PATIENT'S SATISFACTION OF INDOOR ENVIRONMENTAL QUALITY IN HOSPITAL WARDS IN JOS NIGERIA

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To my son (Upon’nmanmi Pontip Nimlyat) and my grandmother
(Mwarmikat Ramko Rimfat)

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ABSTRACT

The main purpose of a hospital building is for the provision of an environment that is appealing to users and also encourage the healing process of patients. Indoor Environmental Quality (IEQ) parameters are viewed as one of the essential elements affecting a building occupant's assessment of the building quality and performance. The IEQ of a hospital ward should therefore be such that it contributes to improve patients' health and wellbeing, and patients' satisfaction with the ward building. The main aim of this study is to investigate the impact of indoor environment on patients' satisfaction in hospital wards and on their health outcome. The study was carried out at two public hospital in Jos, Nigeria. One of the case study hospitals has ward buildings with Northeast–Southwest orientation and closed-plan configuration, while the second hospital ward buildings orientation faced the Northwest–Southeast axis, with an opened-plan design configuration. This study consists of two parts. The first part involved the field physical measurement of IEQ parameters in the context of hospital wards orientation and design configuration. The physically measured data variables consist of air temperature, relative humidity, background noise level, amount of light intensity, carbon dioxide and carbon monoxide concentration. The second part of this study was carried out with a survey instrument designed to evaluate patient's satisfaction with and perception of IEQ parameters in hospital wards. Subjective survey involving questionnaire administration to patients was conducted simultaneously alongside the physical measurement of environmental variables. A total of 268 respondents participated in the subjective measurement of the IEQ variables. The results of this study have shown that hospital ward building orientation and design configuration influenced patient's satisfaction with and perception of IEQ. The teaching hospital wards with open-plan configuration and Northwest–Southeast orientation have better IEQ as compared to the specialist hospital wards having close-plan configuration and Northeast–Southwest orientation. The level of patient's satisfaction with and perception of IEQ performance was higher at the teaching hospital. The results further revealed that IEQ parameters contribute to patient's health outcome and overall satisfaction with the hospital wards. Based on the hospital wards orientation and design configuration, an integrative evaluation framework is proposed that will serve as a diagnostic tool to help designers and planners identify issues relating to IEQ from the patient's perspective, and develop solutions through the design and construction processes. The integrative evaluation framework suggests weighting schemes for each IEQ parameter as it contributes to patient's satisfaction. This study serves as feedback to architects in the design processes, and facilities managers towards achieving improvement in sustainable hospital wards design. The outcome will also influence future design of hospital wards towards promoting patient's health and wellbeing.

ABSTRAK

Tujuan utama bangunan hospital adalah untuk menyediakan persekitaran yang menarik kepada pengguna dan juga menggalakkan proses penyembuhan pesakit. Parameter Kualiti Persekitaran Dalaman (IEQ) dilihat sebagai satu daripada elemen-elemen penting yang mempengaruhi penilaian penghuni mengenai kualiti dan prestasi bangunan. Oleh itu, IEQ sesebuah wad hospital harus sedemikian rupa sehingga ia menyumbang untuk meningkatkan kesihatan dan kesejahteraan pesakit, dan kepuasan pesakit dengan bangunan wad. Tujuan kajian ini adalah mengkaji kesan persekitaran dalaman terhadap kepuasan pesakit di wad hospital dan hasil kesihatan. Kajian ini telah dijalankan di dua hospital awam di Jos, Nigeria. Salah satu hospital kes kajian mempunyai bangunan wad dengan orientasi Timur Laut-Barat Daya dan konfigurasi pelan tertutup, manakala orientasi bangunan wad hospital kedua mempunyai paksi Barat Laut-Tenggara, dengan konfigurasi reka bentuk pelan terbuka. Kajian ini terdiri daripada dua bahagian. Bahagian pertama melibatkan pengukuran fizikal bidang parameter IEQ dalam konteks orientasi wad hospital dan konfigurasi reka bentuk. Pemboleh ubah data diukur secara fizikal terdiri daripada suhu udara, kelembapan, tahap bunyi latar belakang, jumlah keamatan cahaya, karbon dioksida dan kepekatan karbon monoksida. Bahagian kedua kajian ini telah dijalankan dengan instrumen kajian yang direka untuk menilai kepuasan pesakit dengan dan persepsi parameter IEQ dalam wad hospital. Kaji selidik subjektif melibatkan pentadbiran soal selidik kepada pesakit telah dijalankan serentak bersama ukuran fizikal pemboleh ubah alam sekitar. Seramai 268 responden pesakit mengambil bahagian dalam pengukuran subjektif pemboleh ubah dalaman IEQ. Hasil kajian ini telah menunjukkan kepuasan wad hospital orientasi bangunan dan reka bentuk konfigurasi dipengaruhi pesakit dengan dan IEQ. Wad hospital pendidikan dengan konfigurasi pelan terbuka dan orientasi Barat Laut-Tenggara mempunyai IEQ yang lebih baik berbanding wad hospital pakar yang mempunyai konfigurasi pelan tertutup dan orientasi Timur Laut-Barat Daya. Tahap kepuasan pesakit dengan dan IEQ persepsi prestasi tertutup adalah lebih tinggi di hospital pendidikan. Keputusan juga mendedahkan bahawa parameter IEQ menyumbang kepada hasil kesihatan pesakit dan kepuasan keseluruhan dengan wad hospital. Berdasarkan orientasi wad hospital dan reka bentuk konfigurasi, rangka kerja penilaian yang integratif dicadangkan yang akan menjadi alat diagnostik untuk membantu pereka dan perancang mengenal pasti isu-isu berkaitan dengan IEQ dari perspektif pesakit, dan membuat penyelesaian melalui reka bentuk dan proses pembinaan. Rangka kerja penilaian integratif mencadangkan skim pemberat bagi setiap parameter IEQ kerana ia menyumbang kepada kepuasan pesakit. Kajian ini berfungsi sebagai maklum balas kepada arkitek dalam proses reka bentuk, dan pengurus kemudahan ke arah mencapai peningkatan mampan reka bentuk wad hospital. Hasilnya juga akan mempengaruhi reka bentuk masa depan wad hospital ke arah meningkatkan kesihatan dan kesejahteraan pesakit.

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LIST OF ABBREVIATION

AGFI	-	Adjusted Goodness of Fit Index
AIC	-	Akaike Information Criterion
AMOS	-	Analysis of a Moment Structures
ASV	-	Average Shared Variance
AVE	-	Average Variance Extracted
BCC	-	Browne-Cudeck criterion
C.R	-	Critical Region
CFA	-	Confirmatory Factor Analysis
CFI	-	Comparative Fit Index
CMIN	-	Minimum value 'C' of the discrepancy
COS_I	-	Comprehensive Occupant Satisfaction Index
CR	-	Critical Ratio
CTCM	-	Correlated-Trait Correlated-Method
CTCU	-	Correlated-Trait Correlated-Uniqueness
CTUM	-	Correlated-Trait Uncorrelated-Method
CTUU	-	Correlated-Trait Uncorrelated-Uniqueness
Df	-	Degree of Freedom
ECVI	-	Confidence interval for the population
EFA	-	Exploratory Factor Analysis
EPA	-	Environmental Protection Agency (USA)
FMIN	-	Minimum value 'F', of the discrepancy
GFI	-	Goodness of Fit Index
IAQ	-	Indoor Air Quality
IEQ	-	Indoor Environmental Quality
IEQ_{PM}	-	Indoor Environmental Quality Performance Model
IEQ_{POS}	-	IEQ Performance and Occupants’ Satisfaction Model
IUSS	-	Infrastructure Unit Support Systems

KMO	-	Kaiser-Meyer-Olkin
MSV	-	Maximum Shared Variance
MTMM	-	Multi-Trait Multi-Method
NCP	-	Noncentrality Parameter
NEA	-	National Environmental Agency (Singapore)
NFI	-	Normed Fit Index
NPAR	-	Number of Distinct Parameters
PCLOSE	-	A Test of Close Fit
RFI	-	Relative Fit Index
RMSEA	-	Root Mean Square Error of Approximation
SD	-	Standard Deviation
SEM	-	Structural equation modelling
SMC	-	Square Multiple Correlation
SPSS	-	Statistical Packages of Social Sciences
SRM	-	Structural Regression Model
TLI	-	Tucker-Lewis coefficient Index

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The concept of a building as shelter is to provide shield or protection for people from environmental variables within the ecosystem. However, the provision of this protection from external aggressors by a building elements has also created an indoor environment that has adverse effects on man's activities, comfort and wellbeing. In a hospital setting, the negative impact of this indoor environment on a patient could be strenuous, which can lead to further health complications. The indoor environment of a hospital building should therefore be designed such that it provides a therapeutic environment that promotes healing, wellbeing and work efficiency of the occupants. In recent times, the level of satisfaction of building occupants with their indoor environmental quality (IEQ) has become a subject of discussion. The performance of a building IEQ will certainly influence the level of satisfaction the building occupants derive within the environment.

The purpose of this study is to investigate how indoor environmental quality (IEQ) impact on Patient's level of satisfaction in two hospitals. The case study hospitals are located in Jos, Nigeria; within the savannah region of tropical Africa. The study identified the IEQ parameters that significantly affected Patient's overall satisfaction with their hospital wards, and the relationship with their health and wellbeing. This study provides rudimentary data on the correlation between IEQ and Patient's perception and health in hospital wards in order to provide answers to problems arising. The effort of this study towards analysing the impacts of IEQ on the Patients should provide a useful research methodology at the same time providing valuable insight into the relationship between IEQ, hospital wards design, and user perception.

1.2 Background of Study

Indoor environmental quality (IEQ) has been defined as, the determination of the significant factors that have direct effect on a building occupant comfort and wellbeing (Garnys, 2007). On the other hand, Bonda and Sosnowchik (2007) see IEQ as components responsible for an environment that appears to be psychosocially healthy for its inhabitants. Buildings are designed and constructed generally for human habitation, as a result, the requirements for their usage is needed to be fulfil as a precondition for their wellbeing. The design of the hospital building environment should therefore be such that it has positive influence on occupants' health, comfort, and productivity. The interaction of man with his environment is expressed in his physical and social activities which have adverse effect on comfort and wellbeing. The desire to measure this interaction and its impact on both man and the environment has led to different researches on IEQ in buildings.

Human beings are surrounded in all circumstances by an environment, and therefore, sustaining their well-being and comfort is of great challenge (Parsons, 2013). IEQ performance in buildings need to be assess consistently in order to meet the requirement for certification as 'green' for a sustainable environment. This assessment which determines a building success or performance depends to a large extend, on its appraisal by the occupants, especially when the building indoor environment provides them with comfort and enhances their work efficiency (Frontczak et al. 2012). To this end, the provision of an indoor environment that increases occupants' health and wellbeing, satisfaction, and performance should therefore, take the centre stage in building design and environmental sustainability (Fisk, 2000). Today, the assertion of Fisk could be seen in the number of different studies on building IEQ, which are focused on the building occupants' wellbeing, satisfaction and task performance (Bailey, Piacitelli, Martin, & Cox-Ganser, 2013;

Cao et al., 2012; Frontczak, Andersen, et al., 2012; Frontczak, Schiavon, et al., 2012).

In the early days of nursing practice, the protection of people from the adverse effect of the environment was given much attention (Guenther & Vittori, 2007). A building environment noted to be healthy, has significant impact on improvement in patient’s health and wellbeing. Similarly, an environment that promotes restorative processes contributes both to patient’s wellbeing and hospital staff comfort. For example, a previous study by Zborowsky and Kreitzer (2008) has shown that, a hospital building that is rated as having high IEQ performance attracts, maintains, and improved patient healing process and staff work efficiency. Some Scholarly works (Chau, Hui, & Tse, 2007; Roulet et al., 2006) have also shown that recent hypothetical thoughts and practical data on existing building technologies and procedures can influence IEQ in a way that can bring about improvement in wellbeing and efficiency of building occupants. In addition, a research conducted by Apte, Fisk, and Daisey (2000) indicated that, the rates of allergy, asthma symptoms, Sick Building Syndrome (SBS) and worker performance is significantly influenced by building design indicators and the quality of indoor air environment. Consequently, for a hospital facility to fulfil its function as a healing environment, the provision of a friendly and acceptable environment for all the building occupants is most important (Guenther & Hall, 2008). The design and construction of hospital buildings indoor environment should be such that, the requirement for comfort are well articulated. However, the habitability of such buildings depend on how they are being assessed. Furthermore, the extent to which environmental friendliness is achieved in hospital buildings can only be measured through performance assessment of the environmental variables, and occupants’ satisfaction with the building environment.

A building environmental performance is a measure of both environmental parameters and the relationship between the environment and the building occupant. A study by De Giuli et al. (2013) have made suggestion for the consideration of both the perception of people and the physical environment in designing a building environment for peoples’ habitation. The level of comfort, wellbeing, and satisfaction or dissatisfaction with the physical environment is a measure of the peoples' perception. Consequently, it has been shown that building occupants who have the freedom to change certain conditions of their environment have the tendency of higher satisfaction than those within an environment with restrictions (Parsons, 2013). In addition, where about 80% of building occupants are satisfied with their indoor environment, the building can be said to be performing well towards meeting the requirements of the occupants (Mui & Chan, 2005; L. T. Wong, Mui, & Hui, 2008). The understanding of the relationship between the IEQ of buildings and the occupants' satisfaction is a necessary tool that will enhance the formulation of the requirements for architectural and building systems design and control.

A previous study on IEQ in some selected office buildings have shown that the level of satisfaction with the indoor environment is influenced by noise, visual privacy and amount of space (Frontczak & Wargocki, 2011). In addition, there was a strong relationship between the office workstation and occupant overall level of satisfaction. A study by Lee and Guerin (2010) has suggested the design of workspace in LEED-certified office building to be such that it improves occupants' job performance and satisfaction with the environment. This study also identified differences in occupants' perception of personal workspaces using self-rated satisfaction and performance level. Mahbob et al. (2011) in their own study review the relationship between work efficiency and IEQ in office buildings. It can be seen from this study that, work efficiency can be increased where indoor environment is comfortable for the users. As a matter of fact, different studies have already shown that the level of satisfaction and productivity of a building occupant would increase with improved IEQ performance (Bluyssen, Janssen, van den Brink, & de Kluizenaar, 2010; Cena & de Dear, 2001; Mahbob et al., 2011). However, there is a need to validate this relationship as stressed by Chaudhury et al. (2009), which is a motivational driver towards green building initiatives (Berry et al., 2004).

Indoor environmental quality (IEQ) rating systems vary from one rating tool to another, whose merits have been discussed expansively in different literature, which is not relevant in this section. However, the benchmarks for IEQ provided for in different guidelines and rating systems are to a large extend aimed at providing accepted values of IEQ parameters, rather than assessment criteria that could be used towards developing an overall IEQ rating model. As a result, the assessment of IEQ in buildings have mostly focus largely on technical principles rather than the assessment methods and procedures. As the focus of building performance is gearing towards achieving low-energy, the level of occupants' comfort and their level of satisfaction with IEQ should therefore not be neglected. For the purpose of the assessment of IEQ perceived performance of IEQ for benchmarking or ratings, a guidance on the procedures required for evaluating IEQ perceived performance of IEQin hospital buildings therefore need to be drawn. This study therefore proposes an integrative assessment models of IEQ in hospital ward buildings. The evaluation models are important in categorising common IEQ problems and can assist architects and planners in determining interventions toward the achievement of more comfortable hospital ward environments. The purpose of this study is towards achieving healthy hospital wards with improve indoor environmental comfort and with less environmental impacts on Patients.

1.3 Problem Statement

The main purpose of a hospital building is for the provision of an environment that is appealing to users and also encourage the healing processes of patients. The design of the hospital building environment should therefore be such that it has positive influence on occupants' health, comfort, and productivity. Above all, the hospital building as an environment for healing within the community setting is required to provide the occupants with a friendly environment (Guenther & Hall, 2008). The extent to which this environmental friendliness is achieved can only be ascertained or measured by assessing the performance of the environmental variables and how satisfied and comfortable the occupants are, within the building. In the Nigerian context, there is little to none studies on the impact of IEQ in hospital buildings, which make it rather difficult to have data on the need of efficient IEQ in hospital buildings. However, available literature on IEQ studies in hospital buildings in other parts of the world have justified the need of efficient IEQ, which is the basis for this current study. In promoting green building and sustainable development in the Nigerian healthcare system, this research seeks to examine the characteristics of IEQ in healthcare facilities around the Jos Plateau in Nigeria middle belt region in order to examine the nature of the relationship between the perceived performance of IEQ and building occupants' satisfaction.

Studies on building performance and IEQ for healthcare facilities are fewer in number compared to other building types. Within the tropical and subtropical regions of the world, most studies on building performance within the last two decades have concentrated on office buildings (Asadi, Hussein, & Palanisamy, 2014; Kong et al., 2012; A. C. K. Lai, Mui, Wong, & Law, 2009; Liang et al., 2014; Mui & Chan, 2005; Mui, Wong, & Hui, 2009; L. T. Wong & Mui, 2009), with only but few carried out on healthcare facilities environment (Al-Harbi, 2005; Azizpour et al., 2013a; S. Kim & Osmond, 2014; Sadek & Nofal, 2013). For instance, in tropical African countries such as Nigeria, only but very few studies have been carried out in relation to building services and performance (Adewunmi, Omirin, Famuyiwa, & Farinloye, 2011; Ajala, 2012). Therefore, for green building and environmental sustainability to be deeply rooted in the tropics, more researches are needed to be carried out in order to increase awareness and promote measures that will protect the ecosystem.

The healing processes of patients have been found to be affected by the nature of the indoor environment in hospital buildings (Chaudhury et al., 2009; J.-H. Choi, Beltran, & Kim, 2012; Dijkstra, Pieterse, & Pruyn, 2006; Ghazali & Abbas, 2012; Huisman, Morales, van Hoof, & Kort, 2012), which also affects staff wellbeing and task performance (Al-Ahmadi, 2009; Andrade, Lima, Fornara, & Bonaiuto, 2012; Janakiraman, Parish, & Berry, 2011). It has also been discovered that a building thermal and air quality significantly affect occupants in a hospital building environment (Hwang, Lin, Cheng, & Chien, 2007). The presence of indoor air contaminants in hospital environment could result into patients contracting infections, whose risk factor is high. Accordingly, Salonen et al. (2013) stated that the resultant risk factor due to the presence of air contaminant could lead to the death of a patient whose body immunity have been drastically reduced. A research conducted by Ramaswamy et al. (2010) was quite revealing on the effect of air pollutants in hospital buildings where patients were infected with diseases other than the one they were receiving treatment on. Therefore, the control of the movement of air within the hospital environment and provision of effective ventilation would ensure that the indoor air quality is free of pollutants and harmful elements (Ramaswamy et al., 2010). Where ventilation rate is low within a space, there will be no enough air to dilute the pollutants generated within that space. It has further been discovered that air pollutants in a building indoor environment affect the level of reasoning, work efficiency and behaviour of the building occupants (Clements-croome, 2008; Tang & Wan, 2011).

The relationship between IEQ and building occupants' overall satisfaction have been carried out by different researchers (J.-H. Choi, Loftness, & Aziz, 2012; Humphreys, 2005; J. Kim & de Dear, 2012; A. C. K. Lai et al., 2009; J. H. K. Lai & Yik, 2009; L. T. Wong et al., 2008). All of these studies measured the quantitative relationship between performance of individual IEQ parameters and overall occupants' satisfaction. Heinzerling et al. (Heinzerling, Schiavon, Webster, & Arens, 2013) in their review of literature on IEQ evaluation models stated that, the issue of relating occupant satisfaction level with the performance of a building as a whole and level of satisfaction with individual IEQ parameters is a major concern. Again, the above mentioned studies have also shown inconsistency in the IEQ parameter of influence, hence the need to consider their combine impact on overall occupants' satisfaction. This issue can be addressed through the integration of the individual IEQ parameters as measures of performance and relating it to occupants' overall satisfaction. For IEQ parameters to be integrated as factors in hospital wards design, it is expedient to ascertain their relative importance as they contribute to Patient's level of satisfaction. The establishment of an integrated relationship between IEQ, Patient's perception with and satisfaction, and Patient's health outcome can be helpful in identifying problems and finding solutions towards improving IEQ perceived performance from the Patient's perspective.

1.4 Research Gap

A review of relevant literature on IEQ survey and assessment in buildings have shown that Africa, Asia and South American countries are lacking in data (Peretti & Schiavon, 2011), as little or no effort have been made by most of the countries in these regions, especially in the African region. Studies so far conducted on the IEQ in hospital buildings either considered the evaluation of individual parameters (Azizpour et al., 2013b; Lomas & Giridharan, 2012; Ramaswamy et al., 2010; Verheyen, Theys, Allonsius, & Descamps, 2011) or perception by a single group of occupants in the buildings (Croitoru, Vartires, Bode, & Dogeanu, 2013; Mendes, 2008; Zhao & Mourshed, 2012).

Evidence-based and patient-centred design of hospital buildings have been advanced as a result of studies establishing relationships between the environment and peoples' health and wellbeing (Mourshed & Zhao, 2012). The objective measurement of indoor environment of a building can be a basis for comparison of their performance in terms of IEQ. However, the occupant of a building whom the indoor environment is meant for must be considered as an important entity in measuring the perceived performance of IEQof the IEQ. Subjective assessment of IEQ performance in buildings have always been a measure of perceived satisfaction derived by occupants (Mourshed & Zhao, 2012) as such, this measurement in hospital buildings must consider the Patients levels of perception as typical occupants in hospital ward facilities.

Literature review have shown the level of impact the hospital wards environment have on occupants especially patients. The healing processes of patients have been found to be affected by the nature of the indoor environment in hospital buildings (Chaudhury et al., 2009; J.-H. Choi, Beltran, et al., 2012; Dijkstra et al., 2006; Ghazali & Abbas, 2012; Huisman et al., 2012), which also affects staff wellbeing and task performance (Al-Ahmadi, 2009; Andrade et al., 2012; Janakiraman et al., 2011). The presence of indoor air contaminants in hospital environment could result into patients contracting infections, whose risk factor is high. Accordingly, Salonen et al. (2013) stated that the resultant risk factor due to the presence of air contaminant could lead to the death of a patient whose body immunity have been drastically reduced. A research conducted by Ramaswamy et al. (2010) was quite revealing on how air pollutants within hospital buildings could result into other infections. The investigation revealed that some patients were also treated of other diseases besides the ones they were initially admitted for treatment. Therefore, the control of the movement of air within the hospital environment and provision of effective ventilation would ensure that the indoor air quality is free of pollutants and harmful elements (Ramaswamy et al., 2010). Where ventilation rate is low within a space, there will be no enough air to dilute the pollutants generated within that space. It has further been discovered that air pollutants in a building indoor environment affect the level of reasoning, work efficiency and behaviour of the building occupants (Clements-croome, 2008; Tang & Wan, 2011).

There has been a lack in existing evidence on the integration of patient's perspective in the design of healthcare facilities (Zhao & Mourshed, 2012). In promoting an evidence-based and patient-centred design of hospital buildings, considerations must be made into integrating patient's perception of certain key indoor environmental and design indicators. An approach to patient-centred healthcare delivery system requires the consideration of patient perception in every aspects such as care planning and treatment design (Robinson & Thomson, 2001) to building design and operation (J. A. Smith, Scammon, & Beck, 1995).

Generally, the review of relevant literature on IEQ have shown its relative importance on the performance of hospital buildings for sustainable development. However, there is no specific study that had been carried out to investigate the relationship between Patient's overall satisfaction with their hospital wards and the significant influence of IEQ criteria. Having an understanding of IEQ parameters of influence on hospital wards environment could provide a guide in the design processes of hospital buildings as healing environment rather than the one that hinders it. This study therefore, is undertaken to establishing a relationship between the IEQ criteria in hospital wards and Patient's overall satisfaction and health outcome.

1.5 Research Aims

The purpose of this study is to investigate on Patient's perceptions and health outcome in an indoor environment of hospital wards. This is an attempt to establish the relationship between IEQ parameters, Patient's overall satisfaction and perceived impact on health through an integrative evaluation framework. The main aim is to investigate the impact of indoor environment on patients' satisfaction in hospital wards and on their health outcome. The secondary aim is to propose an integrative evaluation framework for improving IEQ in hospital wards towards improving patients' health and wellbeing. The development of the evaluation framework will be based on exploring the relationship between certain IEQ parameters (thermal quality, acoustic quality, lighting quality, and indoor air quality), the hospital ward building orientations and design configuration, and Patient's psychological reactions in response to the hospital wards.

1.6 Research Questions

Towards achieving the main purpose of this study, certain research questions to be investigated are raised.

1. What is the spatial relationship between IEQ and hospital wards orientation and design configuration of the two case study hospitals?
2. What is the level of Patient's perception of IEQ in hospital ward buildings?
3. What is the relationship between physical field measurement and Patient's survey measurement of IEQ parameters in the hospital wards?
4. Which of the IEQ parameter is the most important determinant of Patient satisfaction with and perception of IEQ performance in hospital wards?
5. What is the relationship between Patient's overall satisfaction with and perception of IEQ with patient's health outcome?

1.7 Research Objectives

In achieving the aims of this study, certain measures relating to IEQ must be taken. Therefore, the objectives of this study are;

1. To ascertain the spatial distribution of IEQ in hospital wards based on the physical measurement of the hospital ward units with different architectural features (building orientation, design configuration and windows placement).
2. To conduct a subjective measure of Patient's satisfaction, preferences and perceptions of IEQ in hospital wards.
3. To analyse the relationship between objective (physical) measurement data and subjective Patients' perception.
4. To propose a weighted structural model for IEQ establishing the relationship between IEQ parameters, Patient's overall satisfaction, and patient's health outcome.
5. To establish an integrative framework for assessing Patient's satisfaction of IEQ in hospital wards.

1.8 Conceptual Framework

The environmental performance of a building does not only depend on the physical factors but also on the interface that exist between the physical environment and the occupants. An environment where people have the freedom of changing environmental conditions tends to offer more satisfaction than the one with restriction (Parsons, 2013). Most importantly, the basic requirement of a building is to ensure that the building meets not only the required standards for indoor environment but also occupants' needs and satisfaction. For buildings such as healthcare facilities, the need therefore to pay particular attention to it indoor environmental quality is paramount. It has been discovered that poor IEQ does not only affects the occupant physical health but also their psychological health (Sadek & Nofal, 2013; Salleh, Kamaruzzaman, Sulaiman, & Mahbob, 2011). This impact of

IEQ on patient's comfort and wellbeing is measured based on their psychological reaction and physical complaints (Sadek & Nofal, 2013).

The underpinning theoretical framework of reference for this study is the human ecosystem model (Guerin, 1992), which was derived from a system theory that focuses on complex interfaces between diverse constituents in ecological fields such as biological structure and geological heterogeneity. The human ecosystem theory was adapted in creating a theoretical framework for interior design study by Guerin in 1992. From the four construct of human ecosystem (Human Organism, Natural Environment, Social Environment, and Designed Environment), Guerin (1992), developed a model to show the interrelationship that exist among these constructs.

The Human ecosystem theory, which considered the relationship in man's interaction with his environment as a system (Bubolz & Sontag, 1993) have been applied in different studies (S. Choi, 2011; Freihoefer, 2012; Lee, 2007), to examine the interactions between occupants of different building types and their environmental systems. Lee (2007) proposed a new model that shows the interaction between indoor environment of sustainable office buildings with indoor environmental sustainability and indoor socioeconomic sustainability in order to provide comfort, health, and productivity to office workers. The analysis of the interaction between the three elements in Lee's proposed model contributed to creating comfortable, healthy, and productive indoor environment for office workers. The human ecosystem model was also used by Freihoefer (2012), to explain the potential relationship and interaction between office occupants' satisfaction with IEQ parameters in a science Teaching student service (STSS) building in the University of Minnesota. Freihoefer also used the model in developing hypothesis and research question by looking at, which of the human ecosystem construct could possibly influence occupants' satisfaction with the different IEQ parameters. S. Choi (2011) on the other hand, used the theory to examine the relationships between occupants' satisfaction with IEQ at the work station level, the building facility, and sustainable ethic in sustainable building environment.

In this present study, the human ecosystem theory would be used in determining the interaction between Patients as occupants of hospital wards and their indoor environment. A relationship between occupants' inclusive satisfaction with the hospital wards perceived and measured IEQ will be established. This will serve as the basis for a framework for the assessment of the relationship between perception of IEQ performance and Patient's overall satisfaction in hospital ward buildings. This framework demonstrates the relationship between occupant's interaction with their psychosocial, built, and natural indoor environment as shown in Figure 1.1.

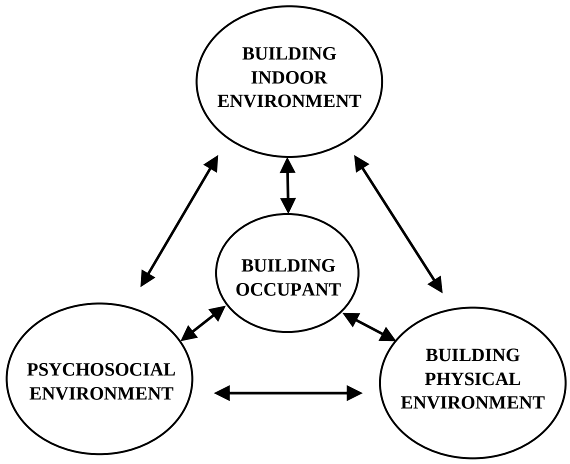

Figure 1.1 Building Indoor Environment as a Reflection of Human Ecosystem (Developed from the Human Ecosystem Model by Guerin, 1992)

1.9 Research Scope and Limitation

Various hospital facilities are in existence in our society today either owned by the government, private sector or non-governmental organizations. For the purpose of this study, only two government-owned hospitals will be considered. The choice of government owned hospitals is for ease of access for field work as compared to the private-owned hospitals. The case study hospitals were selected based on their ward buildings orientation and design configuration, which differs significantly. In order to achieve the main purpose of this study whose main determining factor is the patients as occupants of the hospitals wards, the units to be considered in the hospitals as case-study are the surgical wards where, the patients are conscious enough to participate in the survey. Critical hospital special care units and operating rooms are not within the scope of this study.

The same sampled case study hospitals are visited twice in a month. In order to take into consideration the effect of change in environmental conditions in the case study hospitals, repeated transverse sampling and data collection was conducted within a three months period. In as much as occupants' gender have been found to be a contributing factor on occupant satisfaction with IEQ (Dascalaki, Gaglia, Balaras, & Lagoudi, 2009; J. Kim, de Dear, Cândido, Zhang, & Arens, 2013), it is not a factor of consideration in this study. The thermal quality measurement is based only on temperature and relative humidity, while personal factors such as clothing insulation value (CLO) and activity level is not considered.

The conduct of this study be can said to be limited in some certain aspects as stated below;

1. There are a variety of influential physical elements (both internal and external) that affects the IEQ of hospital ward building space, as well as the use pattern of the building users. However, having many influential physical elements can result into difficulties in measuring and analysis the indoor environmental quality. For this, wind velocity was only measured for the outdoor because of unavailability air velocity sensor in the IEQ mobile measurement station.

2. Standards of IEQ change with time, location and building design configuration. Based on the difference in emotional and psychological state of Patients in hospital wards, they may have different preferences and responses regarding their IEQ perception. This offers great challenges to studies on perception of IEQ performance in hospital wards.

3. The field survey of the case study hospital wards was conducted between the hours of 10:00am and 03:00pm. This is the period approved by the

hospital management ethical committee for the purpose of this study. The conducts of ward rounds by the medical personnel usually last from 08:00am to 10:00am, while the visitation time is from 03:30pm to 05:00pm. To avoid disruption and interference with data collection as a result of visitors' activities, the data collection was restricted to five hours each day.

4. The two case study hospitals cannot be taken to be a representation of the whole hospital settings in Nigeria since there are other categories of hospital settings owned by private individuals and self-help organizations.

5. The results from this study would be limited in its application to IEQ performance evaluation for other hospital ward buildings in other locations, since there are in existence different types of hospital settings located in different climatic zones.

6. The period of data collection was limited only to ones in each hospital, for each of the three months period. This cannot be a representation of the environmental conditions experienced in the hospital ward buildings all through the year. Also, due to limited measuring instruments, the survey was not carried out simultaneously in the case study hospitals.

In conclusion, this study is only based on the main indicator variables of the four IEQ parameters: indoor air quality, acoustic quality, lighting quality, and thermal quality. Other factors considered also as indoor environmental elements such as light intrusion, glare, external views, interior finishes etc. included as factors of IEQ performance and occupants' satisfaction.

1.10 Research Hypothesis

Different studies have established the impact of IEQ criteria on building occupants ((M. P. Fabian, Adamkiewicz, Stout, Sandel, & Levy, 2014; P. Fabian et al., 2012; Frontczak, Schiavon, et al., 2012; Ramaswamy et al., 2010; Salleh et al., 2011; Stauss & Kumar, 2002). However, this current study investigates the hypothesis that four IEQ parameters (thermal quality, acoustic quality, lighting quality and IAQ) influence Patient’s overall satisfaction with the performance of hospital wards. To increased data collection efficiency, this study was carried out at two selected case study hospitals located in Jos, Nigeria.

1. The first hypothesis is that Patient’s level of satisfaction with and perception of IEQ in hospital wards are influenced by different building orientation/design configuration.
2. The second hypothesis is that Patient’s overall satisfaction with their hospital wards is influence by IEQ parameters of the ward buildings.
3. The third hypothesis is that Patient’s level of satisfaction with and perception of IEQ in hospital wards influence patient’s health outcome.
4. The forth hypothesis is that there is a significant relationship between IEQ parameters, Patient’s overall satisfaction with hospital wards and patient’s health outcome.

The selection of the hypothesis were based on literature, which have shown that a building IEQ is affected by the building orientation. It is also evident that, IEQ have impact on occupants’ satisfaction with their environment and also on patient’s healing process in hospital buildings.

1.11 Significance of Study

Indoor environmental quality (IEQ) contribution to building performance is such that it also contributes to a building energy performance. In designing buildings with the focus of achieving better IEQ, the issue of energy efficiency will as well fall into place (Bean, 2012). Consequently, this study will contribute to the achievement of green buildings and sustainable environmental practice in the design and construction of healthcare facilities by the architectural profession. Having a knowledge of the interactions and significance among IEQ parameters as determinants of building indoor environmental performance and occupant satisfaction will enable the incorporation of more effective and reliable design strategies by architectural professionals. This will break the jinx as noted by Nicol, Humphrey, and Roaf (2012) that, architects have handed over the responsibility for the IEQ in buildings to the engineers, which is detrimental to the architectural profession and the building design output.

One main contribution of this research to the body of knowledge is the development of an evaluation framework that provide guidance on the procedures required in assessing IEQ performance and Patient's overall satisfaction for the purpose of performance rating system in healthcare facilities. Remarkably, the assessment framework provides a better robust and clear cut IEQ parameters weightings in their contributions to perceived IEQ performance measurement in hospital buildings.

A review of relevant literature on IEQ survey and assessment in buildings have shown that Africa, Asia and South American countries are lacking in data (Peretti & Schiavon, 2011), as little or no effort have been made by most of the countries especially in the African region. Studies that assess IEQ performance in hospital buildings are not readily available in developing countries, especially Nigeria. This study will be the first field study to be performed in this country, for an overall evaluation of hospital buildings to ascertain their quality and Patient's perception of the physical indoor environment. The motivation for this study within the context of Nigeria is in response to a call for the establishment of standards and guidelines based on a wide knowledge and experience of the indoor environmental quality in different climates of the world (J. F. Nicol et al., 2012).

1.12 Thesis Structure

This thesis is divided into three (3) different sections comprising of seven (7) related chapters. Section one of the thesis establishes the general background for the study as well as the literature review. Section two on the other hand presents methodology, measures and analysis while section three provides details of responses to research questions and conclusion on findings. The summary of the different chapters that constitute this thesis structure is presented below:

Chapter One: This chapter introduced the main highlights of the study. These includes; the general background to the study especially, the problems relating to IEQ in hospital buildings which have exposed a gap in its evaluation processes. Furthermore, the process of achieving the goal of the study through the research objectives are also presented in this chapter. This followed by a statement of the research scope, limitations, and its significance to the body of knowledge.

Chapter Two: In Patient's satisfaction of IEQ in hospital ward buildings, the concept of IEQ and its impact on building occupants is critically reviewed. This chapter therefore presents a reviews of relevant issues relating to the concept of IEQ in buildings, which was also narrowed down to discussions on IEQ in healthcare facilities. This chapter also presents a description of the relationship between IEQ and its impact on occupants in hospital building settings as well as, the different methods or procedures employed in its assessment. A review of the settings and configuration of healthcare facilities with particular reference to the study area also forms part of this chapter.

Chapter Three: Chapter three describes the approaches and philosophies behind the chosen framework of this research. The nature and processes of data collection and the analysis tools employed are explained here in details. This chapter also describes an overview background of the study area and the selected case study hospitals. In addition, the validity and reliability of the study instruments as well as the processes of analysis adopted for the assessment framework is presented in this chapter.

Chapter Four: This chapter is the first of the three parts data analysis within this framework. The chapter describes the quantitative results of data collected from configured instrument used for objective physical measurement of IEQ variables in each of the selected hospital ward buildings. These data provided a clear picture of the nature of IEQ in each of the case study hospitals, the spatial and temporal fluctuation in the different IEQ parameter-indicators in the case study hospitals are also explained in this chapter using descriptive analysis.

Chapter Five: This chapter as the second part of data analysis, presents statistical results of the subjective occupants' survey and perception of IEQ parameters in the hospital buildings. The subjective measurement of the patients as the main occupants in a hospital ward environment were conducted using a designed questionnaire in the hospital wards. The subjective occupants' survey is analysed for comparison to the objective measurement with reference to international guidelines and other previous studies on IEQ in buildings.

Chapter Six: This is the last part of the analysis within the assessment framework. The data analysis is based on a modification of the raw data as analysed in chapter Four and chapter Five. The assessment framework involved the establishment of the relationship between IEQ parameters, Patient's overall satisfaction and impact on health and wellbeing. This chapter describes the relationship between all the variables as described in chapter three using correlation and regression analysis using structural equation model.

Chapter Seven: This chapter presents findings and conclusions drawn from the hypothesis. The main goal of the study as achieved is discussed in this chapter, which provides new insight and perspectives into the processes of assessing perception of IEQ performance and Patient's overall satisfaction in hospital wards.

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