja (Source: Researcher's field work, 2017)

4.4.9 Observation of patients' wayfinding behaviour

The participants observed had visited the hospital one or two times in the last 12 months and were therefore considered unfamiliar with the hospital environments. As such, the wayfinding behaviour observed was on the movement pattern from the origin (main entrance of the hospital building) to the desired destinations. The wayfinding behaviour includes the number of stops made before reaching the destination, the number of looking around, the number of asking for direction, and the number of backtracking made prior to reaching the various destinations (See Table 4.34). These attributes were counted and recorded as shown in Table 4.35.

Table 4.35: Spatial attributes of patients' wayfinding behaviour in the hospitals

S/No.	Wayfinding behaviour	GOPD		A &E		Laboratory		Radiology		Pharmacy	
		M	F	M	F	M	F	M	F	M	F
1	Average number of stops before destination	4	3	3	4	3	6	2	4	2	2
2	Average number of looking around to find destination	5	3	4	3	2	4	4	3	2	3
3	Average number of times of asking for direction	2	1	3	2	3	3	2	2	3	2
4	Average number of times users' backtracked	0	0	0	0	1	2	0	0	0	0

*Accident &Emergency (A & E); Source: Researcher's on-site observation, 2017

The number of stops made by the female participants was between three and four while the male participants generally made between two and three times stops during wayfinding before reaching the various destinations. This implies that the female wayfinder were more prone to wayfinding errors than male such as missing the way. Consequently, where the participants stopped were identified as decision points. The decision points were the place where cues and information were perceived by the wayfinder. The participants had to stop to look around for cues and ask for direction at decision points where the user could not find any cue for direction-finding. This suggests that the decision points had no sufficient cues and information to effectively direct the users to the destinations.

It was observed that the participants looked around to scrutinise the information by understanding the visual content of the cues to confirm been on the right path that could potentially direct the participants to the desired destination (See Plate XIX and Plate XX). The quote from the participant was stated as follows: *''I observed where people entered and ask for confirmation of my destination'' (P7).* Furthermore, on the average all the participants asked for verbal direction between two to three times before reaching the various destinations. In addition, male participants missed the way once while the female participants turned back twice on their way to the laboratories (See Plate XX).

In addition, the circulation space was a bit dark on the way to the laboratories as shown in Plate XX. The participants' quote from the interview was as follows: '*'some of the lobbies were dark and not well illuminated…'' (P8).* As such, signs and cues were not seen clearly by the participants due to poor illumination. Table 4.35 shows that the female participants missed their way more than the male participants by the number of times participants backtracked which could be due to the darkness of the circulation space. The following expressions from the participants implied turning back: *''It looks like I took a wrong path, so, I asked for direction from people around''… (P16); ''Mmm! Let's go back; this is not the right way... I asked the staff for direction''… (P13).* This implies that the hospital buildings were user- friendly since backtracking took place in only the laboratories which means there was effective wayfinding in the hospital.

Plate XIX: GOPD UATH (Source: Researcher’s field work, 2017)

Plate XX: Way to the Laboratories (UITH)
Source: Researcher’s field work, 2017

4.5 Method Triangulation of Research findings

The method triangulation of findings for objectives one to three used was across-methods for case study research where survey questionnaire, semi-structured interview and observations were used in eliciting data from the hospital users in wayfinding. The strategy was to capture most of the findings, to discover any divergence, corroboration of findings, and increased rigor and validity of the studied phenomenon (Heale & Forbes, 2013; Miles *et al.,* 2014). Accordingly, the triangulation was in accordance with the themes of the research attributes across the methods.

4.5.1 Building layout in wayfinding

The major findings in both the survey questionnaire and the interview reveal that building layout was complex to understand by the hospital users. This implies that users' had difficulty finding their way to desired destination with ease. As such, the conceptual composition of the building layout of hospital designs needs to be made simple to navigate and along with each space identified with different identity. However, findings from the observational studies show that building layout was legible, simple to understand and user friendly. The result from the observational studies suggests that the participants found signage, images and directional signs comprehensible to navigate the hospital. This could be due to the formal educational background of the participants observed who committed fewer wayfinding errors such as backtracking during wayfinding (See Table 4.35). As such, these artefacts (signage, mages and pictograph) could be used to support wayfinding.

4.5.2 Landmarks used for wayfinding

The findings from the survey questionnaire show that differentiated building height was used as a landmark which corroborates the result from the observational studies. However, there was a divergent finding from the interview which revealed that signage was used as landmark at decision points for wayfinding in the hospitals. Similarly, trees and pictograph were also found to be used as landmarks in the observational studies. Consequently, landmark had the highest factor loading of 0.854 in the result. This implies that local landmark information should be distinctive, memorable and recognizable along the route to support orientation and ease navigation. This suggests that building height, landscape, signage and pictographs should be used at decision points along the route and at destinations. This outcome concurs with the results of Anacta *et al.* (2017). These features could be used as reference points for orientation, route confirmation and reassurance during wayfinding. Accordingly, information needs at the decision-making points such as circulation intersections (nodes) should be recognized for ease of wayfinding.

4.5.3 Use of signage in hospital wayfinding

The findings from both the survey questionnaire and interview show that signage significantly influenced effective wayfinding in the hospital. Also, the findings from the observational studies show that signage influenced wayfinding which was found to be legible, clear and consistent. Consequently, the result from the observational studies corroborates the findings from the survey questionnaire and interview. This implies that signage provided sufficient information needs of the patients and visitors at both directional and destination points. Accordingly, signs should be consistently clear in terms of meaning and understanding to all users, and be translated to the main local languages of the country.

4.5.4 Visual access in hospital wayfinding

The results from the observational studies reveal that the building's main entrance was visually visible. Also, the visual visibility from the main entrance to the desired destination had challenge due to complexity, but was accessible. Similarly, the findings from both the survey questionnaire and interview show that the visual visibility in the hospital environment during wayfinding was easily accessible. This finding corroborates the result from the observational studies. This implies that visual visibility was influential for effective wayfinding in the hospitals. Accordingly, the visual visibility was statistically established as a significant factor with loading of 0.655 for hospital wayfinding in objective two of the study. As such, the visual access of the building entrance and the interior of the hospital environment should appear legible and simple to see the greater parts of the buildings. In addition, visual access depends on the connectivity of the pathways, nodes and the building layout.

4.5.5 Use of colours and lighting in wayfinding

The finding from the interview shows that the use of lighting in the hospital for wayfinding enhanced the visibility of signage and pathways such that they were adequately illuminated. Likewise, the results from the survey questionnaire and observational studies reveal that lighting was adequate and influential for effective wayfinding. This finding corroborates that of the interview result. This was because of the use of court yards and artificial lighting in the circulation spaces (pathways) in the hospitals. As such, it implies that lighting was significant for the ease of wayfinding in the hospitals.

The results from the interview and observational studies reveal that the use of wall colour strips had no effect for wayfinding in the hospitals. This was because the meaning and the understanding of such colours were inadequate to the patients for effective wayfinding in the hospitals. This implies that the use of colour is a function of light for wayfinding. However, the finding from the survey questionnaire shows that wall colour strips was influential for the ease of wayfindings. This was to suggests that the use of wall colour codes needs to provide both directional and destination information for ease of wayfinding in the hospital environment. This could be achieved by zonig different spaces with different colour codes of not more than four colours for walls or floors of the buildings, which concurs with findings in the study of Ranjbar *et al.* (2016).

4.5.6 Form of assistance in hospital wayfinding

In both the survey questionnaire and the interview, the findings show that verbal direction from hospital staff was the main form of assistance in hospital wayfinding. The use of verbal direction by the unfamiliar users was due to the insufficient cues, directional signs, and information needs at the nodes (junctions) where wayfinding decisions were made. This corroborates the findings from the observational studies that verbal direction influences the ease of hospital wayfinding. This implies that personnel of the hospital should be properly trained on how to humbly direct patient to the various destinations in the hospital.

4.5.7 Wayfinding experience in hospitals

The findings from the survey questionnaire and the interview show that stressfulness and getting lost was the major wayfinding experience in hospital wayfinding. The stressfulness in the hospital was due to the complexity of the hospital spatial layout. In objective two of the study, complexity of the spatial layout was also established with inferential statistics to be a significant factor in hospital wayfinding. That means complex floor plan have the ability to reduce wayfinding performance. Accordingly, hospital spatial layout of buildings should appear simple to navigate with distinctive spaces for easy identification.

4.5.8 Barriers in hospital wayfinding

In both the survey questionnaire and the interview, the findings show that crowdedness in the circulation space was the main barrier in hospital wayfinding. The crowdedness was also established in objective two of the study as one of the critical factors that has effect on the ease of wayfinding in the hospitals. This implies that crowd control in the circulation space is significant in hospital design. As such, sufficient signs and waiting areas should be provided to avoid patients following crowd to wrong destinations especially at the emergency and GOPD’s.

4.5.9 Circulation spaces (pathways) in hospital wayfinding

The results in objective two show that easy direction finding in the circulation space was a critical factor that influences the ease of wayfinding in hospitals. The findings in the survey questionnaire and interview corroborate the result in objective two that legible pathways were significant in the ease of wayfinding. This was because there were sufficient and readable environmental cues at decision points, particularly at destination points, that decrease the complexity of route direction. Accordingly, it implies that pathways should be made legible and suboptimal wayfinding decision points available for path selection should be reduced in hospital design to ease navigation in hospitals.

4.5.10 Nodes (junctions) in hospital wayfinding

The survey questionnaire result corroborates the findings in the observational studies that the number of nodes (junctions) in pathways influences the effectiveness of wayfinding performance. In addition, observational studies reveal that there were insufficient cues such as directional signs at the nodes. Although, nodes loaded higher (0.739) which is a function of the building layout, but the building lyout, pathways and visual visibility loaded lower of 0.412 0.468 and 0.655 respectively. This implies that directional signs should be made to provide sufficient visual content at nodes. Also, in the conceptual composition of building layout, nodes should be an open L form of not more than four in a flight to ease navigation and for effective wayfinding which concur with the findings of Brunye *et al.* (2018).

4.6 Development of Wayfinding Framework

In response to objective four, the development of the wayfinding framework was based on the method triangulation of findings from objective one to three which includes survey questionnaire, interview, and observational studies. The emerging themes from the findings were grouped into four major components which include: the environment, human characteristics, architecture, and wayfinding experiences and behaviour factors in the context of hospital wayfinding.

The environment includes the spatial factors and legible architectural features such as entrances, paths, circulation systems (horizontal and vertical systems), visual object such as differentiated buildings and landmarks. The architectural cues assist to get better the configuration and comparative comprehension of the places. Furthermore, optical factors include signage and graphics which helps to produce optical picture that can be amassed in recollection and get back once needed. In addition, the social values such as gender, age, education and familiarity with the environment of the wayfinder affect the ability of the wayfinder to effectively comprehend the hospital environment and find the desired destination (Dalton *et al*., 2019). Table 4.36 is the outline of findings triangulated from objective one to three that was used to develop the perceptual wayfinding framework.

Table 4.36: Summary of method triangulation of research findings
Source: Researcher's findings, 2019

Figure 4.14 is further used to graphically explain the triangulation using fish bone for better

Themes	Findings for objective 1 – 3		
	Survey questionnaire	**Semi-structured Interview**	**Observations**
	Complexity	Complexity (Stressfulness)	Simplicity, Legible and user-friendly
	Differentiated buildings: Trees (obj. 2)	Signage	Trees, Building height, Pictograph; ATM stand
	Influential in wayfinding	Reading signs	Signs were legible, influential & useful
	Influenced direction finding during navigation.	Facilitates easy navigation	Legible visual access
	Influence ease of wayfinding	Enhanced visibility: Signage & pathways were adequately illuminated	On the average there was adequate lighting and some parts were dark as most corridors opened to court yards.
	Influenced wayfinding	No effect in wayfinding	Not useful, some participants got confused, (same participants were interviewed & observed.
	Verbal direction	Verbal direction and signage	
	Stressfulness	Stressfulness; got lost	*More wayfinding errors by female wayfinder than male; *Asking for verbal direction; *Looking around more than twice to confirm route selection; *Minimal backtracking by wayfinders : User-friendly.
	Crowdedness; Easy navigation; legible pathways	Crowdedness Significant legible pathways	No legible maps legible pathways
	Significant in wayfinding		Insufficient cues, no directional signs & no information at nodes

understanding. Accordingly, the explicit and implicit meaning of the findings elucidated in section 4.5 is used in the diagram. The emerging factors and themes are arranged sequentially in order of significance and loadings.

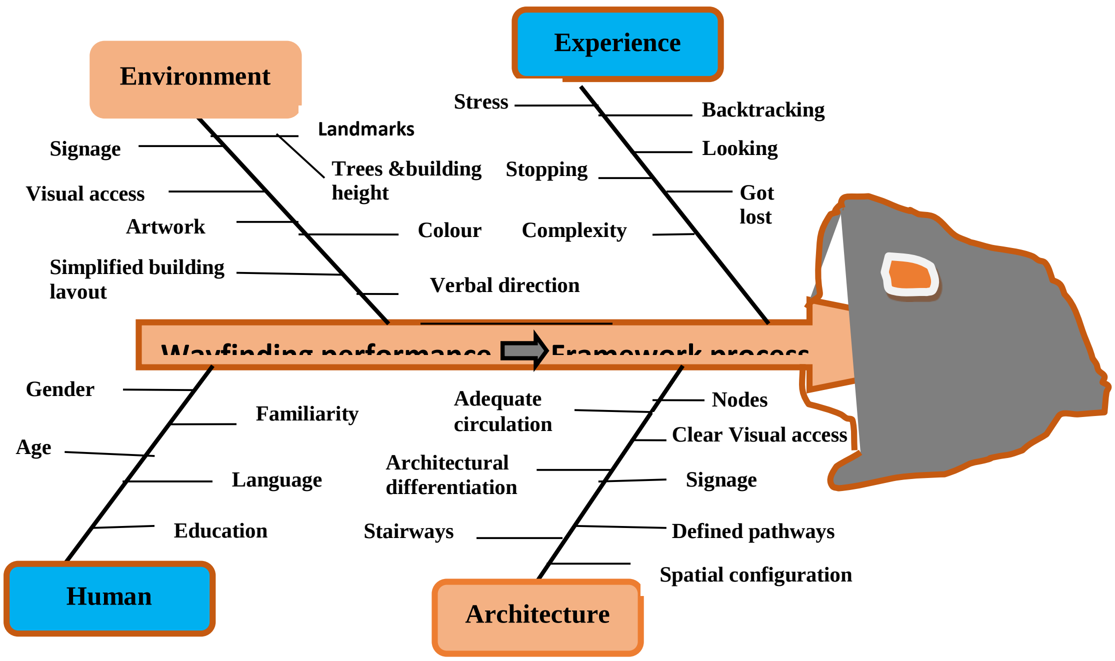


Figure 4.14: Triangulation of wayfinding performance

The perceptual wayfinding framework was created as derived from the outcomes of the research which were grouped into four main domains (the environment, human, architecture, and wayfinding experiences and behaviour factors). The spatal factor resides in the environment. As such, the perceptual wayfinding framework incorporates the wayfinder cognitive schema and perceptual structures within the environment that allow the flow of information from the environment to the wayfinder who effect actions. It focuses on ‘knowledge in the world’ (that is, what data one can obtain straight from the items and spaces observed by the user, namely their affordances) by Norman (1988) to elucidate the action of the wayfinder during the recital of a wayfinding undertaking.

The setting gives intuitions-affordances from the cognising wayfinder and non-cognising items – to the wayfinder. In real hospital environment, the object was bigger than the wayfinder which made it impossible to visualize the entire buildings at once. As such, the observation and perception were done sequentially. Subsequently, the wayfinder decides upon which cue to observe that could enable the person to navigate the setting that sequentially gives novel intuitions until the destination is reached.

Furthermore, the wayfinder needs to choose which affordances to utilize based on the information from the environment such as cues and signs. Accordingly, the inner cognitive scheme directs the wayfinder's procedures of intuition, choice and deed all through the wayfinding assignment. For the wayfinder to perform the task, the data concerning the assignment and target, wayfinding approaches, and rational experience are essential. Also, the assignment account guides the optical intuition in such a method that the wayfinder tests just the pertinent affordances for the task and data needed and available in the setting. In order words, the perceptual wayfinding framework focuses on the real data wants through wayfinding and does not concentrate on erudition the spatial setting. Its basic principle was that all data should be obtainable at every choice position as information in the world (Raubal, 2001). The main goal of perceptual wayfinding framework is to explain human wayfinding in an unfamiliar teaching hospital environment to serve as a guide to the users and designers. Accordingly, decision-making process is imperative in human wayfinding.

4.6.1: Decision-making process in wayfinding framework

The development of the framework involves decision-making process identified by this study towards arriving at the preferred target that is represented graphically in Figure 4.15. Accordingly, the decision made by the wayfinder results in the wayfinding behaviour and experiences.

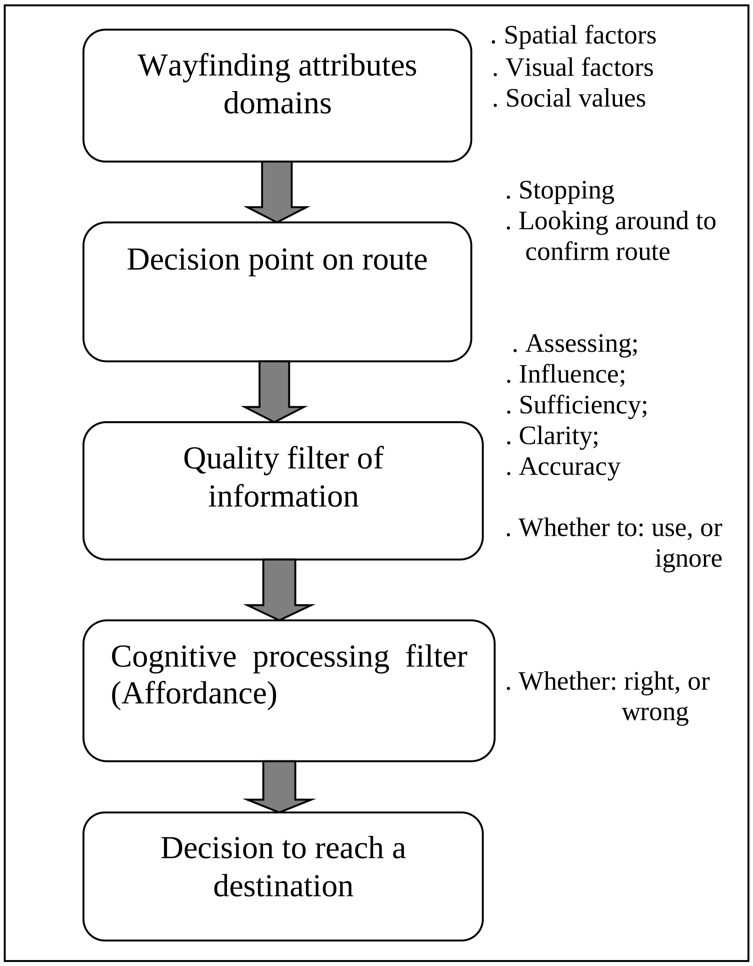


Figure 4.15: Decision-making process
Source: Researcher's work, 2019

4.6.1.1 Collection of wayfinding information

The wayfinding process starts with seeking information from the cues in the wayfinding feature domains to find a destination in the hospital. The wayfinder has to make a choice anchored in the information provided. Consequently, the building designer needs to know the accommodation or adjustments needed to be made in the hospital environment in order to make an effective wayfinding system.

4.6.1.2 Decision point on route

The decision point on the route to navigate is where the person has to decide how to process the information available at the route. Furthermore, the decision point could be directional or destination points along the route during navigation to the desired destinations. Decision point could also occur where there is change in the direction of travel.

4.6.1.3 The quality filter of information

The quality filter of information is where prior to making a decision on the cues to use, the person needs to assess the quality of the information presented in the environment. The wayfinder has to determine whether the information is relevant to the task, influence wayfinding, sufficient to know what to do, and clear enough for successful wayfinding. This filtering requires considerable cognitive processing ability and outcome as it determines whether the person gets close to the destination or not. This study examined the available cues at decision points during observational studies. It is expected that the building designers requires comprehending the wayfinding requirements of the users in sequence to take on quality audit of the proposed wayfinding designs.

4.6.1.4 The cognitive processing filter

The cognitive filter relates to the capability of the wayfinder to make decision based on the available information which may or may not be complete, useful and accurate. As such, the wayfinder may decide to use or ignore the information.

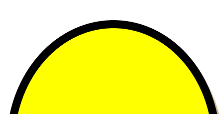
4.6.1.5 The Decision to reach the destination

The end of the process is the decision itself, the outcome of which will either lead to successful wayfinding by reaching the desired destination with ease or failure to reach the destination. The decision made results in the wayfinding experienced by the patients or visitors. In order to effectively take decision on which route or environmental cues to use in hospital wayfinding, spatial and visual factors underlined by social values of the wayfinder are the significant factors that influence effective wayfinding. These factors were used in the development of the framework.

4.7 The creation of the perceptual wayfinding framework

The creation of the perceptual wayfinding framework is a uni-directional influence of spatial factor and visual factor underlined by social values (See Figure 4.16). The framework is created by incorporating the information that is most significant to wayfinding success in the resolution-making procedure in hospital environment. Consequently, the themes that emerged from the triangulation of results were merged into two main domains based on the patterns of the result implications. Therefore, the two main domains used in this study are spatial and visual factors underscored by social values which are critical to hospital wayfinding design.

. Differented buildings



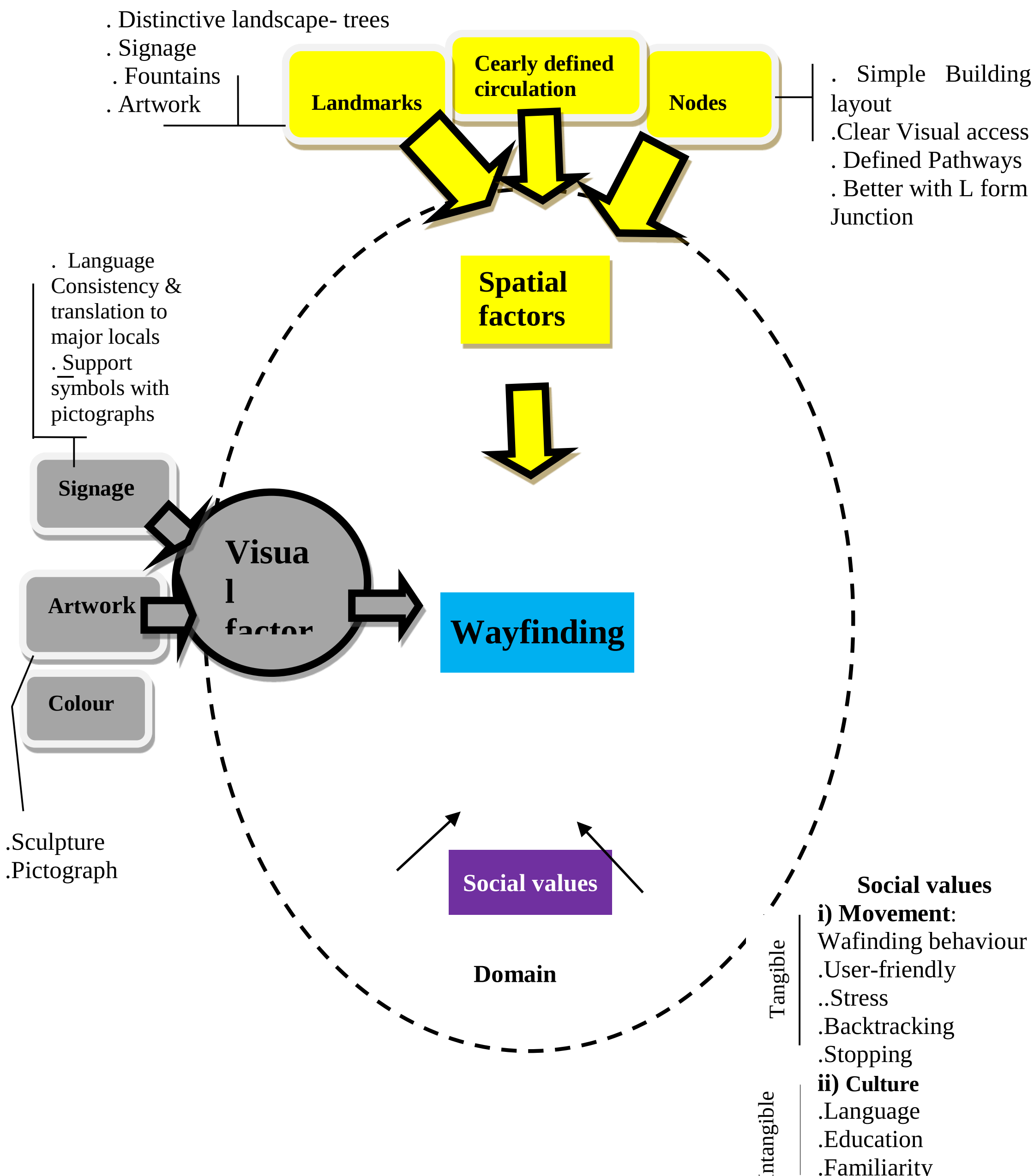
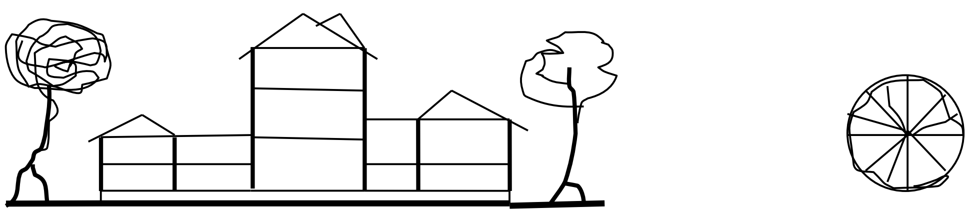


Figure 4.16: Perceptual wayfinding framework
Source: Researcher's work, 2019

According to the factor loadings, the spatial factors had the greatest influence on the effectiveness of wayfinding success that includes features such as landmarks, adequate circulation system, and nodes (junctions). Consequently, architects that undertake hospital building design desires to give particular consideration to these wayfinding features. In addition, the features that became prominent in landmarks were differentiated buildings in terms of building height, distinctive landscape elements such as trees for each zone, signage, and fountains (See Figure 4.17). In the circulation systems, there are waiting areas, horizontal and vertical systems such as pathways and stairs/ramps. The architectural cues assist to get better the configuration and relational comprehension of the space. Furthermore, nodes in hospital wayfinding are functions of building layout, visual access, pathways, and the form of junctions.



(a) Differenntiated buildings (elevation) (b) Landscape element (Tree) plan

Figure 4.17: Landmarks in the hospitals (Source: Researcher's work, 2019)

Nodes are decision points during navigation. For instance, intersection of primary paths at which people need environmental cues to make a choice concerning paths and the direction to follow; or the location at which confusion arises as to the path or direction to take (Tzeng & Huang, 2009). Accordingly, wayfinding paths are divided into three categories as shown in Figure 4.18 which include open L form, the Y form and the four-way intersections. It was established that the node configuration that often produce effective and efficient wayfinding behaviour are the open L forms (Brunye *et al.*, 2018).

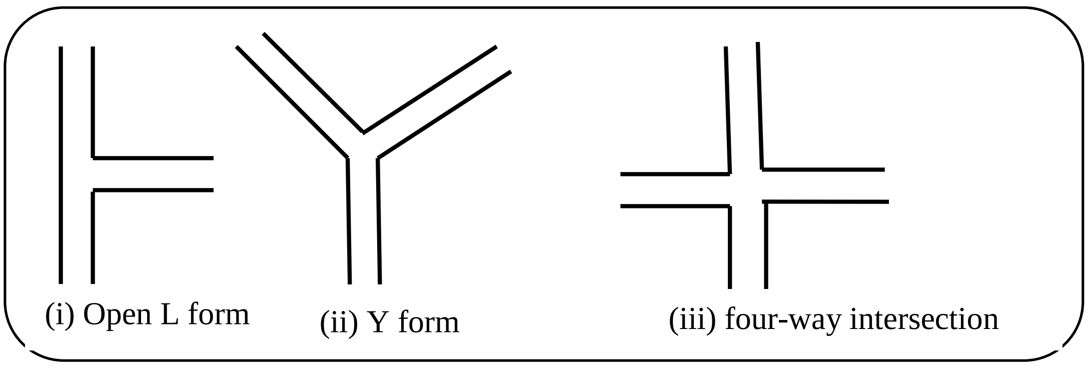


Figure 4.18: Forms of nodes in paths (Source: Researcher's work, 2019)

In addition, visual factors include features that assist patients and visitors during wayfinding by showing similes in different types to augment a person's consciousness of anywhere one is (for instance, signage, artwork and colour); where to go (for instance, signs and indicator); and what to do (for instance, instructional signs). The study established that signage should be consistent in language and translated to major local languages for easy comprehension. Also, artwork and pictographs helps to produce optical picture that can be amassed in reminiscence and get back when needed. As such, artwork should be used for people in wayfinding decision points (patients and vsitors) in order to evoke and provoke memories to remember and recall routes and destinations. In addition, colour is a function of light that illuminates and enhance visibility of pathways. Consequently, use of colour in layout of buildings in hospital should be zoned and differentiatd with colour codes of not more than four colour codes (Ely *et al.,* 2013). As such, colour helps to create visual memory in wayfinding process.

The framework was achieved through affordances and information using the knowledge in the world. The wayfinder perceives the environmental cues from objects using the commonsense knowledge, and affordance which constitute the users' spatial ability. The victorious transactions of these parts were essential during the wayfinding undertaking, so that the wayfinder would be able to reach its desired destination. Accordingly, the utilisation of cue affordance directs the wayfinder from individual junction (node) to another. Further spatial affordances, for instance sign's affordance to show information, a choice position affordance to gaze around to confirm route selection, or doorways affordance to exploit, were understood in the framework. These affordances permit for the wayfinder's intuition and navigation.

Similarly, the mental affordances (commonsense knowledge) were symbolised through the wayfinder's choice procedure. Furthermore, signs data provides it's been coordinated with the wayfinder's data, path affords choice, and resolution positions give inquiring, familiarising, and choosing how to continue. These procedures were overtly integrated in the decision-making process. The wayfinding strategy employed by the wayfinder allows the user to actually perform the wayfinding task based on the desired destinations and preferences in terms of the strategy to be used. Accordingly, the wayfinder is expected to gaze at every choice for cues or sign data having the wayfinders target, and afterward exploit the matching ‘’go-to’’ affordance. This procedure continues pending when the wayfinder reaches the desired destination. Furthermore, at choice positions anywhere there were two or extra likely paths that pilot to the desired destination, path selection have to be made by the wayfinder. As such, the wayfinder needs to apply additional strategy of other possible directions with highest preference value.

When unfamiliar users’ first experience an environment, it is important to first establish knowledge about the world in which to navigate. Consequently, the commonsense knowledge was required to successfully navigate the hospital environment. It is also required to discover and pursue paths from one position to another, and to amass and utilise comparative location of spaces (Kuiper, 1978). This study focused on person’s data desires for getting a destination which comprises the ability to interpret and comprehend the sense of what is interpreted and being able to navigate the environment.

4.7.1: Operationalisation of the perceptual wayfinding framework

The utilisation of the framework is significant to the hospital users (patients and visitors) and the professionals. The major important factors to consider in wayfinding designs are spatial and visual features with their attributes. Consequently, the intuition of the wayfinder on spatial features at each decision-making point during navigation could ease wayfinding in hospitals. Infact, patients find wayfinding performance easy when landmarks (prominent fetures) are properly integrated in hospital designs and positioned at the appropriate decision-making points such as entrances, exit, junctions, along the route, and at destinations. In addition, the optimal attributes to consider in the design of landmarks include differentiated buildings height and form, and wall colour of not more tha four types (Ely *et al.*, 2013). Other landmark features included in wayfinding designs comprise of landscape elements (trees), signage, fountains, sculpture and pictographs. These environmental cues are searched and used by patient and visitors to locate, remember and recall routes during wayfinding to find the desired destination with ease.

There should be precise directional circulation system and adequate waitng areas in hospital design to ease wayfinding. This would prevent patients following crowd to wrong destinations especially as observed in emergency and GOPD's. Furthermore, wayfinders should have clear visual access from the entrance to most destination zones. Consequently, most destination zones should have main circulation routes radiating from the entrance core with appropriate cues and nodes along the route to ease wayfinding (See Figure 4.19).

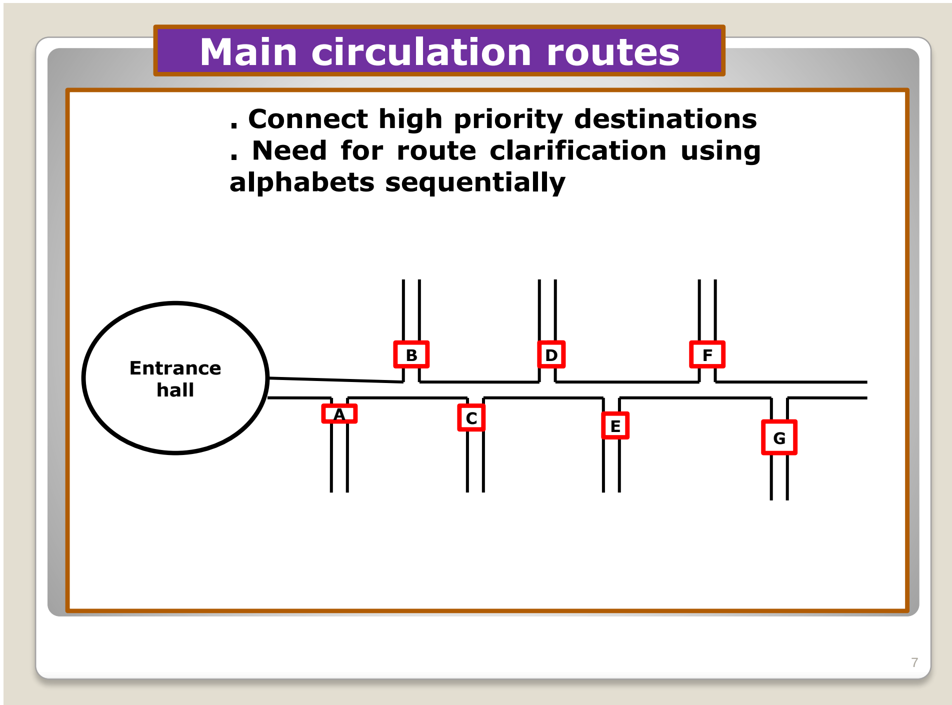


Figure 4.19: Main circulation routes (Source: Researcher's work, 2019)

Furthermore, patients and visitors should be able to read and interpret the signs in English and major local languages supported with cues such as pictographs and sculpture (artwork) for better comprehension. Accordingly, it is suggested the incorporation of smart hospital designs in the development of perceptual wayfinding framework would make navigation easier for patient and visitors unfamiliar with the hospital environment.

4.7.2 Comparison of previous framework with the current framework

Rooke (2012) used prescriptive wayfinding framework, the themes were grouped into three factors which include physical, coded information, and social practices. In addition, the social practices were explained in terms of verbal direction giving by staff and volunteers in the hospital which is not architectural. The perceptual wayfinding framework in this study extended the structure of knowledge with the addition of wayfinding experiences and behaviour as a critical factor in the design of hospital wayfinding. This is because the social values of the wyfinder are vital to wayfinding ability of the patient or visitor in hospital environment. Accordingly, the grouping of the themes on each factor was based on the way the attributes cause users' understanding of the cues for wayfinding in the hospital environment.

The wayfinding feature framework of Castell (2017) was concerned about the manipulation of building attributes on wayfinding accomplishment by grown-ups with and without cerebral disability. Contrastingly, the themes in the study were grouped into spatial features, sensory features, visual features, and supportive features. Similarly, the wayfinder's spatial ability and wayfinding experience in the setting is equally considered to be important which was missing in the wayfinding feature framework of Castell (2017). As such, the perceptual wayfinding framework is developed to explain the social values that was lacking in the previous frameworks. This social value includes the wayfinding behaviour (movement) and culture of the people as one of the domains in hospital wayfinding.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The first objective surveyed users' perceptions of wayfinding in the hospital environment. It was established that signage and visual access significantly influenced users' ease of navigation in the hospitals. Consequently, signage information should be translated into the main local languages for better understanding of the meaning. The design implication is that signage should be legible and consistent in language and design; while visual access should give greater vista with unobstructed sight lines to the larger part of the building interior to ease navigation. Furthermore, building layout was difficult to understand which made navigation to desired destination difficult and stressful to patients. This suggests that building configuration directly impacts on users' wayfinding behaviour and the relationship between spaces.

Secondly, critical factors were determined as stated in objective two which include visual access, landmarks, circulation paths, and path junctions. This will guide the professionals in the prioritisation of factors in hospital wayfinding design. The implication is that the established attributes could aid in the conceptual composition of building layout to appear simple to navigate by unfamiliar users. To design public hospital such as teaching hospital, spatial, visual and social values are significant factors to consider for effective and efficient wayfinding system.

Thirdly, objective three was to evaluate the effectiveness of hospital designs in relation to wayfinding in which the study established that pathways were legible but path junctions had no directional signs which made wayfinding difficult to navigate. Maps provided were not legible to patients in all the hospitals studied. Also, crowding was established to hamper direction-finding in the hospitals. This implies that the number of wayfinding decision points available for path choices should be reduced to minimum numbers in hospital design to ease navigation. Consequently, path junction is a function of building layout, which suggests that building configuration should have simplified circulation network to ease navigation in hospital. The design implication is that circulation intersections should be distinctive with directional signs, and clearly visible cues to reduce direction-finding errors at such decision points. Furthermore, adequate circulation width should be provided for pathways and large waiting areas should be provided to avoid crowdedness and patients following crowd to wrong destinations particularly at Emergency and GOPDs. In addition, the design of circulation systems should be able to predict future extensions and modifications, since hospital design are expected to be dynamic and expand over time due to new specialties, sectors, increase in population, and technologies.

Some features were found to be prominently used as a reference point for new users' during wayfinding in the hospital to orient position, confirm route, and recognise destinations. These landmark features used include architectural differentiation, sculpture, pictographs, landscape elements and sign posts. This suggests that local landmarks that serve as information needs of the users should be distinctive, memorable and recognisable along the route to support orientation, and ease navigation. Consequently, markers must be planned to be discernible from a distance at resolution-making place in the hospital during navigation.

The use of wall colour strips was found not effective for navigation in hospitals. The use of colour should be distinctively applied on buildings zoned differently in the hospitals. The implication is that wall colour strips should provide both directional and destination information needs to ease wayfinding in the hospital environment. This could be achieved by differentiating spaces by zoning with colour codes of not more than four colours for walls of the buildings. In addition, the hospital morphology and zoning should be done with a system of hierarchical circulation radiating outwards from a central core, such that the mould of organisation is through a system. Accordingly, patients or visitors to the hospital are made to first come in contact with the most popular environments, followed by the main significant zones of the structure. As such, the design of the hospital should have a morphologic mould that prioritises the information desires of the patients while still maintaining the established protocol for hospital designs. Consequently, such design could enable the wayfinders to reach destinations in a safe, comfortable, effective, and efficient manner. In addition, major components and modules of smart hospital design such as movement, culture and illumination should be incorporated in hospital buildings to solve most of the wayfinding challenges in hospital environment.

Finally, the main outcome of the study was the development of a perceptual wayfinding framework for effective navigation of unfamiliar users visiting the hospital environment in North Central Nigeria which was achieved in line with objective four. The framework is to guide the professionals and stakeholders in the design and improvement of hospital wayfinding. Consequently, there is the need for collaboration amongst the policy makers, stakeholders and design professionals such as architects, planners, and graphic designers in the provision of hospital wayfinding designs.

Building configuration has the potential of regulating the entire environmental legibility of the hospital with the relationships among spaces. Therefore, in large hospital buildings, the general knowledge of building representations assists persons to familiarise themselves in new locations. Still, the maps and directional signs in most of the hospitals studied were not properly represented for ease of reading and perception. Cue-searching was the main activity during wayfinding for an unfamiliar user to the hospital environment. In searching cues, people depend on their visual senses and perform an optical gesture concerning the perception of searching for cues, selecting the signs and translating the information into action. Consequently, visual factor should be a significant factor to consider in the spatial wayfinding design.

The pace of perception between similar functions should be enhanced by applying graphic information to create the space further discernible and for reassurance. Though, graphic data cannot make up for complex structure formation. As such, both graphic and spatial symbols should serve like markers to complement each other. The teaching hospitals may stimulate anxiety by creating bewilderment and feelings of ineptitude in wayfinding due to the building complexity. As such, building layout should appear simple to navigate by connecting high priority destinations with clear routes and visual access. The design failure in the hospitals might generate problems that people encounter during wayfinding. As such, the same design should be used to solve the wayfinding problems and not signage alone.

Theoretically, enhanced wayfinding systems in hospitals improve the bodily and psychological fitness of patients, but as well the economic fitness of the hospital. Also, it is understood that staff predicament in terms of productivity are connected with direction-finding challenges as staff take time out directing patients to various destinations in the hospital. Accordingly, creating easy direction-finding for the new patients in hospitals require that the space be planned in such a way that it helps person's configuring procedures of tasks. Finally, hospital designers should provide architectural guidance to solve wayfinding difficulties and crowdedness for the users to feel less disturbed, and at the same time improve wayfinding systems in hospitals.

5.2 Recommendations

This inquiry recommends the following additional research:

i) Individual's experience of the experiential world is usually limited due to their intuition of fractions of the world. As such, the experience acquired is generally deficient and inexact, which results in wayfinding errors such as poor perception and recognition errors (Golledge, 1999). These errors were not accounted for in this study. Further research could be carried out to consider these mistakes and incorporate a sift device that chooses the main pertinent affordances and data for a specified undertaking.

ii) Individuals may behave differently in hospital setting based on their characteristics and ability. As such, prospective study might be directed to examine the influence of individual characteristics and ability such as age, educational background, and language on the individual preferences of search strategy in hospital wayfinding.

iii) This study examines teaching hospitals in north central Nigeria. Similar studies could be carried out in other regions of Nigeria to make more wayfinding frameworks for a variety of building category and sites. Similarly, other categories of building could include taking all hospitals in the zone ($\geq$ 250 bed capacity) and similar large environments Like Hotels, Airports and Cities.

iv) Also, estimation of the cost of delays and disappointments caused by wayfinding difficulties can be investigated. Furthermore, in the course of investigation, the departments of the hospitals that have more victims of wayfinding difficulties can be established.

iv) This study did not examine wayfinding for the physically challengd such as the blind and wheel chair users in hospitals. Further research might assess wayfinding for the physically challenged patients in hospitals.

5.3 Contribution to Knowledge

- This study made both academic and practical contributions to the body of knowledge by theoretically establishing the critical design factors as the most predictive indicators for effective wayfinding systems in teaching hospitals. The professionals such as the architects and planner can readily use such information in hospital design.

- Practically, the developed perceptual wayfinding framework is an easy tools that guide professionals and policy makers in the design and post-occupany evaluation of hospital wayfinding systems. The tool was designed to aid quick decision making, such that the guideline becomes handy when decisions are to be taken relating to design or improvement to hospital wayfinding.
- Accordingly, it is suggested in the framework that smart hospital design could solve the majority of the wayfinding difficulties users' encounter in the hospital environment.

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APPENDICES

APPENDIX A: INTERVIEW QUESTIONS

Code no: .... **Respondents:** patients and visitors

Interview schedule of questions: Users' perception of wayfinding performance in teaching hospitals. The aim of this study is to investigate the experience of the hospital users' (such as patients, and their family members), who are unfamiliar with the hospital environment, in terms of their movement pattern in locating their destinations with a view to developing a model to improve wayfinding performance in hospitals.

Part I: Individual attributes : Kindly provide the following information

1. Age: ....
2. Gender: ....
3. Educational level: ....
4. How many times have you visited the hospital: ....?

5. Do you have any form of disability or impairment: ....If any, what form of disability or impairment? ....
6. When visiting the hospital, is your visit as a patient or carer of a patient...

Part II: Environmental attributes

1. How do you understand the arrangement of buildings in space with regards to your movement from parking lot to your destination in the teaching hospital?
....

2. Which form of assistance is available in the information desk of the hospital in finding direction to your destination?
....

3. What kind of information do you generally use to get to your destination when you enter the hospital environment for the first time?
....

4. What is your opinion about the arrangement of the buildings in the hospital in terms of finding your destination?
....

5. What important features aid you in finding your way (landmark) within the hospital environment?
....

6. How have you use signage in locating your destination in the hospital environment?..

Part III: Architectural design attributes

7. How do you consider the building floor plan arrangement (building layout) towards getting to your destination?
....

8. How does the location of the building entrance influence your ability to find your way in getting to your destination in the hospital?
....
....
....

9. How does lighting in the circulation space influence your movement in getting to your destination in the hospital?
....
....
....

10. How does the external wall colour on the buildings help you in finding your way easily in the hospital?
....
....
....

Part IV: Perception and wayfinding performance attributes

11. Kindly describe your experience in locating your destination for the first time in the hospital?
....
....
....

12. What are the obstacles that affect your movement to your destination?
....
....
....
Thank you for your responses to the questions.

Interview Guide

I want to thank you for considering the request and for your time for the meeting. My name is Ahmed Salawu, a PhD research student of Federal University of Technology, Minna. I would like to talk to you about your experiences on wayfinding performance in the hospital. Precisely, we are assessing the users' perception regarding the effectiveness of the architectural design quality in facilitating the legibility and ease of wayfinding in the travel experience in the hospital in order to use the lessons to improve future design interventions in healthcare facilities in Nigeria.

The duration of the interview will be less than an hour. I will be taking notes and the session will be recorded. I want to assure you that all responses will be kept confidential. This implies that only the research team members will have knowledge of your interview responses and we will ensure that any information included in our report does not identify you as the respondent. Haven explained the need for the interview; I hope you agree for the conduct of the interview.

Are there any questions about what I have just explained?

Are you willing to participate in this interview?

APPENDIX B: QUESTIONNAIRE SURVEY

Questionnaire survey: Users' perception of wayfinding performance in hospitals: The aim of this study is to assess the experience of the hospital users' (such as patients, and their family members), who are unfamiliar with the hospital environment, in terms of their movement pattern in locating their destinations with a view to developing a model to improve wayfinding performance in hospitals. Kindly complete the following survey which seeks to assess users' perception of wayfinding performance in teaching hospitals in north central Nigeria.

Instruction: Please tick your response in the options given **Respondents:** Patients

Part I: Users' demographic characteristics: **Department/Unit of visit…………………..**

1. Gender: Male ☐ Female ☐

2. Age: 20-34 yrs ☐ 35-49yrs ☐ 50-64 yrs ☐ 65+yrs ☐

3. Highest educational level attained: Primary ☐ Secondary ☐ Graduate ☐ None ☐

4. Language most spoken: English ☐ Hausa ☐ Yoruba ☐ Igbo ☐ Others ☐

5. How many times in a year do you visit the hospital? 1 time ☐ 2-3times ☐ > 3 times ☐ Never ☐

6. Did you ask someone for direction when you visited the hospital for the first time?

   Yes ☐ No ☐

Part II Statement These statements refer to your perception and ease of wayfinding regarding **environmental attributes** in the hospital buildings. Tick the box appropriately**.**	**Strongly disagree 1**	**Disagree 2**	**Agree 3**	**Strongly Agree 4**
7. Do you agree that the use of verbal route direction can lead one to the required destination in the hospital?				
8. Do you agree that the use of important buildings to mark a place within the hospital can direct someone to the required destination?				
9. Do you agree that the use of important trees in the hospital can direct someone to the required destination?				
10. Do you agree that the use of important shrubs in the hospital can direct someone to the required destination?				
11. Do you agree that to imagine the picture of the buildings' layout in one's mind can direct someone to the required department in the hospital?				
12. Do you agree that the use of hospital map can direct one to the required destination?				
13. Do you agree that from the hospital entrance one can see the various important buildings leading to the required destination (visual access)?				
14. Do you agree that the building arrangement is clear enough for one to locate his destination in the hospital?				
15. Do you agree that the building plan shape is clear enough for one to locate his destination in the hospital?				

16. Do you agree that the directional information obtained from the important buildings along the path is useful for locating one's destination?				
17. Do you agree that the path (passage) taken in the hospital provided useful information to the desired destination?				
18. Do you agree that the information obtained from the path boundaries (edges) is useful in directing one to the desired destination?				
19. Do you agree that the information obtained from the area (districts) is useful in directing one to the required destination.				
20. Do you agree that the information obtained at the corridor intersections is useful in directing one to the required destination?				
21. Do you agree that the door numbers in hospital are useful in identifying your desired destination?				
22. Do you agree that the grouping of related departments together in the hospital is useful for locating one's destination?				
23. Do you agree that the similarity of building arrangement in the hospital influences locating one's destination?				
24. Do you agree that the differences observed in the building design influences locating one's destination?				
Part III: Architectural attributes in wayfinding				
25. Do you agree that the **building entrance** location is easy to identify in directing someone to the required destination (clear)?				
26. Do you agree that the building floor plan arrangement influences one in locating the desired destination?				
27. Do you agree that circulation spaces are clear for easy direction-finding to one's destination?				
28. Do you agree that identifying the pathways to one's destination in the hospital is clear?				
29. Do you agree that identifying the position of stairways/elevators to one's destination in the hospital is clear?				
30. Do you agree that too many patients around the circulation space (crowd) can influences the ease of finding one's way to the required destination?				

31. Do you agree that from the lobby, the picture of the environment is clear to someone in finding the required destination?				
32. Do you agree that the role played by lighting in the circulation spaces influences the ease of locating one's destination?				
33. Do you agree that the floor finishes in the circulation space influences the ease of locating one's destination?				
34. Do you agree that the colour strips used on the walls are very useful in directing someone to the desired destination?				
35. Do you agree that the similarity of the building shape influences the ease of finding one's way to the desired destination?				
36. Do you agree that the number of corridor intersections without directional signs could make it difficult to find one's destination?				
37. Do you agree that the collection of seats to take a rest in the circulation space influences finding one's destination?				
38. Do you agree that the use of plants / water body influences direction-finding to the required destination?				
39. Do you agree that the design of signs/symbols is clear for finding direction to the desired destination in the hospital?				
40. Do you agree that newcomers to the hospital are satisfied with the signage systems of the buildings?				
41. Do you agree that newcomers to the hospital are satisfied with the effectiveness of wayfinding design systems in the hospital buildings?				

Part IV: Wayfinding experience: Statement These statements refer to your perception and ease of wayfinding experience regarding the hospital buildings. **Tick the box appropriately**.	**Strongly disagree 1**	**Disagree 2**	**Agree 3**	**Strongly Agree 4**
42. To what extent do you agree that **wayfinding experience** was **stressful** to new comers to the hospital?				

43. To what extent do you agree that one can **get lost** on the way to one's destination in the hospital by missing the normal direct route?				
44. To what extent do you agree that you **have difficulty** in finding your way around the hospital?				
45. To what extent do you agree to have **stopped more than twice** to ask for direction to your destination in the hospital buildings?				
46. To what extent do you agree to have **stopped to read signs** along the route to your destination?				
47. To what extent do you agree to have **looked around** in finding the way to your destination in the hospital?				
48. To what extent do you agree to have used the **shortest routes** to your destination in the hospital?				
49. To what extent do you agree to have **missed your way** within the hospital?				
50. To what extent do you agree that there are **too many turns** in the **circulation route** to your destination in the hospital?				
51. To what extent do you agree that the directional signs were appropriately placed at **decision points** in the circulation space in the hospital?				
52. To what extent do you agree that the **directional signs** are easy to identify in the hospital?				
53. To what extent do you agree that the **destination signs** are easy to identify in the hospital?				
54. To what extent do you agree that the **circulation path** visibly led you to your destination without confusion in the hospital?				
55. To what extent do you agree to be **confident** in moving from the hospital entrance to your destination without asking for direction?				
56. To what extent do you agree that your **state of mind** affect you (have a feeling of anxiety) in **locating your destination** in the hospital?				

Thank you for your responses to the questionnaire. For any inquiry about your right as research participant, you may please call 08064468801.

APPENDIX C: OBSERVATION SCHEDULE

Standard observation schedule of wayfinding performance in teaching hospital

Respondent: Patients and visitors

Research type: Descriptive research

Research objective: To determine the effectiveness of hospital designs in relation to wayfinding performance in the teaching hospital complex.

Section: The section of the hospital to carry out the observation include: Accident and Emergency unit, Out-patient consulting room, Radiology, Laboratory unit, and Paediatric consulting unit.

Unit code: .... **Respondent's code**: ....

S/No	Behavioural enquiry to observe	Observed behaviour	Comments
1	The distance travelled from origin to destination.		
2	Time taken to complete navigation.		
3	The number of decision making stops to look around.		
4	The number of times the participant needed to look around to find their way.		
5	The number of times the participant backtracked.		
6	The number of wrong turns made in the journey.		
7	The number of times the participant needed to ask for verbal directions on the movement route.		
8	The number of corridor intersections from origin to destination as observed in the floor plan drawings or as observed in the physical setting.		
9	Critical wayfinding aids in the hospital environment.		
10	Crowd interruption in the circulation space.		
11	Layout complexity of the buildings		
12	Architectural differentiation observed from building plan		
13	Floor plan configuration observed		
14	Symmetry of building configuration		

15 How useful is the information obtained from the observed junctions (**nodes)** to the destination?

APPENDIX D: Codebook for survey4hospital wayfinding

S/no	Full variable name	SPSS Variable name	Coding instruction for values
_______	**Identification number**	**Id**	**Subject identification number**
_______	Gender	gender	Male=1 , Female=2
_______	Age	age	1=20-34, 2=35-49, 3=50-64, 4=65+
_______	Highest educational level	educ	1=Primary, 2=Secondary, 3=Graduate, 4=None
_______	Language spoken	langsp	1=English, 2=Hausa, 3=Yoruba, 4=Igbo, 5=Others
_______	No of visit to hospital	timesvis	1=1 time, 2=2-3times, 3=>3times, 4=never
_______	Ask someone for direction	ask	1=yes, 2=no
_______	Use Verbal direction	B1	1=Strongly disagree, 4=strongly agree
_______	Use Important building to find direction	B2	1=Strongly disagree, 4=strongly agree
_______	Use trees to recognize direction	B3	1=Strongly disagree, 4=strongly agree
_______	Use important shrubs to identify direction	B4	1=Strongly disagree, 4=strongly agree
_______	Imagine layout of building picture to get to dept	B5	1=Strongly disagree, 4=strongly agree
_______	Map to direct	B6	1=Strongly disagree, 4=strongly agree
_______	See direct from entrance to important building	B7	1=Strongly disagree, 4=strongly agree
_______	Building arrangement is clear enough	B8	1=Strongly disagree, 4=strongly agree
_______	Building plan shape is clear enough	B9	1=Strongly disagree, 4=strongly agree
_______	Useful Information from important building	B10	1=Strongly disagree, 4=strongly agree
	Useful Information from passage	B11	1=Strongly disagree, 4=strongly agree

_______	Useful Information from path boundary	B12	1=Strongly disagree, 4=strongly agree
_______	Useful Information from area	B13	1=Strongly disagree, 4=strongly agree
_______	Useful Information from junction	B14	1=Strongly disagree, 4=strongly agree
_______	Useful Information from signage	B15	1=Strongly disagree, 4=strongly agree
_______	Grouping of related dept Useful to direct wayfinding	B16	1=Strongly disagree, 4=strongly agree
_______	Similar building influences finding a location	B17	1=Strongly disagree, 4=strongly agree
_______	Differences in building design influences finding dept	B18	1=Strongly disagree, 4=strongly agree
_______	Easy identification of building entrance	A1	1=Strongly disagree, 4=strongly agree
_______	Floor plan arrangement not difficult	A2	1=Strongly disagree, 4=strongly agree
_______	Easy direction finding in circulation space	A3	1=Strongly disagree, 4=strongly agree
_______	Legible pathway identification	A4	1=Strongly disagree, 4=strongly agree
_______	Easy identification of stairway	A5	1=Strongly disagree, 4=strongly agree
_______	Crowd around circulation can influence the ease of wayfinding	A6	1=Strongly disagree, 4=strongly agree
_______	Visible environmental picture	A7	1=Strongly disagree, 4=strongly agree
_______	Lighting up circulation space play role in wayfinding	A8	1=Strongly disagree, 4=strongly agree
_______	Floor finishes make wayfinding easy	A9	1=Strongly disagree, 4=strongly agree
_______	Wall colour strips are useful to wayfinding	A10	1=Strongly disagree, 4=strongly agree
_______	Similarity of building shape influences wayfinding	A11	1=Strongly disagree, 4=strongly agree
	Corridor intersection makes wayfinding difficult	A12	1=Strongly disagree, 4=strongly agree

_______	Seat in circulation influences wayfinding	A13	1=Strongly disagree, 4=strongly agree
_______	Use of plants and water influences wayfinding	A14	1=Strongly disagree, 4=strongly agree
_______	Designed signage systems make destination easy to identify	A15	1=Strongly disagree, 4=strongly agree
_______	Stressful wayfinding experience	WF1	1=Strongly disagree, 4=strongly agree
_______	Got lost on the way	WF2	1=Strongly disagree, 4=strongly agree
_______	Have difficulty in finding a way	WF3	1=Strongly disagree, 4=strongly agree
_______	Stopped more than twice to ask	WF4	1=Strongly disagree, 4=strongly agree
_______	Stopped to read signs	WF5	1=Strongly disagree, 4=strongly agree
_______	Looked around	WF6	1=Strongly disagree, 4=strongly agree
_______	Use shortest route	WF7	1=Strongly disagree, 4=strongly agree
_______	Missed your way	WF8	1=Strongly disagree, 4=strongly agree
_______	Too many turns in circulation	WF9	1=Strongly disagree, 4=strongly agree
_______	Directional signs placed at decision points	WF10	1=Strongly disagree, 4=strongly agree
_______	Directional signs easier to see	WF11	1=Strongly disagree, 4=strongly agree
_______	Destination sign easy to see	WF12	1=Strongly disagree, 4=strongly agree
_______	No confusion in circulation path	WF13	1=Strongly disagree, 4=strongly agree
_______	Confident in moving to destination	WF14	1=Strongly disagree, 4=strongly agree
	State of mind affects wayfinding	WF15	1=Strongly disagree, 4=strongly agree

Apppendix E: Reliability coefficient test by Item Statistics

	Mean	**Std. Deviation**	**N**
B1	2.99	.852	374
B2	2.76	.832	374
B3	2.19	.843	374
B4	2.13	.901	374
B5	2.59	.888	374
B6	2.63	1.029	374
B7	2.49	.824	374
B8	2.51	.869	374
B9	2.46	.820	374
B10	2.93	.723	374
B11	2.81	.782	374
B12	2.66	.802	374
B13	2.68	.721	374
B14	2.84	.784	374
B15	2.97	.808	374
B16	2.91	.799	374
B17	2.51	.824	374
B18	2.70	.849	374
A1	2.83	.807	374
A2	2.57	.777	374
A3	2.67	.765	374
A4	2.67	.758	374
A5	2.61	1.705	374
A6	2.57	.891	374
A7	2.56	.786	374
A8	2.76	.782	374
A9	2.38	.799	374
A10	2.55	.839	374
A11	2.49	.801	374
A12	2.51	.905	374
A13	2.41	.793	374
A14	2.41	.830	374

Appendix F: Participants' attributes for case study one (BSUTH, Makurdi)

	Age (years)	Gender	Educ. level	No of visit	Disability type	Type of visit
Respondent 1	48	Female	Higher Educ.	Several times	No	Patient's Career
Respondent 2	39	Female	Secondary	Several times	No	Patient's Career
Respondent 3	25	Male	Medical lab. Sc.	Several times	No	Staff/Career
Respondent 4	47	Male	PhD	Not often	No	Patient's Career
Respondent 5	33	Male	Secondary	Several times	Nil	Career
Respondent 6	57	Male	None	One time	No	Career
Respondent 7	40	Female	Higher Educ.	Several times	No	Patient
Respondent 8	28	Male	Basic Educ.	Several times	No	Patient
Respondent 9	23	Female	Secondary	Several times	No	Career
Respondent 10	23	Female	Basic Educ.	One time	No	Career
Respondent 11	26	Male	Degree	One time	None	Patient
Respondent 12	28	Male	Degree	Four times	None	Patient's Career
Respondent 13	39	Male	None	Two times	None	Patient
Respondent 14	31	Female	M.Sc.	Several times	None	Patient
Respondent 15	34	Male	Higher Educ.	Many times	No	Patient
Respondent 16	54	Male	Higher Educ.	Often	No	Patient
Respondent 17	32	Female	Higher Educ.	Several times	No	Visitor
Respondent 18	29	Female	None	Many times	No	Career

A15	2.89	.853	374
WF1	3.13	.873	374
WF2	2.99	.804	374
WF3	2.85	.955	374
WF4	2.91	.969	374
WF5	2.91	.901	374
WF6	2.69	.870	374
WF7	2.59	.955	374
WF8	2.71	1.040	374
WF9	2.57	.998	374
WF10	2.49	1.003	374
WF11	2.82	.958	374
WF12	2.67	.974	374
WF13	2.52	.957	374
WF14	2.33	.796	374
WF15	2.52	1.037	374

	Age (years)	**Gender**	**Educ. level**	**No of visit**	**Disability type**	**Type of visit**
Respondent 19	45	Male	Diploma	Several times	Nil	Patient
Respondent 20	35	Male	M.Sc.	Five times	No	Patient
Respondent 21	60	Male	Higher Educ.	Several times	No	Patient
Respondent 22	21	Male	Graduate, B.Sc.	One time	No	Patient
Respondent 23	21	Female	Secondary	Thrice	Nil	Patient
Respondent 24	21	Female	Graduate, B.Sc.	One time	Nil	Career
Respondent 25	30	Female	B. Educ.	Several times	No	Patient
Respondent 26	20	Female	Graduate, B.Sc.	Three times	No	Career

Appendix G: Participants' attributes case study two (UATH, Gwagwalada, Abuja)

Appendix H: Participants' attributes for case study three (UITH, Ilorin)
Appendix I: Participants' attributes of case study four (JUTH, Jos)

	Age (years)	Gender	Educ. level	No of visit	Disability type	Type of visit
Respondent 33	48	Female	Higher Educ.	Several times	No	Patient's Career
Respondent 34	39	Female	Secondary	Several times	No	Patient's Career
Respondent 35	25	Male	Medical lab. Sc.	Several times	No	Staff
Respondent 36	47	Male	PhD	Not often	No	Patient's Career
Respondent 37	33	Male	Secondary	Several times	Nil	Career
Respondent 38	57	Male	None	One time	No	Career
Respondent 39	40	Female	Higher Educ.	Several times	No	Patient
Respondent 40	28	Male	Basic Educ.	Several times	No	Patient
Respondent 41	23	Female	Secondary	Several times	No	Career
Respondent 42	23	Female	Basic Educ.	One time	No	Career
Respondent 43	26	Male	Degree	One time	None	Patient
Respondent 44	28	Male	Degree	Four times	None	Patient's Career
Respondent 45	39	Male	None	Two times	None	Patient
Respondent 46	31	Female	M.Sc.	Several times	None	Patient
Respondent 47	34	Male	Higher Educ.	Many times	No	Patient
Respondent 48	54	Male	Higher Educ.	Often	No	Patient
Respondent 49	32	Female	Higher Educ.	Several times	No	Visitor
Respondent 50	29	Female	None	Many times	No	Career
Respondent 51	41	Male	Higher Educ.	Several times	No	Career
Respondent 52	22	Female	Basic Educ.	Several times	No	Visitor
Respondent 53	33	Female	B. Ed	Several times	No	Career
Respondent 54	48	Female	College Educ.	Several times	No	Career
Respondent 55	36	Female	College Educ.	Several times	No	Patient

	Age (years)	Gender	Educ. level	No of visit	Disability type	Type of visit
Respondent 27	29	Male	Masters degree	Seven times	No	Career
Respondent 28	30	Male	Nil	Two times	No	Career
Respondent 29	26	Male	Undergraduate student	Several times	No	Career
Respondent 30	22	Female	Undergraduate student	Several times	No	Career
Respondent 31	21	Female	Undergraduate student	Several times	Nil	Career

Respondent 32	42	Female	Higher Educ.	Four times	Yes (Recent broken arm)	Patient
Respondent 56	25	Male	College Educ.	Many times	No	Patient

Appendix J: Transcribed interview text for case study one (BSUTH, Makurdi)

[illegible]	**Respondent 1**	[illegible]	[illegible]
[illegible]	The buildings has easy	[illegible]	[illegible]

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Appendix K: Transcribed Interview text for case study two (UATH, Gwagwalada, Abuja)

S/N	Questions	Respondent 19	Respondent 20	Respondent 21
1	How do you understand the arrangement of buildings in space with regards to one's movement from parking lot to your destination in the teaching hospital?	Complex	It is not easy	The building arrangement was ok, and very accessible from the parking lot to the hospital
2	Which form of assistance is available in the information desk of the hospital in finding direction to the desired destination?	Signs and Symbols	Verbal direction	Receptionists

Appendix M: Transcribed interview text for case study four (JUTH, Jos)

3	What kind of information can one generally use to get to his or her destination when someone enters the hospital environment for the first time?	By verbal direction, Sign and symbol	It seemed I took the wrong path. I had to ask for direction	Asking for help
4	What is your opinion about the arrangement of the buildings in the hospital in terms of finding the desired destination?	Simple	It is complex	The arrangement is good
5	What important features can assist one in finding his or her way (**landmark**)	Sign and symbol	The massive height of the building was used to describe the GOPD for me .	Door signs

	within the hospital environment?			
6	How have you use signage in locating your destination in the hospital environment?	Reading the signs and symbols	I follow the directional signs. The labels on the lab doors are small to notice.	I use signage when I am lost
7	How do you consider the building floor plan arrangement (building layout) towards getting to your destination?	Sometimes the building layout was very complex	Easily accessible	The layout is ok
8	How does the location of the building entrance influence one's ability to find his or her way in getting to the desired destination?	The placing of the entrance in front of the car park makes it easy	It is easy because of the information desk that is close to the entrance	It does not influence

Appendix L: Transcribed interview text for case study three (UITH, Ilorin)

S/N	Questions	Respondent 27	Respondent 28	Respondent 29
1	How do you understand the arrangement of buildings in space with regards to one's movement from parking lot to your destination in the teaching hospital?	It is easy	The building arrangements are good and easy accessibility	Simple
2	Which form of assistance is available in the information desk of the hospital in finding direction to the desired destination?	Verbal direction	None	Verbal direction

	destination in the hospital?			
3	What kind of information can one generally use to get to his or her destination when someone enters the hospital environment for the first time?	Ask for direction from security	Asking around	Names of wards encrypted on the walls of the buildings
9	How does lighting in the circulation space influence your movement in getting to the desired destination in the hospital?	The adequate lighting help me to see the sign post better	It is ok	Lighting was adequate and it helps me to see well
4	What is your opinion about the arrangement of the buildings in the hospital in terms of finding the desired destination?	It is okay	The building arrangement was simple and we did not have trouble finding the ward	Simple
10	How does the external wall colour on the buildings help one in finding his or her way easily in the hospital?	Colour of buildings are all the same, it has no effect	It does not help because the colours are similar which confused me	It does not
5	What important features can assist one in finding his or her way (landmark) within the	ATM stand at the entrance to know the path to my destination	There are door posts but I cannot read very well.	The signs and door posts
11	Kindly describe your experience in locating the desired destination for the first	With the aid of the security personnel it was very easy, but moving by	It was a bit stressful	I think I got a nurse that took me to where I was going

	time in the hospital? / hospital environment?	self it is stressful		
6	How have you use signage in locating your destination in the hospital environment?	I follow the signs	I read the ones that I can to help me.	The signage is very helpful. Most especially the sign post and arrows
12	What are the obstacles that affect your movement to your destination?	It is easy for me because I am familiar with the building structure	The colours are similar	So many junctions and turns
7	How do you consider the building floor plan arrangement (building layout) towards getting to your destination?	It is simple to access	Good layout and simple to use	Building floor plan is simple

S/N	**Questions**	**Respondent 25**	**Respondent 26**	
1	How do you understand the arrangement of buildings in space with regards to one's movement from parking lot to your destination in the teaching hospital?	It was easy	It is very easy to find my way from the parking lot to my destination in the hospital	
8	How does the location of the building entrance influence one's ability to find his or her way in getting to the desired destination in the hospital?	It is easy	The entrance location is good and we easily found our way from there	It is actually confusing because there are many buildings and one does not know which one to enter
2	Which form of assistance is available	I never had to use the	Receptionist	

9	How does lighting in the circulation space influence your movement in getting to the desired destination in the hospital?	It is very okay	The light shows us our way very well	The lighting was helpful and aid my visibility to the destination
10	How does the external wall colour on the buildings help one in finding his or her way easily in the hospital?	Departments are difficult to identify because all the walls have the same colour	The wall colours are the same but did not help in wayfinding	I got confused about the colours as which way to take when I had to turn to find my way to the haematology lab in the upper floors
11	Kindly describe your experience in locating the desired destination for the first time in the hospital?	It was difficult	The first time I came here, it was the nurses that help us because it was an emergency	I asked people around the hospital

	to the information desk of the hospital in finding your direction to the desired destination?	Information desk	
3	What kind of information can one generally use to get to his or her destination when someone enters the hospital environment for the first time?	I had help from one of the hospital staff	Asking someone for help
4	What is your opinion about the arrangement of the buildings in the hospital in terms of finding the	It is ok	It is quite confusing

	desired destination?			
12	What are the obstacles that affect your movement to your destination?	Colour of walls are similar making it difficult to navigate the hospital	When there are crowd of people in the hallways	Buildings are very far from the entrance gate
5	What important features can assist one in finding his or her way (landmark) within the hospital environment?	The sign post	Door signs	
6	How have you use signage in locating your destination in the hospital environment?	I was directed	By reading the signage in the hallways	
7	How do you consider the building floor plan arrangement (building layout) towards getting to your destination?	It is ok	I picture the building in my head when walking around	

8	How does the location of the building entrance influence one’s ability to find his or her way in getting to the desired destination in the hospital?	The entrance is in a good location	I do not know
9	How does lighting in the circulation space influence your movement in getting to the desired destination in the hospital?	It is efficient	Lighting reflects signs and helps me see everything
10	How does the external wall colour on the buildings help one in finding his or her way	The colours are the same	The external colours are uniform

	easily in the hospital?		
11	Kindly describe your experience in locating the desired destination for the first time in the hospital?	It was easy	The first time, I had to ask for direction
12	What are the obstacles that affect your movement to your destination?	There are many people in the hallways and corridors at peak period, which makes the hospital crowded and causes difficulty in wayfinding	No obstacles

Appendix N: PCA Correlation matrix environmental factor

Corr.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B17	B18
B1	1.000	.371	.066	-.006	.233	.055	.151	.002	.001	.199	.248	.145	.100	.086	.186	.055	.163
B2	.371	1.000	.256	.124	.241	.141	.156	-.037	-.117	.167	.139	.183	.111	.185	.222	.081	.193
B3	.066	.256	1.000	.483	.224	.092	.134	.001	.012	.009	-.054	.035	-.041	.068	.062	.087	.098
B4	-.006	.124	.483	1.000	.211	.037	.033	.034	.060	.060	.049	-.016	-.013	.063	.038	.105	.122
B5	.233	.241	.224	.211	1.000	-.075	.225	-.213	-.072	.025	.110	.114	.104	.029	.089	.151	.217
B6	.055	.141	.092	.037	-.075	1.000	.161	-.003	-.039	.217	.105	.154	.252	.242	.088	.078	.029
B7	.151	.156	.134	.033	.225	.161	1.000	.058	.021	.091	.218	.183	.141	.089	.173	.182	.143
B8	.002	-.037	.001	.034	-.213	-.003	.058	1.000	.522	-.014	-.036	.011	-.048	-.001	.069	.007	-.074

B9	.001	-.117	.012	.060	-.072	-.039	.021	.522	1.000	.038	.020	-.069	-.026	-.035	.023	.068	-.044
B10	.199	.167	.009	.060	.025	.217	.091	-.014	.038	1.000	.304	.300	.279	.316	.198	.071	.143
B11	.248	.139	-.054	.049	.110	.105	.218	-.036	.020	.304	1.000	.378	.296	.194	.264	.009	.241
B12	.145	.183	.035	-.016	.114	.154	.183	.011	-.069	.300	.378	1.000	.398	.274	.218	.075	.168
B13	.100	.111	-.041	-.013	.104	.252	.141	-.048	-.026	.279	.296	.398	1.000	.381	.155	-.007	.068
B14	.086	.185	.068	.063	.029	.242	.089	-.001	-.035	.316	.194	.274	.381	1.000	.230	.027	.107
B15	.186	.222	.062	.038	.089	.088	.173	.069	.023	.198	.264	.218	.155	1.000	.353	.121	.066
B16	.200	.186	-.011	.053	.142	.133	.115	-.035	-.024	.179	.275	.150	.155	.353	1.000	.105	.115
B17	.055	.081	.087	.105	.151	.078	.182	.007	.068	.071	.009	.075	-.007	.121	.105	1.000	.174

B18	.163	.193	.098	.122	.217	.029	.143	-.074	-.044	.143	.241	.168	.068	.107	.066	.174	1.000

Appendix O: PCA Correlation matrix for architectural factor

		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
Correlation	A1	1.000	.281	.199	.153	.100	-.107	.109	.161	.154	.104	.167	.078	.198	.114	.101
	A2	.281	1.000	.269	.149	.072	.097	.232	.199	.289	.175	.128	.192	.139	.149	.005
	A3	.199	.269	1.000	.261	.098	-.068	.208	.218	.124	.007	.149	.051	.099	.017	.190

A4	.153	.149	.261	1.000	.213	-.136	.287	.171	.037	.079	.133	.024	.006	.051	.179
A5	.100	.072	.098	.213	1.000	-.070	.113	.026	.105	.087	.007	-.002	.036	.028	.048
A6	-.107	.097	-.068	-.136	-.070	1.000	.040	-.033	.015	.134	.054	.272	.028	.015	.003
A7	.109	.232	.208	.287	.113	.040	1.000	.121	.223	.134	.135	.066	.187	.129	.030
A8	.161	.199	.218	.171	.026	-.033	.121	1.000	.299	.286	-.006	.026	.145	.124	.270
A9	.154	.289	.124	.037	.105	.015	.223	.299	1.000	.358	.084	.055	.209	.273	.082
A10	.104	.175	.007	.079	.087	.134	.134	.286	.358	1.000	.120	.042	.088	.311	.270
A11	.167	.128	.149	.133	.007	.054	.135	-.006	.084	.120	1.000	.024	.068	.166	.085
A12	.078	.192	.051	.024	-.002	.272	.066	.026	.055	.042	.024	1.000	.141	.163	.060

A13	.198	.139	.099	.006	.036	.028	.187	.145	.209	.088	.068	.141	1.000	.182	.084
A14	.114	.149	.017	.051	.028	.015	.129	.124	.273	.311	.166	.163	.182	1.000	.062
A15	.101	.005	.190	.179	.048	.003	.030	.270	.082	.270	.085	.060	.084	.062	1.000

Appendix P: PCA Correlation matrix wayfinding experience factor

		WF1	WF2	WF3	WF4	WF5	WF6	WF7	WF8	WF9	WF10	WF11	WF12	WF13	WF14	WF15
Correlation	WF1	1.000	.461	-.101	.017	.015	.027	.048	.025	.010	-.055	-.001	-.025	-.034	.030	.028
	WF2	.461	1.000	-.062	.091	.039	-.037	-.021	.005	.046	-.032	-.073	-.019	-.047	-.069	.070
	WF3	-.101	-.062	1.000	.345	.339	.156	-.160	.203	.226	-.202	-.293	-.183	-.153	-.258	-.019
	WF4	.017	.091	.345	1.000	.353	.198	-.048	.267	.033	-.083	-.118	-.104	-.153	-.237	-.085
	WF5	.015	.039	.339	.353	1.000	.120	-.078	.352	.058	-.147	-.205	-.116	-.047	-.063	.002
	WF6	.027	-.037	.156	.198	.120	1.000	.040	.040	.017	-.083	.133	.089	.053	-.088	.073
	WF7	.048	-.021	-.160	-.048	-.078	.040	1.000	-.051	-.199	.239	.275	.187	.131	.223	-.219

WF8	.025	.005	.203	.267	.352	.040	-.051	1.000	.144	-.068	-.060	-.029	-.013	.010	.039
WF9	.010	.046	.226	.033	.058	.017	-.199	.144	1.000	.001	-.211	-.197	-.163	-.270	.151
WF10	-.055	-.032	-.202	-.083	-.147	-.083	.239	-.068	.001	1.000	.424	.292	.422	.168	-.107
WF11	-.001	-.073	-.293	-.118	-.205	.133	.275	-.060	-.211	.424	1.000	.435	.270	.329	-.163
WF12	-.025	-.019	-.183	-.104	-.116	.089	.187	-.029	-.197	.292	.435	1.000	.169	.315	-.135
WF13	-.034	-.047	-.153	-.153	-.047	.053	.131	-.013	-.163	.422	.270	.169	1.000	.323	-.011
WF14	.030	-.069	-.258	-.237	-.063	-.088	.223	.010	-.270	.168	.329	.315	.323	1.000	-.040
WF15	.028	.070	-.019	-.085	.002	.073	-.219	.039	.151	-.107	-.163	-.135	-.011	-.040	1.000

Appendix R: Regression coefficients[a] for architectural factor

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	Correlations	Collinearity Statistics

Appendix Q: Regression Coefficients[a] for environmental factor

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.157	.257		4.494	.000	.651	1.663					
	B3	.251	.056	**.254**	**4.499**	**.000**	.141	.361	.256	.229	.220	.750	1.334
	B4	-.011	.052	-.012	-.212	.832	-.114	.091	.124	-.011	-.010	.753	1.327
	B10	.095	.063	.083	1.526	.128	-.028	.219	.167	.079	.075	.810	1.235
	B11	.081	.062	.073	1.319	.188	-.040	.203	.139	.069	.065	.791	1.264
	B12	.096	.059	.093	1.624	.105	-.020	.213	.183	.085	.079	.735	1.361
	B13	.001	.066	.001	.017	.987	-.128	.131	.111	.001	.001	.735	1.360
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF

	B14	.109	.058	.102	1.864	.063	-.006	.224	.185	.097	.091	.793	1.261

a. Dependent Variable: B2

1	(Constant)	.737	.231		3.195	.002	.283	1.191					
	A1	.219	.048	.228	4.569	.000	.125	.314	.281	.232	.218	.913	1.096
	A3	.222	.050	.219	4.480	.000	.125	.320	.269	.227	.213	.952	1.050
	A6	.087	.044	.100	2.002	.046	.002	.173	.097	.104	.095	.906	1.104
	A12	.110	.043	.128	2.553	.011	.025	.195	.192	.132	.122	.899	1.112
	A13	.051	.048	.052	1.058	.291	-.044	.146	.139	.055	.050	.942	1.062

a. Dependent Variable: A2

Appendix S: Regression Coefficients[a] for wayfinding experience

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3.226	.284		11.377	.000	2.668	3.784					
	WF3	-.117	.049	-.139	-2.368	.018	-.214	-.020	-.062	-.123	-.122	.771	1.297
	WF4	.099	.048	.119	2.048	.041	.004	.194	.091	.107	.106	.785	1.273
	WF5	.027	.053	.031	.514	.607	-.077	.132	.039	.027	.027	.748	1.338
	WF8	-.012	.043	-.015	-.268	.789	-.097	.074	.005	-.014	-.014	.847	1.180
	WF10	-.001	.049	-.001	-.011	.991	-.098	.097	-.032	-.001	-.001	.700	1.428
	WF11	-.079	.053	-.094	-1.493	.136	-.182	.025	-.073	-.078	-.077	.673	1.485
	WF12	.013	.048	.016	.279	.780	-.081	.107	-.019	.015	.014	.793	1.261
	WF13	-.022	.049	-.026	-.442	.659	-.117	.074	-.047	-.023	-.023	.793	1.262

a. Dependent Variable: WF2

Appendix T: Research Ethics Certificate


THREE

Zertifikat

Certificat

Certificado

Certificate

Certificat de formation - Training Certificate

Salawu Ahmed

Introduction to Research Ethics

August 19, 2017

FMH

FPH

Appendix U: Total Variance Explained for Environmental Factor

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.322	**18.453**	18.453	3.322	18.453	18.453	2.716
2	1.806	**10.035**	28.488	1.806	10.035	28.488	1.831
3	1.610	**8.946**	37.434	1.610	8.946	37.434	1.646
4	1.285	**7.138**	44.571	1.285	7.138	44.571	1.299
5	1.085	**6.030**	50.601	1.085	6.030	50.601	2.212
6	1.033	**5.736**	**56.338**	1.033	5.736	**56.338**	1.592
7	.979	5.441	61.779				
8	.913	5.070	66.849				
9	.804	4.465	71.314				
10	.766	4.254	75.568				
11	.738	4.099	79.667				
12	.667	3.707	83.374				
13	.572	3.178	86.552				
14	.567	3.152	89.704				
15	.523	2.907	92.611				
16	.491	2.730	95.341				
17	.465	2.585	97.926				
18	.373	2.074	100.000				

Extraction Method: Principal Component Analysis
When components are correlated, sums of squared loadings cannot be added to obtain a total variance

Appendix V: Rotated Component Matrix for Environmental factor

	Pattern Matrix[a]						**Structure Matrix**					
	Component						Component					
	1	2	3	4	5	6	1	2	3	4	5	6
B13	**.753**						**.723**					
B12	**.718**						**.714**					
B11	**.610**			.303			**.645**				-.342	
B10	**.589**						**.617**				-.301	
B14	**.524**			.363			**.579**			.358	-.324	
B3		**.854**						.843				
B4		**.814**						.792				
B8			.864						.858			
B9			.858						.843			
B6				.614			.354			.586		
B5				-.442				.400	.316	-.502		.368
B18				.416		.311	.328			-.447		.405
B15					-.687						-.697	
B16					-.686						-.689	
B1				-.417	-.580					-.430	-.609	
B2		.344			-.550			.424			-.600	
B17						.823						.787
B7						.606						.644

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.[a]

a. Rotation converged in 13 iterations. Threshold ≥ 0.4 in the 1st and 2nd column.

Appendix W: Total Variance Explained for Architectural factor

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.827	**18.848**	18.848	2.827	18.848	18.848	1.951
2	1.521	**10.142**	28.990	1.521	10.142	28.990	1.416
3	1.279	**8.526**	37.516	1.279	8.526	37.516	1.726
4	1.121	**7.474**	44.990	1.121	7.474	44.990	1.658
5	1.054	**7.030**	52.019	1.054	7.030	52.019	1.712
6	1.028	**6.852**	**58.872**	1.028	6.852	58.872	1.152
7	.942	6.281	65.153				
8	.898	5.986	71.138				
9	.811	5.410	76.548				
10	.724	4.827	81.375				
11	.622	4.145	85.520				
12	.593	3.950	89.470				
13	.569	3.796	93.267				
14	.522	3.481	96.748				
15	.488	3.252	100.000				

Extraction Method: Principal Component Analysis

a. When components are correlated, sums of squared loadings cannot be added to obtain total variance

b. The variance and the percent cumulative are bolded. Threshold ≥ 1.0 in the 1st.

Appendix X: Rotated Component Matrix for Architectural factor

	Pattern Matrix[a] Component						**Structure Matrix** Component					
	1	2	3	4	5	6	1	2	3	4	5	6
A1	**.655**						**.655**					
A13	**.591**						**.618**	.322			.339	
A2	**.548**						**.587**					
A3	**.412**		.347	.360			**.471**			.444	.375	
A6		**.815**						**.801**				
A12		**.739**						**.746**				
A10			.710	.369					-.723	.409		
A14			.658						-.664			
A9	.318		.595				.425		-.655			
A15				.839						.818		
A8				.615		.305	.357			.644		
A5					.733					.373	.683	
A4					.642						.681	
A7					.590		.310				.620	
A11						-.872						-.872

Appendix Y: Total Variance Explained for wayfinding experience factor

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.016	**20.105**	20.105	3.016	20.105	20.105	2.369
2	1.701	**11.342**	31.447	1.701	11.342	31.447	2.017
3	1.493	**9.952**	41.399	1.493	9.952	41.399	1.495
4	1.194	**7.958**	49.357	1.194	7.958	49.357	1.378
5	1.092	**7.281**	56.638	1.092	7.281	56.638	1.239
6	1.056	**7.040**	**63.678**	1.056	7.040	63.678	1.880
7	.864	5.758	69.437				
8	.793	5.285	74.722				
9	.713	4.754	79.476				
10	.651	4.340	83.816				
11	.563	3.754	87.570				
12	.538	3.589	91.159				
13	.500	3.334	94.493				
14	.466	3.107	97.599				
15	.360	2.401	100.000				

Appendix Z: Rotated Component Matrix for wayfinding experience factor

	Pattern Matrix[a]						**Structure Matrix**					
	Component						Component					
	1	2	3	4	5	6	1	2	3	4	5	
WF10	**.866**					.315	**.806**					
WF13	**.685**						**.688**					
WF11	**.586**						**.667**					-.359
WF12	**.429**						**.519**					-.396
WF5		**.791**						**.787**				
WF8		**.777**						**.737**				
WF4		**.533**		-.306				**.591**			.372	
WF3		**.468**				.316	-.329	.561				.438
WF2			.845						.846			
WF1			.845						.842			
WF15				.859						.831		
WF7				-.495			.325			-.540		-.315
WF6					.927						.900	
WF9						.794						.761
WF14	.314					-.683	.474					-.736

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization

a. Rotation converged in 18 iterations.

APPENDIX A2: Participants' verbal protocol for observational studies

P 1: I read the signs and symbols (Female, 38years).

P2: I looked at the signs and read the signs as I pass bye.... the signs actually help me to find my destination (Male, 24years).

P3: Hmm! I was confused with the colour strips when I had to turn to find direction to haematology laboratory in the upper floor (Female, 40years).

P4: I used the ATM stand to know the direction to the GOPD from the main entrance (Male, 33 years).

P5: Both natural and artificial lighting were adequate and helps in finding my destinations (Male, 35 years).

P6: The building plan was simple and I did not have difficulty to find my destination (Female, 28 years).

P7: I observed where people entered and asked for confirmation of my destination (Female, 26 years).

P8: Some of the lobbies were dark and not well illuminated (Female, 31 years).

P9: Lighting helps me to see the pathway and signs better in getting to my destination (Male, 37 years).

P10: The building plan was simple to understand (Male, 34 years).

P11: I read the signs and symbols on the wall and signpost to find my way (Male, 36 years).

P12: The wall colour strips did not direct me to the laboratory (Female, 29 years).

P13: Mmm! Let's go back; this is not the right way..... Then, I asked the staff for direction (Male, 42 years).

P14: I used the ATM stand at the entrance, used the signs on the walls and doors to find my way to my destination (Female, 39 years).

P15: I used the pictures and signpost on the wall (Male, 40 years).

P16: It looks like I took a wrong path, so, I asked for from the people around...... (Female, 32years).

Appendix A3: Determining Minimum Returned Sample Size for a Given Population for Continuous and Categorical Data

Population size	Sample size					
	Continuous data (margin of error = 0.03)			**Categorical data (margin of error = 0.05)**		
	alpha=0.10	alpha=0.05	alpha=0.01	P=0.50	P=0.50	P=0.50
	t=1.65	t=1.96	t=2.58	t=1.65	t=1.96	t=2.52
100	46	55	68	74	80	87
200	59	75	102	116	132	154
300	65	85	123	143	169	207
400	69	92	137	162	196	250
500	72	96	147	176	218	286
600	73	100	155	187	235	316
700	75	102	161	196	249	341
800	76	104	166	203	260	363
900	76	105	170	209	270	382
1000	77	106	173	213	278	399
1500	79	110	183	230	306	461
2000	83	112	189	239	323	499
4000	83	119	198	254	351	570
6000	83	119	209	259	362	598
8000	83	119	209	262	367	613
10000	83	119	209	264	370	623

Source: Bartlett *et al.*, 2001