WORKSPACE UTILISATION, MAINTENANCE PRACTICE AND LECTURERS' SATISFACTION WITH INDOOR ENVIRONMENTAL QUALITY IN SELECTED NIGERIAN UNIVERSITIES

BY

JIMOH, ISSA AYODEJI (099052096)
B.Sc, HONS. (BUILDING), MBA, MSc (CONSTRUCTION MANAGEMENT)

A THESIS IN THE DEPARTMENT OF BUILDING SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) IN BUILDING OF THE UNIVERSITY OF LAGOS, NIGERIA.

DECEMBER, 2017

SIGNING OFF OF OWNERSHIP RIGHT OF THESIS

I hereby agree to give the University of Lagos through the University of Lagos Library, a non-exclusive, worldwide right to reproduce and distribute my thesis and abstract (hereinafter "the work") in whole or in part, by any and all media of distribution, in its present form or style or in any form or style as it may be translated for the purpose of future preservation and accessibility provided that such translation does not change its content.

By the grant of non-exclusive rights to University of Lagos through the Library under this agreement, I understand that the rights of the University of Lagos are royalty free and that I am free to publish the Work in its present version or future versions elsewhere.

Warranties

I further agree as follows:

i. That I am the author of the work and I hereby give the University of Lagos the right to make available the Work in the way described above after a three (3) year period of the award of my doctorate degree in compliance with the regulation established by the University of Lagos Senate.

ii. That the Work does not contain confidential information which should not be divulged to any third party without written consent.

iii. That I have exercised reasonable care to ensure that the Work is original and it does not to the best of my knowledge breach any Nigerian law or infringe any third party's copyright or other Intellectual Property Right.

iv. That to the extent that the Work contains material for which I do not hold copyright, I represent that I have obtained the unrestricted permission of the copyright holder to grant this license to the University of Lagos Library and that such third party material is clearly identified and acknowledged in the Work.

v. In the event of a subsequent dispute over the copyrights to materials contained in the Work, I agree to indemnify and hold harmless the University of Lagos and all its officers, employees and agents for any uses of the material authorized by this agreement.

vi. That the University of Lagos has no obligation whatsoever to take legal action on my behalf as the Depositor, in the event of breach of intellectual property rights, or any other right, in the material deposited.

I.A. JIMOH	30/10/2017	issa.jimoh@yahoo.com
Author's Name	Signature/Date	Email
Prof M.O. Dada	30/10/2017	mdada@unilag.edu.ng
1st Supervisor's Name	Signature/Date	Email
Prof. G. I. Idoro	Idoro 30/10/2017	iroroidoro@yahoo.co
2nd Supervisor's Name	Signature/Date	Email

SCHOOL OF POSTGRADUATE STUDIES
UNIVERSITY OF LAGOS

CERTIFICATION

This is to certify that the Thesis:

WORKSPACE UTILIZATION, MAINTENANCE PRACTICE AND LECTURERS' SATISFACTION WITH INDOOR ENVIRONMENTAL QUALITY IN SELECTED NIGERIAN UNIVERSITIES

Submitted to the
School of Postgraduate Studies
University of Lagos

For the award of the degree of
DOCTOR OF PHILOSOPHY (Ph.D.)
is a record of original research carried out
By:

JIMOH, ISSA AYODEJI
In the Department of Building

I.A JIMOH	[signature]	22/12/2017
AUTHOR'S NAME	**SIGNATURE**	**DATE**
PROF M.O. DADA	[signature]	22/12/2017
1ST SUPERVISOR'S NAME	**SIGNATURE**	**DATE**
Prof. G. I. Idoro	[signature]	22/12/2017
2ND SUPERVISOR'S NAME	**SIGNATURE**	**DATE**
Dr. O. J. AMEH	[signature]	22/12/2017
1ST INTERNAL EXAMINER	**SIGNATURE**	**DATE**
PROF K T ODUSAMI	[signature]	22.12.17
2ND INTERNAL EXAMINER	**SIGNATURE**	**DATE**
PROF I. MBAMALI	[signature]	22/12/17
EXTERNAL EXAMINER	**SIGNATURE**	**DATE**
Prof Alabi Soneye	[signature]	22/12/17
SPGS REPRESENTATIVE	**SIGNATURE**	**DATE**

DECLARATION

WORKSPACE UTILISATION, MAINTENANCE PRACTICE AND LECTURERS' SATISFACTION WITH INDOOR ENVIRONMENTAL QUALITY IN SELECTED NIGERIAN UNIVERSITIES

I declare that this thesis represents my original work in the Department of Building, University of Lagos. It has not been accepted for any previous application for a higher degree or previously published by any other person.

I authorize the University of Lagos to lend it to other institutions or individuals for the purpose of scholarly research.

Jimoh, Issa Ayodeji
December, 2017

SUPERVISORS' ATTESTATION

We hereby certify that the work in this thesis titled: **Workspace Utilisation, Maintenance Practice and Lecturers' Satisfaction with Indoor Environmental Quality in Selected Nigerian Universities"** was carried out under our supervision and that it is the original work of the researcher, **Jimoh, Issa Ayodeji**

1st Supervisor

i. **Name:** M.O. Dada

ii. **Designation:** Professor

iii. **Department:** Building

iv. **Signature: ________________**

v. **Date: _________________**

2nd Supervisor

i. **Name:** G.I. Idoro

ii. **Designation:** Professor

iii. **Department:** Building

iv. **Signature: ________________**

v. **Date: _________________**

DEDICATION

This Thesis is dedicated to the Almighty Allah, the most beneficent, the most merciful.

My parents, late Alhaji Mohammed Jamiu Alabi Aikore and Hajia Mariam Alake Iya-Alore Aikore.

My dear wife, Hajia Suliat Adunni Jimoh, my children namely: Muritala, Ibrahim, Abdulrasaq, Baidhau and Rahma.My siblings, relations, friends and the unknown.

ACKNOWLEDGEMENTS

I was highly humbled by the thoroughness of supervision and the goodwill of so many people in executing the Ph.D study. Well appreciated are the personalities involved in initiation, motivation, sponsorship, supervision, representation as proxies, accommodation, fieldwork, desk-work, statistical analysis, family support, home management and other forms of genuine kidness. May Allah the most merciful, the most beneficent support and bless their efforts and aspirations in all holy endeavours.

My supervisors, Prof. M.O. Dada and Prof. G.I. Idoro painstakingly ensured high quality output at every stage. The efforts of the supervisors were reinforced by the P.G.Coordinator, Dr. O.J. Ameh, the Head of Department, Prof. O.A. Adenuga, Prof. K.T. Odusami, Prof. R.O.A. Iyagba, Prof. O.S. Oyediran, Dr. O.E. Ogunsanmi, Mr. K.A. Popoola, Dr. O.J. Oladiran, Dr. J.A. Babalola, Dr. A.A. Soyingbe, Mr. F.O. Achi, Dr. O.A. Ajayi, Dr. O.M. Ajayi, Dr. W.A. Bello, Mrs. A.O. Johnson, Dr. O.S. Dosumu, Dr. J.O. Faremi, Dr. I.B. John, Hajia K.I. Zakariyyah, Mrs. A.O. Akinsola, Mr. C.O. Egbe, Mr. A.R. Aminu, Mr. A.O. Adegbile, Mr. A. Osunsanya, Mr. G. Kadiri, Mrs. F. Owolabi. Beyond the Department, Prof. T.C. Nubi, Prof. M.M. Omirin, Prof. S.J. Timothy-Asobele, Dr. H.A. Koleoso, Mr. J.U. Osagie, Mr. O.B.A. Idowu, Mr. A.A. Alabi, Dr. V. Ilechukwu, and Dr. O.A. Agunloye,among others. Accommodating me, at varied times and forms, were Dr. W.A. Bello, Prof. R.O.A. Iyagba, Dr. A.A. Soyingbe, Mr. F.O. Achi, Mr. M.A. Lawson's family and Alhaji Ahmed Alfa's family.

Sponsorship was facilitated and aided by my employer, Federal University of Technology, Minna under management of Prof. M.S. Audu, Prof. M. Akanji, Mrs. V.I. Kolo, Prof. Sadiku, Prof. O.O. Morenikeji, Prof. Y.A. Sanusi, Prof. Yahaya, Dr. W.P. Akanmu, Mr. M.A. Bello, Dr. R.A. Jimoh, etc. Mr. S. Yusuf. Dr. P. Bajere, Dr. H.I. Ogiri, Mr. I.O. Jimoh, Mr. Gabriel Sunday, Mr. Abdulrasaq Saka, Mr. Ladan Mohammed, Mr. Ismail Ojetunde, Mr. Seun Olubajo and others stood in for me on official assignments and I am very grateful.

Statistical analysis was accomplished through Mr. G.Oke, Dr. K. Garba (Unilorin), Mr. M.A. Lawson (LUTH), Mr. Saka Ismail, Mr. Ezekiel etc. Typing and proof reading were done extensively by Miss. Felicia Omonike and Mr. M.A. Lawson.

Mr. Uche Ebosi, Mr. I.O. Jimoh, Mr. A.O. Jimoh, Mr. Yunus Jimoh, Mr. Abdulrasaq Fagbenro, Mr. Tomisin Ashaolu who worked with me, during the fieldwork and proof-reading.

I am highly indebted to my family, relations and reliable friends, who contributed at one stage or the other in achieving success. They include my dear wife Hajia S.A. Jimoh, my siblings and five children, Prof. K. Salami, Prof. D.A. Muazu, Prof. S.N. Zubairu, Alhaji H.T. Abdulrahman, Prof. L.O.Tiamiyu, Mr. I.M. Awodi, Dr. Issa Ahmed, Comrade L.S.Ajibade, Prof. Tunde Ayodabo, Mr. Stephen Salami, Alfa Tunji Shuaib, Dr. Shuaib Ologele, Mr. H.B. Olola, Alhaji I. Kailani, Alhaji Bolaji Suleiman, etc.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATION AND ACRONYMS

ABC	-	Air-borne Bacteria Count
ANSI	-	American National Standards Institute
ASHA	-	American Speech – Language Hearing Association
ASHRAE	-	American Society of Heating, Refrigerating & Air-conditioning Engineers
ASUU	-	Academic Staff Union of Universities
BMS	-	Building Management System
BREAM	-	Building Research Establishment Environmental Assessment Method
BRI	-	Building Related Illness
CABE	-	Commission for Architecture and the Built Environment
CBE	-	Center for Built Environment
CBM	-	Condition Based Maintenance
CI	-	Confidence Interval
CIBSE	-	Chartered Institution of Building Services Engineers
CMMS	-	Computerised Maintenance Management System
DCV	-	Demand Controlled Ventilation
DLCA	-	Dynamic Life Cycle Assessment
EMAS	-	Eco-Management and Auditing Schemes
EPA	-	Environmental Protection Agency
FCT	-	Federal Capital Territory
GIA	-	Gross Internal Area
GMAT	-	Green Mark Assessment Tool
HKEPD	-	Hong Kong Environmental Protection Agency Department
HVAC	-	Heating, Ventilating and Air Conditioning
IAQ	-	Indoor Air Quality
ICT	-	Information and Communication Technology
IEQ	-	Indoor Environmental Quality
ILO	-	International Labour Organisation
ISO	-	International Standards Organization
LCIA	-	Life Cycle Impact Assessment
LEED	-	Leadership in Energy and Environmental Design
MIS	-	Mean Item Score

MM	-	Maintenance Management
MMIS	-	Maintenance Management Information System
MP	-	Maintenance Practice
MS	-	Mean Score
NAAQS	-	National Ambient Air Quality Standards
NABERS	-	National Australian Built Environment Rating System
NAO	-	National Audit Office
NIOSH	-	National Institute of Occupational Safety and Health
NRC	-	National Research Council
NRCC	-	National Research Council of Canada
NUC	-	National Universities Commission
OLR	-	Ordinal Logistic Regression
OR	-	Odds Ratio
OSHA	-	Occupational Safety and Health Act
OTF	-	Operate To Failure
PdM	-	Predictive Maintenance
PLEA	-	Passive Low Energy Architecture
PM	-	Particulate Matter
PPM	-	Planned Preventive Maintenance
PMV	-	Predicted Mean Vote
POE	-	Post Occupancy Evaluation
PPD	-	Predicted Percentage Dissatisfied
PPDU	-	Physical Planning and Development Unit
RAM	-	Reliability, Availability, Maintainability
RCM	-	Reliability Centered Maintenance
RSP	-	Respirable Suspended Particles
SBS	-	Sick Building Syndrome
SD	-	Standard Deviation
SMG	-	Space Management Group
TAEK	-	Turkish Atomic Energy Institution
TPM	-	Total Productive Maintenance
TVOC	-	Total Volatile Organic Compound

UC	-	Users' Characteristics
VOC	-	Volatile Organic Compound
WC	-	Workspace characteristics
WHO	-	World Health Organisation
WMU	-	Works and Maintenance Unit
WSRT	-	Wilcoxin Signed Rank Test
WU	-	Workspace Utilisation

LIST OF SYMBOLS

%	-	Percentage
^0C	-	Degree Centigrade
clo	-	Clothing
CO	-	Carbon monoxide
CO_2	-	Carbon dioxide
Df	-	Degree of Freedom
g/m3	-	Gram per cubic metre
H_0	-	Alternative Hypothesis
H_1	-	Null Hypothesis
K	-	Vertical air absolute temperature
l	-	Litre
L/S^2	-	Litre per second per second
L/sm^2	-	Litre per square metre
m	-	Metre
m/s	-	Metre per second
m^2	-	Square metre
N	-	Number of subjects in population
O_3	-	Ozone
p	-	Probability level/value
r		Correlation coefficient
R^2	-	Likelihood of contribution to Lecturers' satisfaction
SO_2	-	Sulphur dioxide
Ƶ	-	Standard score
x^2	-	Chi square
Yus	-	User's satisfaction (Dependent variable)
β	-	Standard Error
μ	-	Micro

ABSTRACT

Global concern over Indoor Environmental Quality (IEQ) emanates from its effects on health, general well-being and labour productivity because 60-90% of daytime is spent indoors. Evidence of Building Related Illnesses (BRI), Sick Building Syndrome (SBS) and absenteeism from work due to poor IEQ has made IEQ one of the indices of environmental sustainability. There is, however, paucity of research on IEQ and its relationship with workspace utilisation and maintenance practice in Nigeria. The aim of the study is to investigate the relationship between workspace utilisation, maintenance practice and lecturers'satisfaction with IEQ in selected Nigerian universities. The objectives are: to evaluate the intensity of workspace utilisation by lecturers; determine the difference between satisfactory and unsatisfactory IEQ; determine the effects of lecturers' and workspace characteristics on IEQ; examine the relationships between maintenance practice, workspace utilisation and lecturers' satisfaction. Lecturers in the University of Agriculture, Makurdi, Federal University of Technology, Minna and University of Ilorin were purposively selected as respondents. Data for the study were gathered through questionnaire survey and physical measurements of temperature, humidity, acoustics, lighting and airflow in 18 offices containing 43 workspaces. Mean score, Analysis of Variance (ANOVA), Wilcoxin Signed Rank Test (WSRT), Paired-samples t-test, Mann-Whitney U test, Krukas-Wallis test and Spearman rho correlation are the statistical tools used for analysis. Predictions were modelled using Ordinal Logistic Regression (OLR). Results revealed fairly good intensity of workspace utilisation (32.01-42.31%) by lecturers in the three selected universities. There were no significant differences between measured IEQ parametres (temperature, humidity, acoustics, airflow and lighting)which were adjudged as satisfactory and unsatisfactory by lecturers. Lecturers' characteristics (gender, age, qualifications, and tenure in workspace) affect lecturers' satisfaction with IEQ parameters such as acoustics, adjustability of furniture and airflowwhile workspace characteristics (type of building, floor level, direction faced by window, and type of office) affect lecturers' satisfaction with IEQ parameterslike size of workspace, airflow, and visual comfort. Correlation was established between maintenance practice tasks except users' role and IEQ parameterswhich include visual quality, acoustics, size and layout of workspace. There was also correlation between workspace utilisation on formal reading, internet surfing and relaxation and IEQ parameters such as IAQ, thermal quality and visual quaity. OLR models revealed lecturers' characteristics and maintenance practice as major predictors of satisfaction based on subjective assessment (Pseudo R-Square (R^2)=0.261; Odds Ratio (OR) =1.157). Prediction with objective data, however indicated workspace characteristics as major predictor (R^2=0.86; O.R=1.976). In conclusion, lack of uniformity in provision and use of workspace have effects on maintenance practice and lecturers satisfaction in Nigerian universities. The findings of this empirical study indicate that IEQ affects lecturers'satisfaction and comfort in workspaces. By implication, satisfaction and comfort of lecturers will create optimal workspace utilization, higher academic productivity and better global rating of Nigerian universities.Retrofitting and monitoring of workspaces, by maintenance units, are therefore recommended for desired IEQ in workspaces of lecturers. Adoption of the predictive models for assessment, policy formulation, bench-marking, environmental design of new buildings and performance evaluation of existing stock are also recommended.

Keywords: Indoor Environmental Quality (IEQ); Lecturers' satisfaction; Maintenance practice; Ordinal Logistic Regression (OLR) ; Workspace utilisation; University.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Academic buildings in universities are constructed to create stimulating and adaptable indoor environments with workspaces that support various styles of teaching, learning and research (Lateef, Khamid & Idrus, 2010; Okolie, 2011). Lecturers' satisfaction in such buildings is affected by Indoor Environmental Quality (IEQ), which, in turn, is influenced by characteristics of the users and the building itself (Frontczak, Schiavon, Goins, Arens, Zhang & Wargocki, 2012). The inherent utility of academic buildings as enabling facilities and operating resources for academic work has therefore become a maintenance management challenge to stakeholders (McGregor & Then 2001; Thompson, 2002; Roelofsen, 2002). The challenge is in recognition of the fact that lecturers spend a high percentage of time, in allocated offices, on assigned duties. The condition of the indoor environment thus has far-reaching effects on the health, stress level, productivity and general well-being of lecturers (Frontczak & Wargocki, 2011; Zalejska-Johnson & Wilhelmsson, 2013).

Scientific investigation into IEQ commenced during the Industrial Revolution whenTredgold's work of 1824 on ventillation was published, as stated by Salthammer (2011). Efforts of other researchers and institutions like Pettenhofer in 1858, Billings in 1889, American Society of Heating and Ventilating Engineers (ASHVE) in 1915, Yaglou in 1936 and Fanger in 1982, 1988 thereafter culminated into the issue of Standard No.62 'Ventilation for Acceptable Air Quality' by American Society of Heating, Refregerating and Air conditioning Engineers (ASHRAE), (ASHRAE, 2007).This standard has been subsequently revised by National and International organisations as guidelines and reference values in industrialised nations. In developing countries, like Nigeria, such guidelines and reference values have not been established (Lahri & Ray 2010). In the same vein, a research group led by Elton Mayo undertook what is known as the Hawthorne studies, based on the assumption that a change in physical work environment could cause increase in workers' satisfaction and productivity (Mayo, 1933). Mayo's study however, revealed that the improvement in output was majorly due to social blend and individual recognition of workers by management (Dale, 1984).

IEQ is the condition created in buildings by contextual features like characteristics of building elements, characteristics of the occupant, furniture and furnishing and mechanical and electrical conditioning facilities (Frontczak, 2011). IEQ basically involves measurements of the quality of indoor air, lighting, acoustics and thermal quality (Al Horr, Arif, Katafygiotou, Mazaoei, Kaushik & Elsarrag, 2016). IEQ is now extended to include spatial and ergonomic parameters, building integrity, building maintenance and cleanliness (Leaman & Bordass, 2007; Collinge, Landis, Jones, Schaefer & Bilec, 2013).

The factors affecting IEQ are closely related, interdependent and are perceived by the users, at a time and specific location, in either expressing satisfaction or determining the intensity of workspace utilisation (Huang, Zhu, Quyang & Cao, 2012). The contributions of maintenance practice to satisfactory IEQ, with the attendant stimulation of workspace utilisation and comfort of users, remain unexplained in published research works. The multi-sensory impact of the indoor environment on occupants is complex and affects their psychological and physical health, even restricting communication (Barret, Zhang, Moffat & Kobbacy, 2013).

Research works by Olanrewaju and Kafayah (2008), Vischer (2008), Best and Purdey (2012), have established positive correlations between IEQ and comfort levels of users for enhancing well-being, health, safety and productivity. A poor workspace environment could cause health-related problems or even lawsuits that are associated with poor indoor air quality, inadequate lighting, thermal discomfort and ergonomic-related occupational injuries, collectively described as the Sick Building Syndrome (SBS). Consequently, poor workspaces cannot adequately support the space and comfort requirements of the increasingly collaborative and highly information-based knowledge workforce of the 21st century. A working environment that allows people to perform work optimally remains one of the fundamental human requirements for commensurate, economic and desirable workspace utilisation (Roelofson, 2002).

The level of satisfaction with IEQ has underpinned Post Occupancy Evaluation (POE) of buildings since the 1980s and led to renewed interest, through certification of green buildings, on reduction of absenteeism and sick leave and improvement of productivity (Leaman & Bordass 2007, Best 2010, Armitage, Murugan & Kato 2011). The Center for the Built Environment (CBE) at the University of California, Berkeley has been conducting web-based POE surveys for over a decade on buildings to collect information about occupants' evaluation of IEQ and building features (Zagreus, Huizenga, Arens & Lehrer 2004, Frontczak& Wargocki 2011). Some findings of these surveys show that improved building maintenance practices, such as monitoring and timely rectification of defects, could prevent many health and performance problems associated with indoor environmental conditions. Beyond commissioning of buildings, maintenance practices required to ensure satisfactory IEQ, include top management commitment, relevant maintenance objectives, maintenance planning, organising maintenance, control of maintenance works and users' feedback.

Researchers have made concerted efforts since the Industrial Revolution on solving the inherent problems of IEQ in occupied buildings through application of varied approaches that are often related to specific knowledge domains.Majority of the intensive research works focused on either maintenance management, indoor environmental quality or workspace utilisation as independent separate entities. Adebayo (1991), Zubair (1999), Buys and Nkodo (2006), Adenuga (2008), Arslankaya and Atay (2015), Pukite and Geipele (2017) and others were limited to physical performance of building elements without considering their influence on condition within the building. Increasing growth of global interest on socially responsible building management practices is dictating and directing research efforts towards more inclusive, integratedand pro-active maintenance management of the building life cycle. Environmental sustainability, climate change, green house emissions and energy efficiency which bear relationships with workspace utilisation, IEQ and maintenance practice are some areas of interest.

International Standards Organization (ISO-14031), British Standards (BS 7750) and the European Union's Eco-Management and Auditing Schemes (EMAS) are among organizations having or developing guidelines for evaluating environmental performance of building facilities (Lavy, Garcia & Dixit, 2010). Environmental Protection Agency (EPA) exists in Nigeria but the functions covered relate more with external environment of buildings than the indoor. Maintenance of offices of lecturers for functional comfort, satisfaction, good health, productivity and improved workspace utilisation remains an evolving challenge to be addressed by maintenance and facilities managers in the Nigerian universities.

This study investigated the relationship between lecturers' characteristics, workspace characteristics, workspace utilization, maintenancepractice and lecturers' satisfaction with IEQ in selected universities in North Central geo-political zone of Nigeria. Derived relationships werefurther used to develop overall predictive models on lecturers' satisfaction with IEQ in allocated workspaces.

1.2 Statement of the Research Problem

Office buildings for lecturers constitute an integral part of the infrastructural facilities required for academic work in universities. However, the conditions within office buildingsfor meeting job requirements are either satisfactory or unsatisfactory (Frontczak, 2012; Barret, Zhang, Moffat & Kobbacy, 2013). The poor work environment resulting from infrastructural decay in Nigeria's 236 Universities as at 2016 (42 Federal, 44 State and 150 Private) has been a subject of concern amongst stakeholders in the education sector (Okebukola, 2002; Ojogwu &Abutu, 2009; Odiake, 2016). Major parameters of IEQ affecting health and comfort like thermal and visual qualities have not been included in Minimum Benchmark for Academic Standards (BMAS) by the National Universities Commission (NUC). Furthermore, the recent Needs Assessment exercise undertaken in universities failed to consider IEQ as an essential factor for improved workspace utilisation, lecturers' productivity and satisfaction.

The consequences of negligence of provision and maintenance of infrastructure include brain drain, academic tourism and capital flight on overseas training. In a bid to address the real or perceived failures associated with the dilapidation of infrastructure, labour unions have frequently disrupted the academic calendar of many Nigerian universities via industrial actions. Frequent industrial actions culminate in low research productivity, poor-quality graduates and lecturers' discomfort. The aforementioned consequences, combined with the effects of limited executive capacity, inadequate funding and rapid expansion without commensurate physical development, have negatively impacted on global ranking of Nigerian universities.

Relevant research works have been limited to the effect of individual IEQ parameter on the comfort and satisfaction of occupants of buildings. Examples include: Nicol and Humphreys (2002) on thermal comfort, Galasiu and Veitch (2006) on the visual aspect, and Kim and de Dear

(2012) on acoustics performance of indoor enviroment. Nevertheless, parametric research works have not considered how workspace utilisation and maintenance practice influence IEQ in occupied buildings.

The interrelatedness and interdependency of IEQ parameters, the contributions of maintenance practice to lecturers' satisfaction with IEQ and its attendant stimulation of workspace utilisation remain unexplained in aforementioned and similar published research works. Yet, an empirical investigation of the interaction and relationships that can form the basis for scientific decision-making on lecturers' satisfaction to make Nigerian universities viable and sustainable, is crucial.

1.3 Research Questions

The following questions are developed for addressing the research problem.

1. What is the intensity of use of office workspaces by university lecturers?
2. Are the IEQ factors adjudged satisfactory different from those adjudged unsatisfactory?
3. What are the effects of lecturers' characteristics and workspace characteristics on IEQ?
4. What is the relationship between maintenance practice and lecturers' satisfaction with IEQ?
5. What is the relationship between workspace utilisation and lecturers' satisfaction with IEQ?
6. What model(s) will predict lecturers' satisfaction with IEQ?

1.4 Aim and Objectives of the Study

The aim of the study is to assess the relationship between workspace utilisation, maintenance practice and lecturers' satisfaction with indoor environmental quality (IEQ) in selected Nigerian universities with a view to enhancing lecturers’ satisfaction with workspaces. The objectives set for achieving the aim of the study are to:

1. evaluate the intensity of the use of office workspaces by lecturers in public universities in the North Central geo-political zone of Nigeria;
2. compare the IEQ of workspaces adjudged as satisfactory and unsatisfactory by lecturers;
3. assess the effects of lecturers’ characteristics and workspace characteristics on IEQ;
4. determine the relationship between maintenance practice and lecturers’ satisfaction with IEQ;
5. determine the relationship between workspace utilisation and lecturers’ satisfaction with IEQ;
6. develop models for predicting lecturers’ satisfaction with IEQ in workspaces.

1.5 Hypotheses of the Study

H_1: There is no significant difference in intensities of workspace utilisation among universities in the study area.

H_2: There is no significant difference between perceived IEQ adjudgedas satisfactory and unsatisfactory by lecturers.

H_3: There is no significant difference between lecturers’ satisfaction with perceived IEQ on the basis of lecturers’ characteristics.

H_4 There is no significant difference between lecturers' satisfaction with perceived IEQ on the basis of workspace characteristics.

H_5: There is no significant relationship between maintenance practice and lecturers' satisfaction with IEQ.

H_6: There is no significant relationship between workspace utilisation and lecturers' satisfaction with IEQ.

1.6 Scope and Delimitation of the Study

This study is limited to evaluation of satisfaction with IEQ in workspaces of lecturers in three sampled Universities out of the existing six Federal Universities within North Central geo-political zone of Nigeria. The Universities are University of Ilorin in Kwara State, the Federal University of Technology, Minna in Niger State and the University of Agriculture, Makurdi in Benue State. The IEQ parameters considered include: acoustics, Indoor Air Quality (IAQ), thermal quality, space layout, size of work space, proximity of external window, which are largely in conformity with those used in subjective assessments by CBE and ASHRAE.These parameters translate to performance criteria for measuring lecturers' satisfaction. Physical measurement was however limited to five IEQ parameters (temperature, humidity, lighting, sound, and air movement) using appropriate instruments. Locational variations and measurement of other parameters within sampled workspaces were not included owing to the limited number of instruments available, time constraints and the small size of sampled offices. Measurements were simultaneously taken in each workspace as far as practicable to avoid wide variations and ensure comparability.

IEQ parameters adjudged satisfactory as perceived by lecturers, in response to questionnaire survey or measurements with instruments, were taken as the comfort levels of the identified 13 uses of workspaces. Although, studies (Vischer, 2008; Best & Purdey, 2012; Barret, Zhang, Moffat & Kobbacy, 2013) affirmed that IEQ has a high-level impact on labour productivities, behaviour and behaviour change of building occupants, the scope of this study is limited to lecturers' satisfaction in relation with performance of assigned duties in the workspaces only. The psychological aspect of satisfaction in the workspace was not covered. Respondents to the questionnaires were limited mainly to lecturers in related disciplines, such as Environmental Sciences, Engineering, Life Sciences and Environmental Management, who are in a better position to assess performance of occupied buildings on IEQ in terms of job requirements, maintenance status and workspace utilisation.

1.7 Significance of the Study

Workspace utilization by University lecturersfor academic works is an index of satisfaction, comfort and productivity. All efforts and decision making directed towards realization of high intensity therefore contribute to viability and global rating of Nigerian Universities. Top management of universities, maintenance managers, facilities managers, and other stakeholders therefore require workspace utilization data for decision making and policy formulation on availability, reliability, and comfort in lecturers' workspaces. Reduction of avoidable costs on operation, cleaning, maintenance of utilities in lecturers' workspaces could also be achieved through optimal use of workspaces. National Universities Commission (NUC) and each university could use the baseline data on workspace utilization to set National and local standards comparable with SMG (2006) benchmarks. Such standards are useful as prerequisite or justification for procurement of new buildings by universities in view of huge financial commitment required for construction.

Units responsible for physical planning, development and maintenance in Nigerian universities require baseline data on IEQ for performance evaluation of existing academic buildings and the much needed transformation in the environmental design of new construction. Knowing the difference between the desired and actual IEQ in workspaces, through monitoring and feedback from lecturers will guide the units more relevantly. IEQ is an important index in environmental sustainability rating of buildings by BREEAM, LEED,and NABERS, in United Kingdom, United State of America and Australia respectively.

Measured IEQ parameters like temperature, lighting and acoustics, which were adjudged satisfactory by lecturers, are useful in setting standards for monitoring and regulating indoor environment of academic buildings.

Determination of effects of workspace characteristics and lecturers' characteristics on satisfaction with IEQ is essential for selecting materials to rectify defects and in specifying materials for the design of new buildings by the maintenance and physical development units of universities respectively. Satisfying the comfort requirements of lecturers will raise academic productivity.

Consultants, Designers, Construction managers, Maintenance managers Facilities managers, Building owners, Environmental Protection Agencies (EPA) and other stakeholders will find the predictive models useful in addressing, pro-actively, functional failures and enhancement of performance of physical infrastructure in Nigerian universities. This study revealed lack of commensurate attention on IEQ by the Universities studied.

1.8 Definition of Operational Terms

1. **Indoor Environment:** It consists of the floor space within the confines of the internal walls of lecturers' offices. It has physical, administrative and social attributes. Environmental factors attributable to indoor environment of lecturers' workspace include: ambient environmental conditions (sound, light, air-flow and heat), furniture layout and ergonomics. The behavioural or outcome measures include lecturer's satisfaction, lecturer's feelings of comfort about the work-environment and productivity.

2. **Indoor Environmental Quality (IEQ):** IEQ entails the combined status of experienced indoor air, thermal, visual, aural characteristics, furniture and furnishing in a workspace. IEQ includes size and layout of workspaces, building integrity, building maintenance and cleanliness.

3. **Lecturer:** An employee of a university whose jobs entail teaching, research and community development in conformity with the mission of university education in Nigeria. Categories of academic staff are Graduate Assistant, Assistant Lecturer, Lecturer II, Lecturer I, Senior Lecturer, Associate Professor/Reader and Professor.

4. **Maintenance Practice:** Maintenance practice implies deployment of resources and management actions towards creation of acceptable quality performance of workspace environment for lecturers to perform assigned duties in a University. The major aspects are top management commitment, maintenance objectives, maintenance planning, organising maintenance, controlling maintenance works and involvement of lecturers in quality control through feedback information.

5. **Satisfaction/Comfort:** It is the feeling of physical and mental well-being experienced by a lecturer in an allocated office or workspace environment. The feeling is derived from the building's physical elements and mechanical/electrical installations for providing and maintaining set of thermal, luminous, aural and acoustic comfort for academic works. The hierarchical categorization of comfort is based on physical, functional, psychological and social influence on performance of formally assigned academic works within the workspace.

6. **Workspace:** It is a floor space within a building furnished and equipped for lecturers to carry out assigned duties in public universities within the study area. Workspace in a university setting entails formally allocated, equipped and furnished floor-space in an office building for performance of academic works by lecturers. An office may therefore contain one, two, three or more workspaces.

7. **Workspace Utilization:** It is a measure of how workspace is being used for academic work by lecturers in a university. Utilization rate is a function of frequency of use and occupancy rates. Frequency rate measures, in percentage, the proportion of time out of available or scheduled time (for use), that workspace is used for academic works compared to its availability. Occupancy rate, also expressed in percentage, is a measure of how filled the space is, while carrying out an assigned duty, compared to its accommodation capacity.

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Perspective of Maintenance Management

Asset preservation and failure prevention were not established maintenance objectives in the early years of the twentieth century (Chute, 2003). The practice before the industrial revolution had been Corrective Maintenance (CM) or Operate To Failure (OTF) which entail repair as soon as defects were detected by craftsmen like carpenters, masons, smiths, etc.

The discovery of steam power and iron hulls in 1860 contributed to quality control and then automation in manufacture of spares which led to simpler, quicker and cheaper replacement than repairs. The craftsmen, who learned the trades as apprentices, would naturally fit a stronger part to replace the defective one. As stated by Sherwin (2000), such maintenance policy was worthwhile then because of the slow evolution and the fact that skilled labour was cheap relative to the utility value of assets. Maintenance job gradually improved,after the initial slow but accelerating development of the concept of interchangeable spare parts, to the level of requiring less craft skill but more diagnostic ability (Waeyenbergh & Pintelon, 2002). As the maintenance job became more and more diagnostic, centralization of apprentice training in craft schools for speedy skill aquisition came into the fore. In addition, rapid expansion of higher education caused reduction in the number of craft skills and technicians because brilliant youths with skill potentials were drawn out of engineering and allied professions.Consequently, the skills shortage created became and remained a problem, making reliability of facilities more important relative tomaintainability.Maintenance has therefore been recognized more as a component of integrated business concept (Eti, Ogaji & Probert, 2006).

Table 2.1: Maintenance in a Time Perspective

< 1950	1950 - 1975	> 1975	"2000 & beyond"
Manpower (Simple) "affix it when it breaks"	Mechanization (Complex) "I operate, you fix" (Availability, Longevity, Cost) PM, WO- Management	Automation (More Complex) RAM (safety, Quality Environment) CBM, CM, DOM, Multi-skilling, MMIS Asset Management	Globalization (Crossing Boundaries) Optimal concept + Outsourcing & ICT
Maintenance is "A production task"	Maintenance is "A task of the maintenance dept"	Maintenance is "(maybe) Not an isolated function" Integration efforts	Maintenance is "External and Internal partnerships" maintenance meets production
"Necessary evil"	"Technical matter"	"Profit contributor"	"Partnership"

RAM: Reliability, Availability, Maintainability; PM: Preventive Maintenance; ICT: Information and Communication Technology; CBM: Condition Based Maintenance; CM: Condition Monitoring; WO: Work-Order; MMIS: Maintenance Management Information System;

Source: *Waeyenbergh and Pintelon (2002), p.301.*

As indicated in Table 2.1, Predictive Maintenance (PdM) or Condition Based Maintenance (CBM), which entails condition monitoring and tracking, was introduced between 1975 and 2000. This development arose because of the challenges brought about by improved technology, higher sophistication and associated demand requirements of the users, more attention to risk and environmental issues by government regulating agencies (Gabbar, Yamashita, Suzuki & Shimada, 2003). The need for reliability in both operation and consistent performance led to the integration of CBM with Preventive Maintenance (PM) between 1980 and 1990.

Reliability Centered Maintenance (RCM) was developed as maintenance strategy for air-line maintenance and reliability by Nowlan and Heap at United Airlines, San Francisco between 1960 and 1970. RCM looks at every component in the production process and asks how can or has the component failed in its functions in order to eliminate the intolerable functional and physical failures (Eti, Ogaji &Pubert, 2006). The challenges of intense global competition that demanded reduction in costs without sacrificing quality led to the initiation of RCM.

Total Productive Maintenance (TPM), an innovation of the 1980s consists of management initiative and interventions, which heavily emphasize operator's involvement in routine maintenance of physical assets (Marquez & Gupta, 2006). TPM has transformed many conventional preventive maintenance strategies into condition-based ones and has strongly applied techniques for better communication, participation and the generation of personnel motivation to reduce downtime and interruption of production activities.

Proactive maintenance took on new meaning for maintenance in the early part of 21st century by combining all available strategies into an approach which prevents failure, maximize asset life and its reliability, and assure that they perform as intended or better. Proactive maintenance requires organisations to utilize the best of 'high-technology' methods and maintenance strategies which are built upon solid foundation of quality equipment, good installation, proper operation and application of maintenance best practices by a dedicated maintenance work force.

2.2 Maintenance Management of Buildings

Maintenance management process is the course of action and the series of steps to follow in executing maintenance work. Maintenance management processes are continuous closed loop processes in which feedback is used to lead to continuous improvement (Marquez & Gupta, 2006). European committee for standardization (2001) defined maintenance as "the combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function". The committee went further to define in clear terms, maintenance management, (MM) as all the activities of the management that determine the maintenance objectives or priorities, strategies and responsibilities and implement them by means such as maintenance planning, maintenance control and supervision, and improving the methods including economic aspects in the organisation (EN 13306,2001).

Wireman (1998) stated that Maintenance Management (MM) would include, but would not be limited to Preventive Maintenance (PM), inventory and procurement, work order system, Computerized Maintenance Management System (CMMS), technical and inter-personal training, operational involvement, proactive maintenance, Reliability Centered Maintenance (RCM), Total Productive Maintenance (TPM), statistical financial optimization, and continuous improvement. Visser (1998) and Campbell, Duffua and Raouf (2000)however indicated MM as a simple input-output system in which the inputs are the manpower, management, tools, equipment, and so on and the output is the asset working reliably and efficiently.

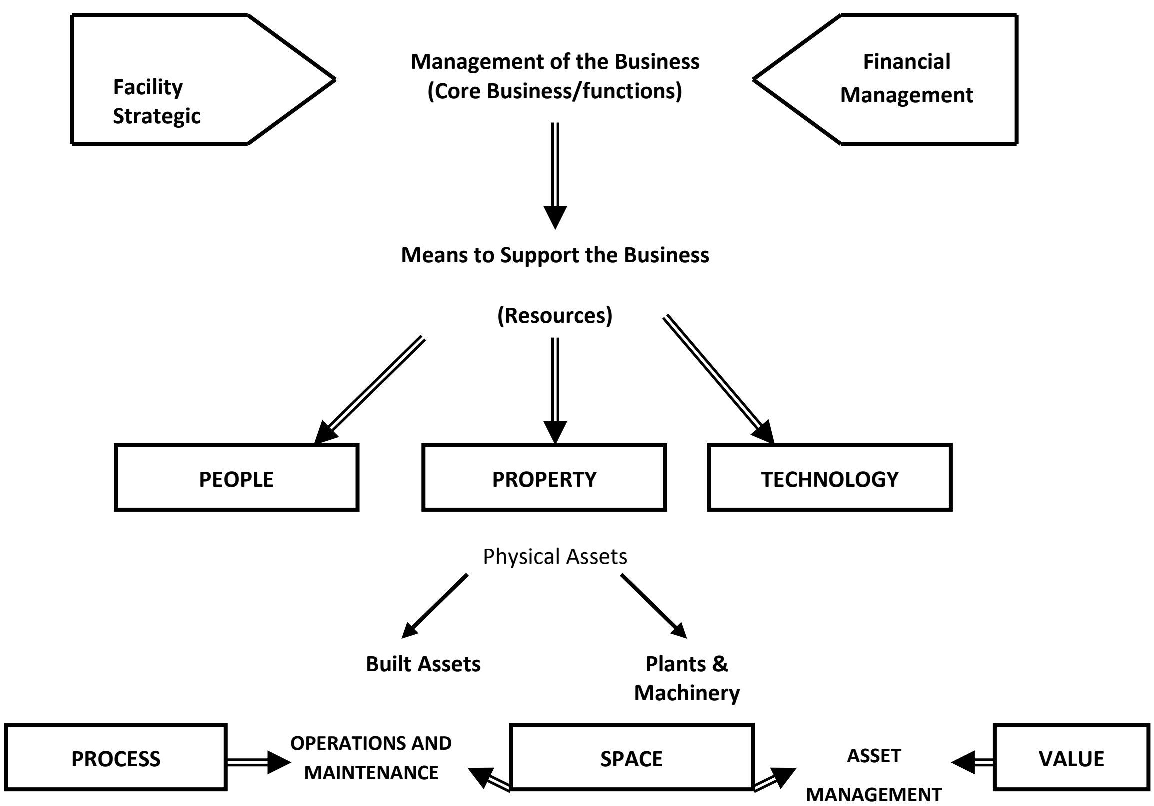


Fig.2.1: The context of Asset Maintenance and Management
Source: *Then (1994), p.25*

Planned Preventive Maintenance (PPM) has been described as the most effective management strategy against the frequency of breakdown (Seeley, 1976; Wood, 2003). Study about the effectiveness of PPM, with empirical data to support its efficiency, is however limited (Wood, 2003). It is also claimed by Loosemore and Hsin (2001) and Wood (2003) that the effectiveness of PPM has been challenged more by the top management.

To achieve objectives of any organization, strategic facility management and financial management are directed to core functions through appropriate deployment of people, physical assets and technology. In operating and maintaining built assets, Then (1994) has indicated the relatedness between production process, asset's value and the amount of occupied space as shown in Fig. 2.1. By implication, value of workspace depends on optimisation in its allocation and use by workers and production facilities.

Maintenance management processes are depicted in a flowchart (Fig. 2.2) by Dessouky and Bayer (2002). The process starts with generation of scheduled or requested maintenance work such as alterations, repairs or preventive maintenance. Trade assignment done by a Central work centerleads to assingnment of work to appropriate crew of craftsmen by the Craft work center. The two aforementioned processeses are taken further through execution and documentation. Work requests are either modified before execution or executed as planned.The same maintenance management processes have been categorized by Hassanain, Froese & Vanier (2003) into identification of assets, determination of performance requirements, and evaluation of performance while in use, planning maintenance and managing maintenance operations.

Buildings in tertiary institutions are identified through physical inspection for the purpose of documentation and are classified in line with the objectives of maintenance vis-à-vis the

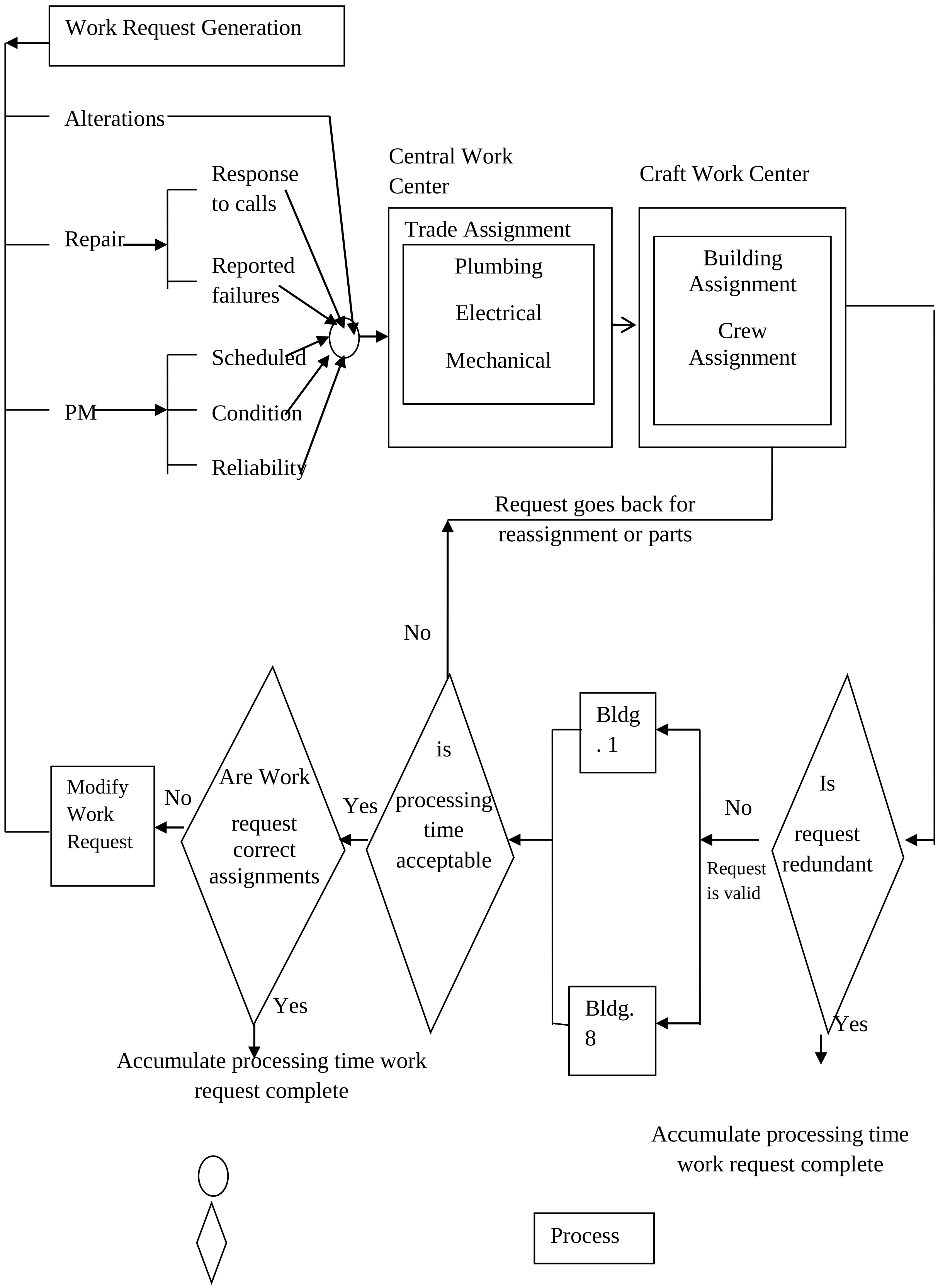


Fig 2.2: Graphical representation of the maintenance process

Source: Dessouky & Bayer (2002), p.426

institutional policy and strategies. Buildings have been classified by Bergley (2007), based on physical condition, into:

- As new or ideal condition which comprise buildings built within the last five years or which had undergone major refurbishment within the last five years. Such buildings have been maintainedor serviced to ensure fabric and building services replicate conditions at installation. It is expected that the buildings will have no negative impacts on operations within and provide a satisfactory standard of service if properly maintained.

- Sound, operationally safe buildings with minor deterioration which could be executed within the existing maintenance budget. Minor defects on internal and/or external finishes, few structural, building envelope, building services or statutory compliance issues evident, and possibility of executing maintenance during operational period exists. Impact on operations within the building is minor.

- Operational but major repair or replacement necessary within a reasonably short period, with costs included within the long term maintenance plan. Many structural, building envelope, building services or statutory compliance issues exist. Safety risk or breach of statutory compliance which curtail operations within the building or one particularly significant issue. Impact on operation is major.

- Inoperable and unsafe buildings with serious risk of major failure or breakdown that needs urgent attention and/or expenditure. The condition of the building constitutes a health and safety risk or breach of statutory compliance which curtail operations within the building (Bergley, 2007).

Buildings are sometimes identified for the determination of priorities in executing maintenance works based on the following criteria:

- Building status in terms of its relative significance vis-à-vis function, present and future intended use in relation to other buildings within its location.
- Physical condition that gives an indication of defective elements, as analysed, to determine level of risk.
- Importance of usage e.g. learning compared with social activities.
- Effects on users.
- Effects on fabrics.
- Special criteria e.g. ability to accommodate change in use.

The data on buildings may be coded and expressed either quantitatively, as a numerical rating (a condition index) or qualitatively as a categorical rating for input into the computer, as data bank, dedicated to maintenance in CMMS. Other forms of data include floor area, number of workstations, usage over time, costs, failure mode and pattern, etc. which are often kept in the Asset register.

2.2.1 Indoor Workspace Environment in Buildings

Workspace entails an environment in a building in which the worker performs his work (Chapin, 1995). Environment, on the other hand, refers to the physical, administrative and social attributes of settings in which people live, work and play. Environmental aspects of workspace stated by Vischer (2008) are ambient environmental conditions (noise, lighting, air quality and thermal comfort), furniture layout and ergonomics (work stations, offices and shared amenities) and process issues (user participation in decision making). He went further to state the behavioural or outcome measures as employee satisfaction, employee feelings about their work environment as expressed in the sense of territory, ownership and belonging and employee productivity. Ajala (2012, p.141) referred to the workplace environment as “the most critical factor in keeping an employee satisfied in today’s business world”.

An effective workplace is an environment where results can be achieved as expected by the management of an organization (Shikdar, 2002; Preiser & Vischer, 2005; Mike, 2010). Unsafe and psychologically unhealthy workplace environment affects worker’s health and productivity in terms of poor ventilation, inappropriate lighting, excessive noise, etc. (Chandrasekar, 2011). Systematic scientific investigation into the hygiene of the indoor work environment started in the age of the industrial revolution with a work dealing with questions of ventilation written by Thomas Tredgold in 1324 (Salthammer, 2011). Environmental conditions, furniture and office layout and production processes are the three aspects covered in research on environmental psychology of workspace as shown in Table 2.2. The three aspects were appraised as they affect satisfaction, territoriality or sense of belonging and productivity of occupants and users of a building.

Table 2.2: Typology of Research on the Environmental Psychology of Workspace

S/N	Aspect	Satisfaction	Territoriality & Belonging	Productivity
a.	Ambient environmental conditions	Do people like the lighting, noise levels indoor air quality and thermal comfort?	How do conditions such as day lighting and natural ventilation as well as local controls over interior conditions affect the way people feel about their work and work space?	Do changing environmental conditions help people work better or faster?
b.	Furniture and office layout	Do people like their furniture, location, access to meeting-rooms and on-site services?	How do moves changes and other reconfigurations of workplace affect people's feeling about territory, their sense of privacy and their social status?	Does a changing furniture layout, the location of equipment, meeting- space and bath rooms help people work better or faster?
c.	Process issues e.g. user participation	Do people report more satisfaction with the work environment if they have been involved in space related decisions?	How does involving workers in making decisions about their workspace affect their feelings of ownership and belonging, and increase employee loyalty?	Do environments designed to meet organizational goals and objectives have a positive impact on the organization's bottom line?

Source: *Vischer (2008), p. 98*

Studies by McCoy and Evans (2005) indicate that both worker's performance and organizational success are compromised when the physical environment interferes with actions taken towards achievement of objectives. An ideal indoor work environment is therefore, that which alsosatisfies all occupants through reduction to the lowest level of all the risks associated with illness or injury in relation to health and work (Kortum, Leka & Cox, 2011).

Understanding how satisfied occupants are with the workspaces they occupy has underpinned post occupancy evaluation of buildings since the 1980s (Marans & Spreckelemeyer, 1982; Oldham & Rotchford, 1983; Ornstein, 1999). The difference between a supportive and unsupportive workspace is the degree to which occupants can conserve their attention and energy for their tasks, as opposed to expending it to cope with adverse environmental conditions (Evans & Cohen, 1987; Dewulf & van Meel, 2003). In view of the fact that people spend 85-90% of their time indoors, quality of indoor environment is one of the most significant environmental aspects, relating to buildings, which has attracted tremendous research efforts and legislation in western countries (Malmqvist & Glauman, 2009).

The characteristics of the physical indoor environment of a building are the dimensional and spatial features, visual features, auditory features, tactile features and atmospheric features (Vural & Balanli, 2011).Workers are affected in different ways by workplace conditions depending on whether their tasks are defined individually, in the context of a team or with reference to overall organization operations (Vischer, 2006). Workplace features considered highly significant to users' satisfaction include lighting, ventilation rates, access to natural light and acoustic environment (Becker, 1981; Hinks & McNay, 1999; Veitch, Charles, Newsham, Marquardt & Geers, 2004 & Humphries, 2005). Lighting and other factors like ergonomic furniture indicated in Fig. 2.4 have been found to have positive influence on employee's health (Milton, Glencross & Walters, 2000; Veitch & Newsham, 2000; Dilani, 2004) and consequently productivity. Ambient features in office environments, such as lighting, temperature, existence of windows, free air movement, etc suggest that these elements of the physical environment influence employee's attitudes, behavior, satisfaction, performance and productivity (Veitch & Gifford, 1996; Larsen, Adams, Deal, Kwon & Tyler, 1998). The indoor environment is of an important priority to academic institutions because of its impact on learning process (Wong &Jan, 2003). In corroborating aforementioned impacts of IEQ, Collinge et al. (2013) classified them in Fig. 2.3 into human health chemical, human health non-chemical and, productivity and performance.

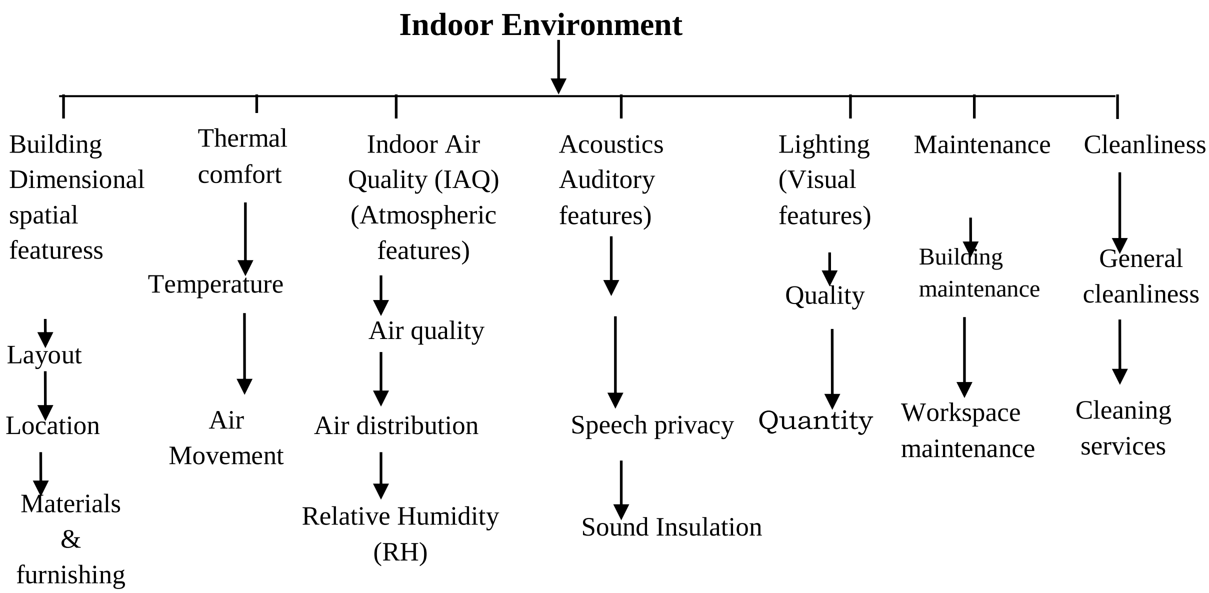


Fig.2.3: The different factors of physical indoor environment.
Source: Takki *et al.* (2011), p.3

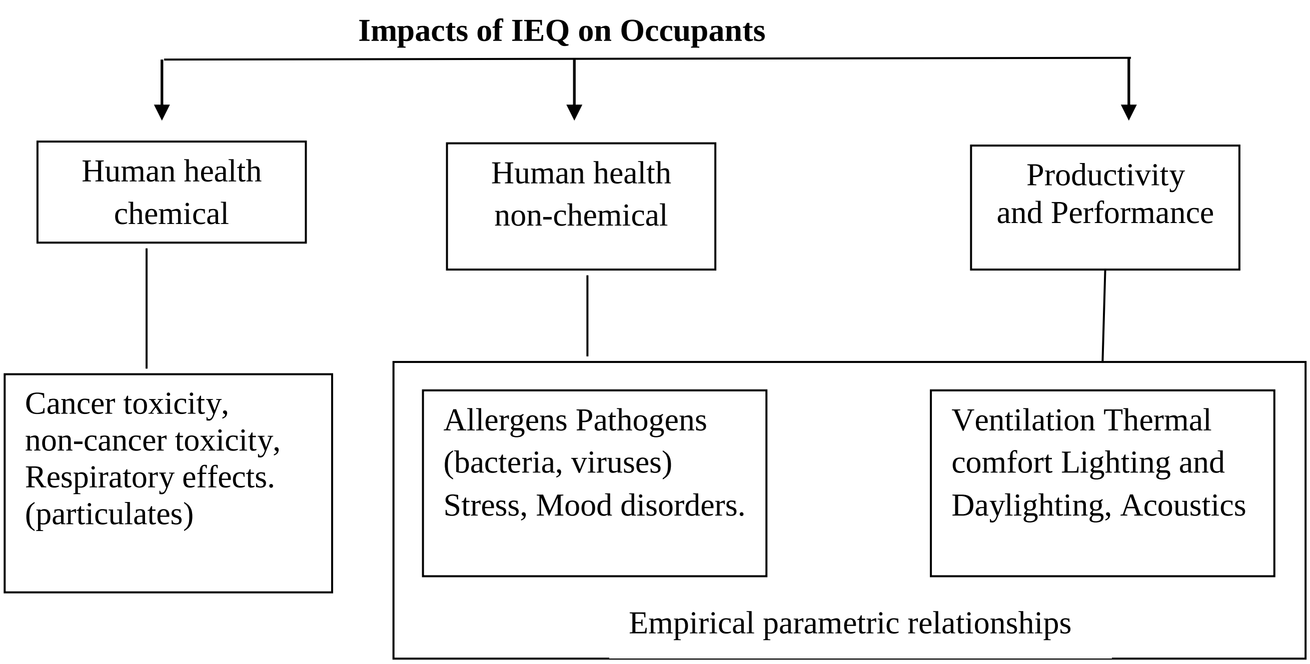


Fig.2.4: Impacts of IEQ on building occupants.
Source: Collinge *et al. (2013), p.18*

Workers are affected in different ways by workplace conditions depending on whether their tasks are defined individually, in the context of a team or with reference to overall organization operations (Vischer, 2006). Workplace features considered highly significant to users' satisfaction include lighting, ventilation rates, access to natural light and acoustic environment (Becker, 1981; Hinks & McNay, 1999; Veitch, Charles, Newsham, Marquardt & Geers, 2004 & Humphries, 2005). Lighting and other factors like ergonomic furniture indicated in Fig. 2.4have been found to have positive influence on employee's health (Milton, Glencross & Walters, 2000; Veitch & Newsham, 2000; Dilani, 2004) and consequently productivity. Ambient features in office environments, such as lighting, temperature, existence of windows, free air movement, etc suggest that these elements of the physical environment influence employee's attitudes, behaviour, satisfaction, performance and productivity (Veitch & Gifford, 1996; Larsen, Adams, Deal, Kweon & Tyler, 1998).The indoor environmental quality is of an important priority to academic institutions because of its impact on learning process (Wong & Jan, 2003).

As observed by Clements-Croome (2011), an indoor environment must display the following characteristics to be conducive to health and well-being of occupants:

- A fresh thermal environment;
- Ventilation rates to provide fresh air with good distribution and acceptable levels of carbon dioxide (CO_2);
- Good natural lighting;
- Minimal lighting glare from within and external to the workspace;
- Spatial settings to suit various types of working;
- Ergonomic work places so as to minimize muscular skeletal disorders and,
- Minimum pollution from external sources including noise

Four basic components, namely: thermal comfort, Indoor Air Quality (IAQ), aural and visual comforts have been identified by Wong *et al.*, (2008) and Frontczak and Wargocki (2011) for determining an acceptable indoor environmental quality. Room air temperature is identified by Frontczak and Wargocki (2011) as the most significant indoor environmental parameter. The CBE's IEQ web-based and interactive survey on large number of variety of buildings is oriented toward managing facilities and diagnosing operational problems by measuring occupant satisfaction with regard to nine environmental parameters namely: office layout, office furnishings, temperature, air quality, lighting, acoustics, cleaning and maintenance, overall satisfaction with building and with workspace (Zagreus*et al.*, 2004).

As indicated in Table 2.3, objective measurements (with instruments), on causes of dissatisfaction with indoor environment, are used to corroborate subjective assessment and create basis for comparism with standards or guidelines (Korpi et*al.*, 2011). Causes of dissatisfaction include odour, stuffy air, irritative agents, unsuitable relative humidity, temperature, drought, acoustics and lighting.

The parameters of IEQ were classified by Zagreus, Huizenga, Arens and Lehrer (2004) into core and optional modules for web-based survey. The core survey modules are office layout, office furnishings, thermal comfort, air quality, lighting, acoustics, building cleanliness and maintenance. The optional modules are way finding, safety and security, operable windows, shading systems, floor diffusers and wash rooms.

Table 2.3: Causes of Dissatisfaction with Indoor Environment

Cause of Dissatisfaction	I.E.Q Determinants/Markers
Odour, stuffy air	VVOC/VOC/SVOC levels from air/material sample
	CO_2 concentration
	Temperature and relative humidity (RH)
	PM_{10} and other particulate matter measurement in the air
	Dust on surfaces
	Air flow rates (supply and exhaust rates)
	Pressure differences (Room and surroundings)
	Cleanliness of the ventilation system
	Micro-organisms from materials
	Micro-organisms from air samples
	Surface moisture
Irritative agents	VVOC/VOC/DVOC levels from air/material samples
	Dust sampling for fibres
	Total air-borne dust
	Temperature and RH
	Air flow rates
	Pressure differences -Room and surroundings
	Cleanliness of the ventilation system.
Unsuitable R.H	R.H
	Cleanliness of the ventilation system
Too high/low Temperatures	Air flow
	Pressure differences (Room and surroundings)
Drought	Air flow pattern
	Temperature, air velocity and turbulence intensity
Poor acoustic Environment	Noise level; reverberation time; Speech transmission index
	Air borne sound insulation between rooms
Poor quantity or Quality of lighting	Light intensity Luminance factor

NB: Not all measurements are necessarily needed in a successful sampling strategy prepared by IAQ and HVAC system specialists.
Source: Korpiet *al.*, (2011).

Studies of Post Occupancy Evaluation (POE) methodologies have tended to focus on commercial and residential buildings whilst the performance of Higher Education (HE) buildings has received less attention. Educational facilities host a large number of users with various needs (Hassanain & Mudhei, 2006); therefore understanding how to make the most of this particular work environment would not only benefit the users but also the institutions themselves (Riley, Kokkarinen & Pitt, 2010).

2.3 Space Management (Spatial Comfort)

Space management, one of the important components in facilities management, is meant to effectively manage the space within buildings so as to reduce the cost of wasted space and optimize the use of space (McGregor& Then, 1999; Ibrahim, Yusuff& Bilal, 2012). Space management is also defined by Hier and Biddison (1996, p.17) as "the art and science of maximizing the value of existing space and monitoring the need for new space''.

Space utilization survey originated from the University of Iowa (UOI) as early as 1916 (SMG, 2006). The survey was applied thereafter by United Kingdom for measuring and managing space utilization in Higher Educational Institutions (HEI). Manual for studies ofspace utilization in colleges and universities by Russel and Doi (1957) is the oldest research output on space utilization. National Audit office (NAO, 1996) used the manual to produce guidelines for performing space utilization survey on public HEIs (HEFCW, 2002; SMG, 2006). Countries like USA, Australia and Malaysia have been applying the survey for improving space utilization on higher education institutions to date (Downie, 2005; Ahmadfauzi, 2005).

The importance of space in facilitating the primary tasks of any work group and supporting other less formal activities is emphasized by Ibrahim, Yussof and Sidi (2011). One of the challenges is creating balance between minimizing cost of space and meeting the pedagogical and research needs of university lecturers. Worthy of consideration is the trend in growth and changing priorities of universities (Fink, 2002).

The needs of human beings, based on their biological, psychological and sociological structure are usually resolved by actions taken to satisfy specific objectives. The actions performed within a building require space of certain size, dimensions and shape. The size of the workspaces in building is based on static and dynamic anthropometry (Toka, 1989).

Awareness on the need for systematic and analytical approach to effective management of space utilization is growing (Rogers, 2002; Minior, Hanafin & Bringhurst, 2004). The approach entails explicit treatment of space as business resource and its efficient contribution to core function of any organization; thus replacing the traditional concept of measuring efficiency in space use by levels of occupancy alone (Unwin, Fetcht& Bergsman, 2008).

Spatial configuration for satisfying organizational objectives and strategies like collaboration, interaction and knowledge flow for enhancing performance has been emphasized by Penn, Allan, Desyllas and Vanghan (1999), Heerwagen, Judith, Kampschroer, Powell and Loftiness (2004), Sailer and Penn (2007), Wineman, Felichism and Gerald (2008). The authors and several others explored relationships between physical space and communication among coworkers based on proximity, territoriality, between physical space and organizational outcomes and between size of workspace and status of occupants. The significance of physical space for organizations was emphasized and variety of influencing factors like density, visibility, proximity, layout and furniture arrangement were also identified.

Sailer and Penn (2009; p.4) also claim that "the effects of spatial configuration on movement and intelligibility shape organizations before any of the specific functional requirements such as task-structures, reporting lines, activities, organizational cultures, etc are brought to bear". The predictive power of spatial configuration on movement is however limited in workspace environments by two constraints: programming of buildings for activities e.g. university's teaching activities are tailored towards strong schedule entailing programme in time and space.

The programme determines movement flows to some extent while attractors placed within movement track often deflect movement e.g. office equipment and some functions.

The relationship between space and organization, though regarded as intricate, was explained by the concept of spatiality and transpatiality by Hiller and Hanson (1984). Spatiality is explained as closeness between individuals by virtue of proximity in location whereas transpatiality connotes conceptual closeness or relatedness that is mechanical. Spatiality (organic solidarity) demands an integrated close space while transpatiality (mechanical solidarity) dictates separated and distant space in location. In relation to knowledge-intensive organizations like universities, the work environments require peculiar spatial configuration for creating distinct space-organization relationship.

The four characteristics of workspace affecting extent of interpersonal contact among employees are openness, density and architectural accessibility (Oldham &Rotchford, 1983). Openness is the ratio of total area to the total length of interior walls and partitions of the office (Gump & Ross, 1977). Office density is the total area divided by the total number of employees working in the office. Workspace density on the other hand is the number of co-worker workspaces within a walking distance of 7.6m from each employee’s desk (Sundstrom, Burt & Kamp, 1980). Architectural density is measured by the number of walls and partitions that surround each employee’s individual workspace. Walls include doors that could be closed and partitions as high as 1.2m or above.

Effective and efficient space management in universities is germane because of its influence on academic works (research, teaching learning, etc), operation and maintenance costs and value creation on built assets. Influences of space include its location, size and quality in relation to innovation and collaboration in academic works. To achieve the desired outcome, management requires procedural rationality, decision rationality and action rationality on space management issues (Dean & Sharfman, 1996; Eckel, 2002) despite the decentralized organizational structure of universities.

Spaces for academic works in universities are instored in lecture rooms, lecture halls, lecture theatres, laboratories, workshops, seminar rooms, offices for academic staff, library, auditorium, faculty board rooms and conference centers.The research work of Fink (2002) on space use in 25 university campuses indicates that only 5% of space, on average, is devoted to classroom use. Classroom use ranged from 3-12% of all academic, administrative and support space. To couch the effect of low space utilization (of classroom), Ibrahim, Yusoff and Bilal (2012) regards space charging as the best management tool for ensuring optimal utilization. The four elements of space charging are the space to be charged, amount to be charged, mechanism for costing and the source of payment (NAO, 1996; Ibrahim, Yusuff, Martin &Sidi, 2011).

Systematic and analytic approach to effective space management entails data acquisition at three levels: data base on workspaces and their functions, financial data on labour utilisation within the workspaces and maintenance management data based on space sizes, space types and units responsible for management and use of space (Unwin *et al.*, 2008). Space utilization as indicated in the formula below, is a measure of extent of use of space in terms of frequency and occupancy. Frequency rate measures the proportion of time a space is used when compared to its availability. Occupancy rate, on the other hand, is a measure of how filled the space is, compared to its accommodation capacity. By implication space utilization is a function of activities being undertaken by variety of people at the workstations within academic buildings.

$$\text{Space Utilization (UFO)} = \frac{\text{Frequency (\%) X Occupancy (\%)}}{100} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.1$$

Where: Frequency (F) is the number of hours an accommodation is in use as a proportion of its availability over a period of time e.g. time table week;

- Occupancy (O) is the average size of a group as a proportion of total capacity for the period the accommodation is in use (NAO, 1996).

SMG (2006, p.7) stated the following reasons as justification for measuring space utilization:

- To determine the best match between space needs and space provision;
- To provide a sound basis for allocating spaces or planning new buildings;
- To monitor efficiency in use of space;
- To reveal under-use and over-use of space;
- To identify the differences between scheduled use and actual use of space.
- To track changes in use of space over time;
- To provide feedback information on use of space as data bank and,
- To demonstrate good practice.

The aforementioned reasons may be difficult to achieve in academic institutions where poor environmental quality and poor functional suitability exist. Other impediments are restrictions to accessibility, health and safety constraints, availability of audio-visual equipment, layout of the rooms, split sites, specialist spaces and equipment that have a limited range of uses, etc.

Balance Score Card (BSC) approach was used in evaluating effects of space utilisation on performance of HEIs by SMG (2006). Four key factors affecting performance of HEI on space utilisation, considered strategic, are finance, management functions, customers(lecturers and students) and, innovation and development (Fig. 2.5). The components of strategy considered are corporate plan, estate strategy, space management plan, actual and target space utilisation by HEIs.

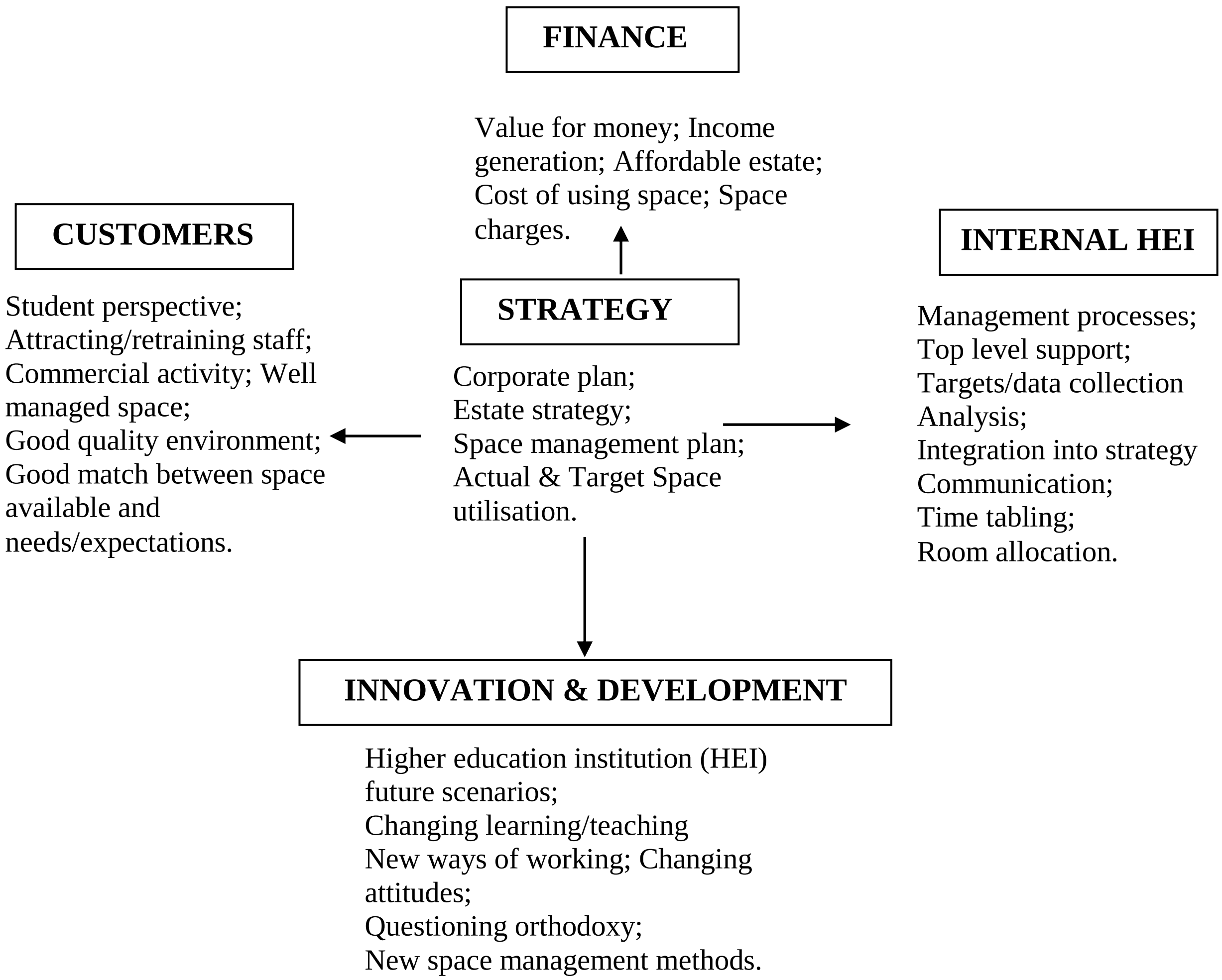


Fig.2.5: Key factors affecting space utilization rates by Balanced Score card (B.S.C) approach
Source: SMG (2006), p.16

2.4 Indoor Air Quality (IAQ)

Indoor air quality refers to the quality of the air inside buildings as represented by concentrations of pollutants and thermal condition (temperature and relative humidity)that affect the health, comfort and performance of occupants (Goyal&Khare, 2012). Acceptable indoor air is explained by ASHRAE (1989, 2001 & 2004) as "air where no known contaminants in dangerous concentration levels specified by public authorities are found and 80% or more of the people living within this air feel satisfied with the air quality". The World Health Organization (WHO) reported in its Air Quality Guidelines for Europe, that most of an individual's exposure to many air pollutants comes through inhalation of indoor air.

The atmosphere (i.e.outdoor air) contains Nitrogen, Oxygen, Argon, Carbon dioxide and little amount of other gases as indicated in Table 2.4. Air pollution is the consequence of changes in the ratio of the aforementioned constituents of the atmosphere. Collinge, Landis, Jones, Schaefer and Bilec (2013, p.182), described components of IAQ as "chemical pollutants such as Volatile Organic Compounds (VOCs), Particulate Matter (PM) and biological contaminants like bacteria, viruses and fungi". Correlation was established between air quality and a range of health and productivity impacts on occupants by Marbury, Samet, and Spengier (1987), Jones (1999), Milton (2000) and Black, Brunner and Fish (2011). Indoor air also contains many highly reactive molecules and radicals such as ozone (O_3), Nitrogen Oxides (NO_2) hydroxyl radicals (OH) and sulphur dioxide (SO_2) that are either introduced from outdoor or generated directly indoors through human activities (Uhde & Salthammer, 2007).

Table 2.4: Gaseous Contents of the Atmosphere

Components	Volume (%)	Concentration, ppm
Nitrogen	78.084±0.004	780,900
Oxygen	20.946±0.00	209,400
Argon	0.934±0.001	9,300
Carbon dioxide	0.033±0.001	315
Neon		18
Helium		5.2
Motun		1.5
Krypton		0.5
Hydrogen		0.5
Xenon		0.08
Nitrogen dioxide		0.02
Ozone		0.01-0.04

Source: *Vural (2011), p.60*

Pollution worldwide, as stated by World Health Organization (WHO), (2008), include indoor combustion of solid fuels, tobacco smoking, outdoor air pollutants, emissions from construction materials and furnishings and improper maintenance of ventilation and air conditioning systems. Air quality guidelines in respect of particulate matter, Ozone Nitrogen dioxide, Sulphur dioxide and carbon monoxide are shown in Table 2.5. These pollutants are associated with human activities in buildings which in turn create maintenance challenges.

Table 2.5: World Health Organization (WHO) Air Quality Guidelines

Particulate matter with a diameter of 2.5μg/m or less (e.g pm$_{2.5}$)	**Annual mean 10μg/m^3**	**24h mean 25μg/m^3**
Particulate matter with a diameter of 10μor less (PM$_{10}$)	20μg/m^3	50μg/m^3
Ozone	100 μ g/m^3	(8hr mean)
Nitrogen dioxide	40 μ g/m^3	200 μ g/m^3
Sulphur dioxide	-	(1hr mean)
Carbon monoxide		20 μ g/m^3
		500 μ g/m^3
		(10min. mean)
	-	-
	60mg/m^3	(30min. mean)
	30mg/m^3	(1hr. mean)
	10mg/m^3	(8hr. mean)

Source: *WHO (2008)*

Hall, Hardin & Ellis (1995) also determined factors affecting indoor air pollution levels as maintenance activities, the presence of contaminant indoors (e.g. building materials, furnishings and equipment), the levels of contaminants outdoors, the season, indoor humidity and temperature and ventilation rates. Possible sources of some of the pollutants, their reactions and products are indicated in Table 2.6. The sources include wood products, coating systems, linoleum and nitrocellulose. These Volatile Organic Compounds (VOCs) are emitted by building materials, furnishings and household products during construction and in usage (Salthammer, 2004). Heating, ventilating and air conditioning systems, and water damage to the building envelope are the most common sources of building related IAQ problems.

Table 2.6: Reaction Products in Indoor Air, their Potential Emission Sources and Reactions

Reactions	Products	Possible source
$\alpha-$Pinene	Pinene oxide, Pinonaldehyde	Wood wood-based Products
Limonene	Limonene oxide, Carvone, formaldehyde	Wood, coating Systems
Oleic acid	Heptanal, Octanal Nonanal, decanal, 2-decenal	Linoleum, Eco-lagners, Nitrocellulose
Linolenic acid	2-pentenal, 2-lexenal, 3-hexenal, 2-heptenal, 2.4-heptedienal, 1-penten-3-one	

Source: *Molhave (1991), p. 363*

On average, office workers spend approximately 40 hours a week in office buildings. The workers study, eat, drink and in certain work settings sleep in enclosed environments with make-up air (i.e. fresh air added to the re-circulated). In low and middle-income countries, 3.9% of all deaths are attributable to indoor air pollution. For example, particulate matter is estimated to cause about 8% of deaths from lung cancer, 5% of deaths from cardiopulmonary disease and about 3% of deaths from respiratory infections (WHO, 2009).

Natural and artificial agents pollute the air either as particles or in the form of gas and vapours. The particles include aerosols like asbestos dust, pollen, etc and organisms like bacteria, fungi and virus. Gas and vapour are made up of combustion products like carbon monoxide. Compounds commonly found are benzene, toluene, formaldehyde, and the toxic natural gases which include ozone and radon. Sources of the pollutants include external environment of the building, usage of the building and building products in Table 2.7, possessing physical and chemical properties. The properties create toxic, harmful, irritating and allergic environment.

Table 2.7: Classification of Indoor Pollutants

S/N	Sources	Physical Properties	Chemical Properties	Types
1.	External environment of the building	1. Gas and vapour 2. Particles	1. organic 2. Inorganic	1. Toxic pollutants 2. Harmful and irritant pollutants 3.Carcinogenic pollutants 4. Mutagenic pollution 5. Allergens
2.	Usage of the building (user and user' activities)			
3.	Building products (construction and maintenance)			

Adapted from:*Patrick (1994),Griffin (1994);Godish (1995); Meckler (1996);Brennan and Turner (1999);Spengler, Samen and McCartht (2000).*

The prevalence of contaminants in indoor air depends on the building properties, material used for constructing the building, heating system, ventilation condition; work being carried out in the building and the behaviour of the people living inside (Bako-Biro *et al.*, 2004). Risks caused by different pollutants occur differently depending on the biological and psychological condition of the user. Severity of ill-health caused is determined by the dose of the pollutant in the air as well as exposure times and condition.

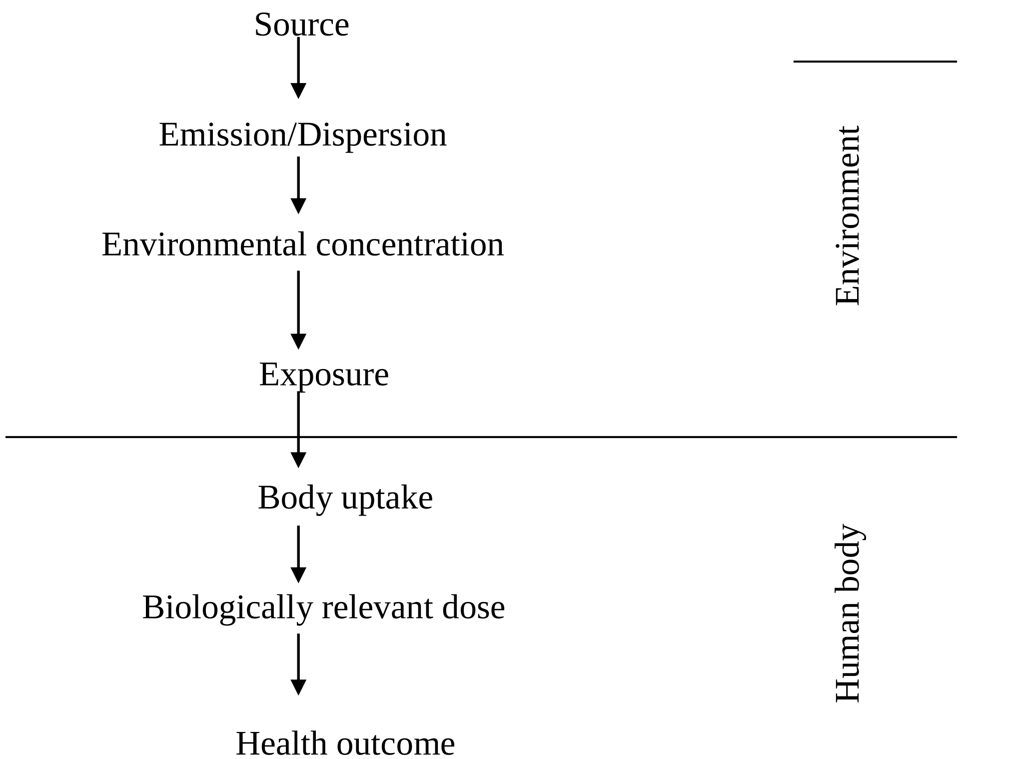


Fig.2.6: *Receptor model for air-pollutant.*
Source: *Nieuwenhuijsen (2003), p. 78*

Symptoms of poor indoor air quality include irritations of the eyes, nose and throat, dry mucous membranes and skin, erythema (reddening of the skin, rashes), mental fatigue, headache and sleepiness, air-way infections, cough, hoarseness, wheezing, nausea, dizziness, unspecific hypersensivity reactions (Bruyere, 2002).

Effects of pollutants on occupants occur in two stages depicted by the flowchart in Fig. 2.7. The two stages are the ambient environment containing pollutions in various degrees and, the human body within such environment. Exposure to such an environment leads to body intake in biologically relevant dose and consequential negative health outcome.

Carbon monoxide reduces the capacity of blood to carry oxygen and the associated symptoms of exposure include dizziness, nausea, headache, loss of consciousness and death. Exposure to biological contaminants of indoor air that are related to dampness and mould increases the risk of acute and chronic respiratory diseases including asthma. Exposure to particulate matter, on the other hand, has been linked to adverse health effects on the respiratory tract and impaired pulmonary function and increased death from cardiovascular and respiratory diseases or lung cancer. Short-term exposures to ozone are also linked with effects on pulmonary function and the respiratory system, lung inflammation, increased medication usage, hospitalization and mortality. The long-term exposure to ozone is linked with reduced lung function. Random is the second leading cause of lung cancer after smoking.

Acceptable levels of indoor air pollution are indicated in Table 2.8. For example, WHO (1987) and NAAQS (1990) gave acceptable level of Carbon monoxide as 60mg/m^3or 50ppm for 30minutes, 40mg/m^3or 35ppm for 1hour and, 10mg/m^3or 10ppm for 8hours. Other limits given include $CO_2$by ASHRAE (1982) and WHO (1987), $NO_2$by WHO (1987) and NNAQS (1990).

Table 2.8: Acceptable Levels of Indoor Air Pollutions

Pollutant	Acceptable Level	Source and Year
Carbon Monoxide (CO)	60mg/m^3 (50ppm) for 30min 40mg/m^3 (35ppm) for 1hr 10mg/m^3 (10ppm) for 8hr	WHO, 1987 NAAQS, 1990
Carbon Dioxide (CO^2)	500ppm for 8hr < 1800mg/m^3 < 800ppm	ASHRAE, 1982 WHO, 1987 TS, 12281
Nitrogen Dioxide	150 μ g/m^3 (0.08ppm) for 1hr 400 μ g/m^3 (0.21ppm) for 24hr 100ppb (<0.05ppm) for 1hr	WHO, 1987. NNAQS 1990 TS 12881
Sulphur dioxide (SO_2)	<0.5mg/m^3 for short-term exposure 75ppb for 1hr 0.14ppm for 24hr	WHO, 1984
Benzene	No safe level <0.01mg/cm^3	WHO, 1987 TS, 12281
Formaldehyde (HCHO)	0.1mg/m^3 (0.08ppm) for 30min 120 μ g/m^3 Continuous 0.75ppm for 8hr 0.16ppm <0.065ppm	WHO. 1987 ASHRAE 62-1999 OSHA TS 12881
Ozone (O_3)	150.200 μ g/m^3 (0.076-0.1ppm) for 1hr 100-120 μ g/m^3 (0.05-0.06ppm) for 8hr 0.05-0.12ppm for 1hr 0.075ppm (2008 std) for 8hr <0.12mg/cm^3	WHO, 1987 ASHRAE 62-1999 NAAQS 1990 TS 12881
Radon (Rn)	100Bq/m^3 for 1yr 2pCi/L 148 Bq/m^3 400 Bq/m^3	WHO 1987 EPA TAEK
Asbestos	No safe level 0.6 fiber/cm^3/8hr chrysotile 0.3 fiber/cm^3/8hr other than chrysotile 0.21 fiber/cc/8hr.	WHO, 1987 TS 11597 OSHA
Particles	$PM_{10\text{-}150}$ μ g/m^3 for 24hr $PM_{2.5}$-35 μ g/m^3 for 24hr	

Source: *Vural (2011), p.62*

Implication is that the indoor environment of a building will not be habitable if these acceptable limits are exceeded.

Allergic asthma is a common health problem from contamination of air quality in classrooms by chalk dust (Wang & Jan, 2003). The Hong Kong Environmental Protection Department (HKEPD) proposed twelve parameters for IAQ assessment consisting of nine major indoor pollutants and three comfort-based parameters namely: carbon dioxide (CO_2), carbon monoxide (CO), respirable suspended particles (RSP), nitrogen dioxide (NO_2), ozone (O_3), formaldehyde (HCHO), Total Volatile Organic Compounds (TVOC), Radon (Rn), Air-borne Bacterial Count (ABC), Temperature (T), Relative Humidity (RH), and air velocity (V) (IAQMG, 1999; HKEPD, 2003; Burnett, 2005). The IAQ performance is to meet the minimum requirements of ASHRAE 62.1-2004. Two common methods employed to mitigate effects of poor IAQ in buildings are: by increasing out-door air in-flow rate into a building or reducing the source of pollution within and outside the building (Daisey *et al.*, 2003).

Installation of automatic sensors and controls to maintain proper temperature, humidity and rates of outdoor air introduced to occupied spaces also plays a key role in maintaining optimal air quality. Use of sensors to alert building maintenance staff to potential IAQ problems such as CO_2 build-up in an occupied space can also effectively balance energy and IEQ issues.

2.5 Thermal Comfort

Thermal comfort is defined by ASHRAE 55 as "condition of mind that expresses satisfaction with the thermal environment''. Thermal comfort has a goal to develop a "comfort zone" or the temperature range in which most people feel comfortable (Nasir, *et al.,* 2011, p.344). ISO Standard 7730:1994 recommends acceptable conditions in which at least 90% of people are satisfied with their thermal environment. ASHRAE Standard 55–2010 defines the same limits but recognizes that local discomfort and asymmetric could produce an additional 10% dissatisfaction.

The purpose of ASHRAE Standard 55, thermal environment conditions for human occupancy "is to specify the combinations of indoor space environment and personal factors that will produce thermal environmental conditions acceptable to 80% or more of the occupants within a space" (ASHRAE, 1994). ASHRAE standard is therefore, to have no more than 20% dissatisfaction on temperature. Standard ISO 7730 defines thermal environment as "a function of four physical variables (air temperature, mean radiant temperature, relative air velocity and air humidity) and two variables related to people (activity level and personal characteristics which are clothing, gender and body shape)" (ISO 7730, 1993; Nasir, *et al*., 2011; Olesen, 2015).

Thermal performance refers to the temperature, relative humidity and air movement within occupied spaces (Wong & Jan, 2003). Acceptable limits by ASHRAE 55 are temperature 24 – 28°C, Relative Humidity (RH) 20 – 70% and Average air movement of less than 0.8m/s. Higher RH may lead to serious microbial and IAQ problems while higher temperature and air movement will lead to thermal discomfort (Wong & Jan, 2003).The historical development of thermal comfort indices was given by Mahdavi and Kumar (1996:170) as follows:

- the scientific approach to thermal comfort research has aimed at identification of measurable environmental indicators with the hope of correlating these with people's perception and evaluation of thermal conditions (thermal sensation vote);

- historically, a trend may be postulated toward identification of an increasing number of comfort relevant environment (and occupancy) indices and an increasing level of refinement and detail in their description and,

- effective indoor temperature which combined the effects of air temperature and relative humidity into one index was derived, as multi-criteria thermal comfort description; through experiments in Pittsburgh about 1920.

Mahdavi and Kumar (1996:170) define effective temperature as "an index which combines into a single number, the effect of dry-bulb temperature, humidity and air motion on the sensation of warmth or cold felt by the human body; the numerical value is that of the temperature of still saturated air which would induce an identical sensation"

Three factors contributing to increase in temperature in buildings are:

- Emission of heat from electrical lighting, household appliances and office equipment.
- Infiltration of heat from external environment through walls, windows and roofs of the building.
- Heat convection of hot air from external environment of the building.

Air movement compensates for warm temperature in making people comfortable especially in hot seasons (Arens *et al*., 1998). Higher levels of air movement are allowed by ASHRAE Standard 55 (2004) only when they render personal control of the occupant. Where there is no personal control, limits of air movement are determined by predictions of draft discomfort (DR), based on laboratory studies by Fanger and Christiansen (1986) and Fanger *et al.,* (1988).Toftum (2004) also deduced from four ASHRAE field studies on preferred air movement, that people who feel cold prefer less air movement and those who feel hot prefer more air movement and the dividing line is 22–23°C without personal control by the occupants.

Perception of comfort and thermal adaptation of an occupant are defined by behavioural adjustment, psychological adaptation and psychological habitation or expectation (Nikolopoulou & Steemers, 2003). Satisfaction with both thermal comfort and air quality increases significantly in buildings that provide occupants with some means of personal control over their environment such as installation of thermostat or operable windows (Huizenga *et al.*, 2006). Room temperatures in classrooms could be controlled through installation of air conditioning, sun shield and, sufficiently high ventilation. Total ventilation for a room is calculated based on diluting emissions from people and the building emissions.

Table 2.9: Recommended Categories and Criteria for the Thermal Environment

Category	**Thermal state of the body as a whole**		**Operative temperature °C**		**Max. mean air velocity m/s**	
	PPD %	PMV	Summer (0.5 clo) Cooling	Winter (1 clo) Heating	Summer (0,5 clo) Cooling	Winter (1 clo) Heating
I	< 6	-0.2<PMV<+0.2	23.5-25.5	21.0-23.0	0.18	0.15
II	< 10	-0.5<PMV<+0.5	23.0-26.0	20.0-24.0	0.22	0.18
III	< 15	0.7<PMV<+0.7	22.0-27.0	19.0-25.0	0.25	0.21

Soure: *Mahdavi and Kumar (1996), p.170*

Study by Seppanen *et al*.(2003) on relationship between temperature and workers' performance indicates 2% shortfall in performance for every 1°C increase in temperature within the range of 25–32°C but no effect on performance in the temperature range of 21–25°C. An indoor temperature above 25°C can cause headache and fatigue while indoor temperature below 18°C is likely to cause chills and influenza like symptoms.

As stated by Seppanen and Fisk (2006, p.964) "thermal conditions inside buildings vary considerably with time e.g. as outdoor conditions change, and spatially within building; air temperature could influence productivity indirectly through impact on SBS symptoms or satisfaction with air quality.

"ASHRAE Standard 55 is based on the heat balance model of the human body, which predicts that thermal sensation is exclusively influenced by environmental factors (temperature, thermal radiation, humidity and air speed), and personal factors (activity and clothing)" (Brager & de Dear 2001, p.1). On the other hand, the adaptive model considered the match between occupant expectations on the indoor environment in a specific context and what actually exists. Some degrees of behavioural adaptation, like changing to appropriate clothing or adjusting air velocity within one's location could be accounted for by the heat balance model. The psychological dimension of adaptation may alter occupant's expectations, the thermal sensation and satisfaction e.g. personal thermal control or diverse thermal experiences.

Thermal comforts can be measured in a variety of methods that include seven-point ASHRAE scale, Bedford scale, and the scale of Humphreys and Nicol (Nasir *et al*., 2011). Scales are used to obtain information about the human preference (subjects) on the terms of the surrounding environment. Predicted Mean Vote (PMV) is defined by Mahdavi and Kumar (1996, p.171) as "the mean response of a large group of people according to the ASHRAE seven-point thermal sensation scale". Predicted Percentage Dissatisfied (PPD) is an index expressing the thermal comfort level as a percentage of thermally dissatisfied people and is directly determined from PMV (Olesen & Brager 2004, p.22).

Olesen and Brager (2004) described comfort zone in terms of a range of operative temperatures that result in a specified percentage of occupants who will find the range and specified values of other four thermal comfort factors (humidity, air speed, clothing insulation and metabolic rate) acceptable.

Table 2.10: Recommended Categories for Local Thermal Discomfort Parameters

Category	Vertical air temp. diff. K	Floor surface temperature °C	Radiant temperature asymmetry K			
			Warm ceiling	Cool ceiling	Cool wall	Warm wall
A	< 2	19-29	< 5	< 14	< 10	< 23
B	< 3	19-29	< 5	< 14	< 10	< 23
C	< 4	17-31	< 7	< 18	< 13	< 35

Source: *Olesen (2015), p.19*

2.6 Aural Comfort (Acoustics)

Nasir *et al*. (2011) and Vural and Balanli (2011) referred to any sound that is unwanted or causes discomfort as noise.Noise pollution is also defined scientifically byNasir *et al*. (2011, p.356) as "the signal that does not give any information and the strength that changes dramatically over time".

Acoustic satisfaction is a function of satisfaction with both noise and speech privacy (Osborn & Brill, 1994; Evans & Johnson, 2000; Wong & Jan, 2003; Jensen & Arens, 2005). Poor acoustics environmentwas regarded by Sundstrom, Town, Rice and Ajala (2012) as one of the leading causes of employees' distraction, leading to reduced productivity, annoyance, serious inaccuracies, increased job related stress, negative influence on communication and development of poor conversational habits. Indoor noise may come from mechanical systems within workspaces, from other human activities or outdoor noise like traffic and construction.

The acoustic comfort of buildings is the capacity to protect occupants from noise and offer an acoustic environment suitable for the purpose for which the building was designed. Acoustic problems in offices were categorized into air-borne sounds, outdoor noise, noise from adjacent spaces, noise from office equipment and sound of nearby facilities (Al-horr, Arif, Katafygiotou, Mazroei, Kaushk & Elsarrag, 2016).

The objective of room acoustics is, therefore, to enhance desirable sounds and at the same time reduce non-desirable sounds so that they are not perceived as disturbing. There are two important acoustic descriptors, namely:room acoustics which comprises intelligibility of speech inside the room,noise level of HVAC systems,reverberation time of the room and noise level of external sources of sound;the second descriptor is sound insulation which entails insulation air borne sound between room and insulation of impact sound between rooms.

Room acoustics is an important factor for audio comfort, the elements of which are the reflection, absorption, propagation, refraction and reverberation, focus and echo of sound in enclosed spaces. Work premises are categorized into three in accordance with the room acoustic environments by Takki and Virta (2007) as follows:

- Large spaces for several independent knowledge workers such as. libraries, open plan offices etc.
- Spaces for good oral communication like auditoria, lecture theatre, conference rooms, classrooms, etc.
- Small rooms such as private offices and consulting rooms.

Noise greater than 120dB damages the small hearing bones and can impair hearing permanently. Other effects are personal pain, dizziness, nausea and vomiting, speech disturbances and behaviour that can deteriorate the quality and efficiency of work, tiredness, irritation and anxiety. The purposes of evaluating acoustical performance of buildings in educational institutions include an assessment of acoustic annoyance that would affect study and performance of other academic works-speech and telephone communication, listening conditions and privacy, assurance of speech intelligibility, speech privacy and sound insulation. The parameters of discomfort from noise are categorized by Berglund and Lindvall (1995) as the occupant's current action, sound quality, noise level, noisespectrum, personal sensitivity to noise perception, age, duration, nutrition and bad habits, certain drugs and toxic substances.

Acoustic comfort studies have focused on correlating physical measures, such as signal–to–noise ratios at different densities, background noise levels and intensities, and speech intelligibility under different physical conditions, with occupant judgments of distraction and annoyance (Mital, McGlothlin & Faard, 1992; Ayr, Cirillo & Martellota, 2001; Chu & Warnock, 2002). In order to achieve comfortable sound level, the rectification of the defect through re-design and maintenance activities are done by positioning rooms far from noise sources, incorporating sound insulation materials,selecting good floor and wall fabric with a high sound reduction index and providing sound absorbing materials. Acoustical performance of the building elements is assessed in stages through benchmarking.

2.6.1 Acoustical Performance Benchmarks

2.6.1.1 Basic Purpose

To assess acoustic annoyance (discomfort) that would affect study or work performance, a simple and quick evaluation of background noise and an occupant acoustics satisfaction survey is conducted.

2.6.1.2 Intermediate

To assess acoustic annoyance that can affect study and work performance, as well as speech and telephone communication, listening conditions and privacy, an accurate frequency band assessment of background noise as well as reverberation time is done..

2.6.1.3 Advanced

To assure speech intelligibility, speech privacy and sound isolation, advanced measurement techniques to validate the highest levels of performance is carried out.

2.6.1.4 Measurement

Occupant survey is conducted for identifying acoustical problems in the building. A weighted sound pressure level in the occupied spaces is determined through measurement with appropriate equipment. Occupant survey covers more spaces in a building than measurement and it is useful in identifying daily or seasonal conditions that may degrade the acoustic performance of a building.

2.7 Visual Comfort (Lighting)

The quality of the indoor environment depends significantly on several aspects of lighting including the illuminance (i.e. intensity of light that impinges upon a surface), the amount of glare and the spectrum of the light (Veitch & Newsham, 1998; Fisk, 2001). As stated by Chang and Chen (2005), view type, view quality and social density are some of the visual comfort criteria having impact on physical and psychological health of building occupants. For most spaces and environments, the perceived quality of light in any situation depends also on the type of activity or task being undertaken, the age and eyesight of workers and the visual difficulty of the task being carried out (Brown & Cole, 2009).

Occupant's satisfaction with lighting may vary with illuminance and with the characteristics of the lighting system (Katzev, 1992). Lighting characteristics influence the quality of vision, and can have psychological influences on mood and on perceptions about the pleasantness of a space (Tiller, 2001). Inadequate illumination, glare, flicker and lack of contrast can also cause tiredness, dry and gritty eyes and headache, as stated by Vince (1987). Lighting and task conditions that improve visibility lead to better task performance (Veitch, Newsham, Mancini & Arsenault, 2010).

Drahonovska (2006) asserted that relationships exist between lighting, comfort of visual performance and general satisfaction in the indoor environment. Mendell *et al*. (2002) had earlier confirmed poor lighting design as the cause of health problems in terms of irritation, distraction and lethargy. Lecturers and students in universities make observation on the intensity of lighting as it affects their activities and makes the environment uncomfortable. Visual tasks in academic institutions are performed in vertical and horizontal planes of chalkboard or screen and at desks respectively.

The European Standard, CEN 12464 (2007) does not call for uniform lighting throughout a room but the work area and areas in its close proximity have to be illuminated properly. The intensity in other parts of the room can be lower for flexibility in locating lighting fixtures and conservation of energy. The important factors in lighting quality are:

- Sufficiency of illumination;
- Suitable luminance ratios in the work area and its immediate surroundings;

- Limiting of glare from both lighting fixtures and windows;
- Good colour rendering;
- Comfortable and luminous colour and,
- Lighting that does not fluctuate.

As a general rule, the lighting system should be designed and installed to effectively reveal the task(s) and to provide safe and comfortable visual environment (Cooperative Research Centre for Construction Innovation, 2008). Effective lighting can enhance the mood, energy and effectiveness of people using the space. Light also affect people's circadium rhythms, an important factor in maintaining healthy sleep cycles (Armstrong & Walker, 2006).

Wherever possible there should be natural lighting in a building as this improves occupants' comfort and health while reducing energy costs. Day lighting is supplemented by artificial lighting where the former is insufficient or where the building is to be used beyond daylight hours (Jansz, 2011). Passorelli (2009) identified that a significant lack of natural daylight, flickering mechanical lights or lights that are too bright or too dull for the work that needs to be performed can contribute to SBS symptoms like headaches or eyestrain.

Day lighting research has linked increased comfort and productivity with window size and proximity, as well as with view out, control over blinds and shielding from glare (Leather, Pyrgas, Beale & Lawrence, 1998; Hedge, 2000; Mallory-Hills, Vander Voost & Van Dartmost, 2004). Study by Moloney (2011) showed a 3-18% gain in productivity in buildings with adequate lighting. Fisk (2001) pointed out that lighting has at least the theoretical potential to influence performance directly because work performance depends on vision and indirectly, because lighting may direct attention, or motivation.

The quality of artificial indoor lighting is a function of the types, locations and number of luminaries and the optical characteristics of indoor surfaces such as their spectral reflectivity and colour (International Performance Measurement and Verification Protocol, 2001).The size, height and depth of a room, the number of desks or workplaces, the type of work, colour and surface quality and the geographical orientation of the building (especially windows) are factors to consider in creating efficient lighting (Drahonovska, 2005).An understanding of the lamps, ballasts, luminaries and control options as well as the techniques used to develop efficient lighting, will yield lighting that is energy efficient, cost effective and better quality.

Recommended value for lighting in the classrooms, where the activities carried out within are considered to be tasks with simple visual requirements is 500lux for both horizontal and vertical planes (Wong & Jan, 2003). Common problems with artificial lighting as enumerated by the Property Council of Australia (2009, p. 24) include:

- Inadequate lighting design or intensity leading to widespread or localized dark areas;
- Inappropriate lighting for specialized tasks;
- Flicker arising from the oscillation of fluorescent lights typically associated with using magnetic rather than electronic ballasts;
- The colour of the lamp source;
- Poor configuration of lights and,
- Unsympathetic colour schemes which contribute to lighting discomfort.

2.8 Ventilation (Air-flow)

Ventilation is defined in ASHRAE Standard 62.1 as the process of changing or replacing air in any space to provide high indoor air quality (to control temperature or to remove moisture, bad odors, smoke, excess heat, dust, air born bacteria, carbon-dioxide (CO_2) and to replenish oxygen). Ventilation is used to remove unpleasant smells, introduce fresh air, to keep interior building air circulating, and to prevent stagnation of the interior air. Sufficient ventilation is crucial to remove indoor-generated pollutants from indoor air or to dilute their concentration to acceptable levels.Paradigm shifts in the philosophy of ventilation since 1800 as shown in Table 2.11 include concern for personal aesthetic, health, productivity and comfort by occupant of building.

Table 2.11: Paradigm shifts in the philosophy of ventilation

Paradigm		Pollution Sources
2050	Personal aesthetics	People
2025	Health, productivity, comfort	Buildings Outside environment
2000	Comfort (+ health)	People + Buildings
1975		
1935	Comfort	
1900	Contagion	
1800	Poison	People

Source: *Spengler and Chen (2000), p.29.*

As stated by Fromme *et al.* (2008), measurement of CO_2 is commonly used as convenient indicator of the building ventilation rate because human beings emit CO_2 and the concentration of CO_2 in the external environment (i.e. atmosphere) is constant. By implication, shutting windows and doors during academic works (e.g. lecture) contribute to high concentration of CO_2 indoor. ASHRAE Standard 62–1999 (ASHRAE, 1999) recommends a minimum ventilation rate of 8.0l/s–person (15 cfm/person) for classrooms with a typical occupant density of 33 per 90m² (100ft²) and a ceiling height of 3m (10ft). The current ASHRAE Standard would require an air exchange rate of about 3 air changes per hour (ACH) for a classroom (Salleh *et al*. 2011, p.419),

Adequate wind or air flow is required to accelerate the necessary evaporation for reducing the discomfort of the stickiness of the skin by sweating. It is also needed for decreasing the indoor air temperature to bearable level. The minimum ventilation rate is 10-15 l/ s^2 per person which is approximately 1 l/s per m^2 in office buildings with normal occupant density. Ventilation rate, classified into three categories as shown in Table 2.12, is based on pollution load with the building and use of the building.

Table 2.12:Ventilation rates for Office Buildings

Category	**Occupants only**		**Low-polluting materials**		**High-polluting materials**	
	L/sm²	**cfm/ft²**	**L/sm²**	**cfm/ft²**	**L/sm²**	**cfm/ft²**
A (high)	1	0.20	2	0.40	3	0.60
B (medium)	0.7	0.14	1.4	0.28	2.1	0.42
C (Basic)	0.4	0.08	0.8	0.16	1.2	0.24

Source: *ISIAQ-CIB Task Group (2004), p.16.*

Ventilation influences indirectly the air temperature and humidity inside the room or on the surface of the wall (Nasir *et al.,* 2011; Lee, Mui, Wong, Chan, Lee & Cheng, 2012).Three basic methods specified byASHRAE 62.1 (2004) are passive or natural ventilation,active or mechanical ventilation and mixed-mode (i.e combination of natural and mechanical ventilation).

Natural ventilation is provided by thermal, wind or diffusion effects through doors, windows or other intentional openings in the building. The two components of natural ventilation are daytime ventilation and night time cooling. The more commonly used is the daytime ventilation which uses the outdoor air to remove the heat gains and contaminants within the building.

Mechanical ventilation is provided by mechanical powered equipment, such as motor-driven fans and blowers, but not by devices such as wind-driven turbine ventilators and mechanically operated windows. Mixed mode ventilation is a ventilation strategy that combines natural ventilation with mechanical ventilation by allowing the building to be ventilated either mechanically or naturally and at times both mechanically and naturally simultaneously (ASHRAE, 2004).Thermal comfort is increased by daytime ventilation through increase in convective and evaporative heat transfer between the occupants and the room air (Givoni, 1998). ASHRAE Standard 62 requires that all naturally ventilated spaces shall be permanently open to and within 7.6m of operable wall or roof openings and that the operable area be at least 4% of the net occupiable floor area.

Indoor air is perceived as unacceptable when the CO_2 concentration exceeds 1,000ppm (ASHRAE, 1999). However, Seppanen and Fisk (2004) suggested 800ppmof CO_2, which corresponds to a personal outdoor air flow of about 10l/s, as unacceptable limit. Researchers emphasized the importance of classroom ventilation for achieving healthy indoor environment for academic works in school environment. Concentration of CO_2 exceeding 600ppm can cause significant physiological effects like fatigue, drowsiness, lack of concentration and breathing difficulties (Bayer, Crow & Fischer, 1999; Sundell, 2004).Nasir *et al., (*2011), suggested the following requirements as essential for ventilation and air flow in a building:

- meeting the health needs of occupants by maintaining air quality above a minimum level through conversion of used air into clean fresh air;

- providing thermal comfort by increasing heat loss of the body and reducing thereof the discomfort of the moist and sticky skin and,
- Cooling effect on the structure of the building where prevailing temperature levels caused by exchange of air lead to thermal pressure.

Carbon dioxide (CO_2) monitors are often used to monitor the effectiveness of the ventilation system in delivering the needed outdoor fresh air. A Demand Controlled Ventilation (DCV) system is used where the outdoor air rate supplied to an occupied space is based on readings taken by one or more CO_2 monitors. The DCV system is often installed as an energy conservation strategy for large spaces with variable occupancy, such as large lecture hall where the number of occupants and times of use varies significantly – the DCV system adjusts the ventilation rate to match changing requirements. Maintenance unit needs to make inspection of CO_2 monitors and airflow monitoring stations as part of routine Operations and Maintenance (O & M) and preventive maintenance scheduled activities. Monitoring of CO_2 is also essential for achieving acceptable IAQ in buildings. Buildings and its components are therefore planned, designed, constructed and maintained to ensure compliance with IEQ guidelines and standards. Table 2.13 indicates the effects of building components on quality of indoor air. Location, building envelope, HVAC, materials used for internal finishings, furnishings, equipment and cleaning are some of the building components.

Table 2.13: Building components potentially affecting IAQ planning and construction

Building Components	Effects
Site (location)	• Traffic, parking • Unwind sources or changes of airflow • Soil emissions of radon • Moisture / drainage
Building envelope	• Moisture intrusions • Cooling/heating loads affecting dilution and condensation (If cooling capacity is over designed) • Unintended filtration of untreated air
Waste Services leading Dock Entrances served by vehicles (convention / recreational centers, schools)	• Odors from waste and diesel servicerucks drawn in through loading dock and/or window vents • Particle intake and possible health risk e.g soot)
HVAC system Plumbing system Electrical system	• Filters, condensation traps, wet insulation dirty return air ducts as source of odor, micro biological • Air intakes, venting, potential of re-Entrainment • Operating set points can cause cool surfaces and unwanted condensation • Unintended pathways • Sweaty and leaking pipes, values and gaskets provide moisture leading to material damage and microbiological growth • Electromagnetic fields causing interference to equipment (e.g. computers), exposures and noise
Sanitation vents, kitchen Exhausts, fume hoods, Cooling towers	• Potential chemical biological exposuresto workers on roof or to pedestrians around building • Entrainment into air intakes of present and neighboring buildings
Communications	• Excessive wiring in ceiling space restricts repairs, off gases VOCS • Wire, drainage, pipe chase provide unwanted pathways for air flow • Electromagnetic exposures near antennae.
Materials used for internal Finishings, furnishings, Equipment, and cleaning	• Sources of VOC, aldehydes, phthalates, and particles • Sources of nutrients for micro organisms

Source: *Spengler and Chen (2000), pp.29-30*

Low ventilation in schools exposes users to significantly high risk of dry cough and rhinitis when school children are under exposure of CO_2>1,000ppm. Increased concentration of CO_2 in computer classrooms has also been associated with headache (Norback& Nordstrom, 2008).

Relationship between low air exchange rate in schools and occurrence of nasal obstruction and nasal inflammation was demonstrated by Walinder *et al.*(1998). Asthmatic symptom in school children was reduced when new ventilation systems with displacement ventilations were installed in schools, as reported by Smedje and Norback (2000).

Dilution of the indoor contaminants by ventilation is the most effective means of controlling and achieving an acceptable level of IAQ because of the limitations associated with source elimination and local source control. Natural ventilation is preferred because its energy consumption is low, it requires little maintenance, the investment costs are low and is also very user friendly. Out of the three mechanical ventilation systems (mixed ventilation, displacement ventilation, and localized ventilation), the displacement ventilation systems appear to be the most beneficial in terms of IAQ and thermal comfort level indoors (Spengler & Chen, 2000).

2.9 Theoretical Framework and Conceptual Model

This section discusses some of the relevant theoretical frameworks in order to build a conceptual model for this study. The dependent and independent variables of the research and relationships between them were examined and explained in relation with the research problem and objectives.

2.9.1 The Concept of Theoretical Framework

A theoretical framework is a summary of related research works done earlier which indicates, in clear terms, the relationships between the dependent and independent variables of the study (Ogolo, 1996). A theory is a conceptualization or description of a phenomenon that attempts to integrate all that is known about the phenomena into a concise statement or question (Marczyk, De Matteo & Festinger, 2005). Asika (2005) described theory as a statement of invariant relationship among measurable phenomena with the purpose of explaining and predicting the phenomena. In explaining phenomena, theory makes use of related constructs, concepts, definitions and propositions in a systematic view. The dependent and independent variables of this research and relationships between them were examined and explained in relation with the research problem and objectives. Frameworks found relevant are as follow:

- Framework on Indoor Environmental Quality and Dynamic Life Cycle Assessment (IEQ+DLCA) of building by Collinge, Landis, Jones, Shaefer and Bilec (2013). External and internal impacts of chemical pollution on building occupants were assessed.
- Model on Indoor Risk Analysis by Vural (2004).Effect of IAQ on indoor environment was evaluated using risk analysis approach.
- Model on outdoor and indoor characteristics of building in terms of building biology by Balanli and Ozturk (2004).
- Model on Maintenance performance measurement by Muchiri, Pintelon, Gelders and Martin (2011). Relationship between performance driven maintenance objectives and corporate performance in manufacturing was the focus.
- Model on impact of perceived IEQ on overall satisfaction in Swedish dwellings by Zalejska-Johnson and Wilhelmsson (2013).
- Framework on influence of IEQ on performance of students by Heath and Mendell (2002).
- Model on relationship between Workspace planning and Workspace conflict in the Industrial Building System (IBS) project by Seman et al. (2015).

2.9.1.1 Framework on Indoor Environmental Quality and Dynamic Life Cycle Assessment (IEQ+DLCA) of Building

The framework considered the dynamic interaction between building's indoor environment, the occupants and chemical pollution in assessing life cycle impacts of indoor environmental quality (IEQ). The impact of IEQ on whole building life cycle was assessed to identify gaps or overlaps between chemical specific impacts and non-chemical specific impacts. Impacts on indoor and external environments of the sampled academic green building were separately treated.

DLCA is a tool for analyzing a building's environmental performance that incorporated metrics which are relevant to the design of buildings. The framework employed dynamic process modeling, in the context of temporal and spatial variations in the indoor and external environments, to assess impacts. Predictors were indoor environment; occupants and chemical pollution while impact of IEQ constituted the dependent variable. Impacts on internal environment, as shown in Fig.2.7 include human health, productivity and performance.

Collinge, Landis, Jones, Shaefer and Bilec (2013) opined that internal impacts which are specific to the population of the occupants will cause some finite but small overlap between the occupants. Beyond dynamic estimation of occupancy levels, other dynamic data required include indoor and outdoor air temperatures, ventilation and circulation air flows, humidity, lighting, noise levels, pollutant concentrations and emissions. Dynamic data were obtained through real time metrics monitored by Building Management System (BMS) and periodic assessment of performance was done by maintenance staff. Only chemical impact was partially considered in the Life Cycle Impact Assessment (LCIA). The basic idea could however be extended to other parameters of IEQ revealed in literature. It is also observed that relationship between workspace utilization, maintenance practice and impact of IEQ did not feature in the model.

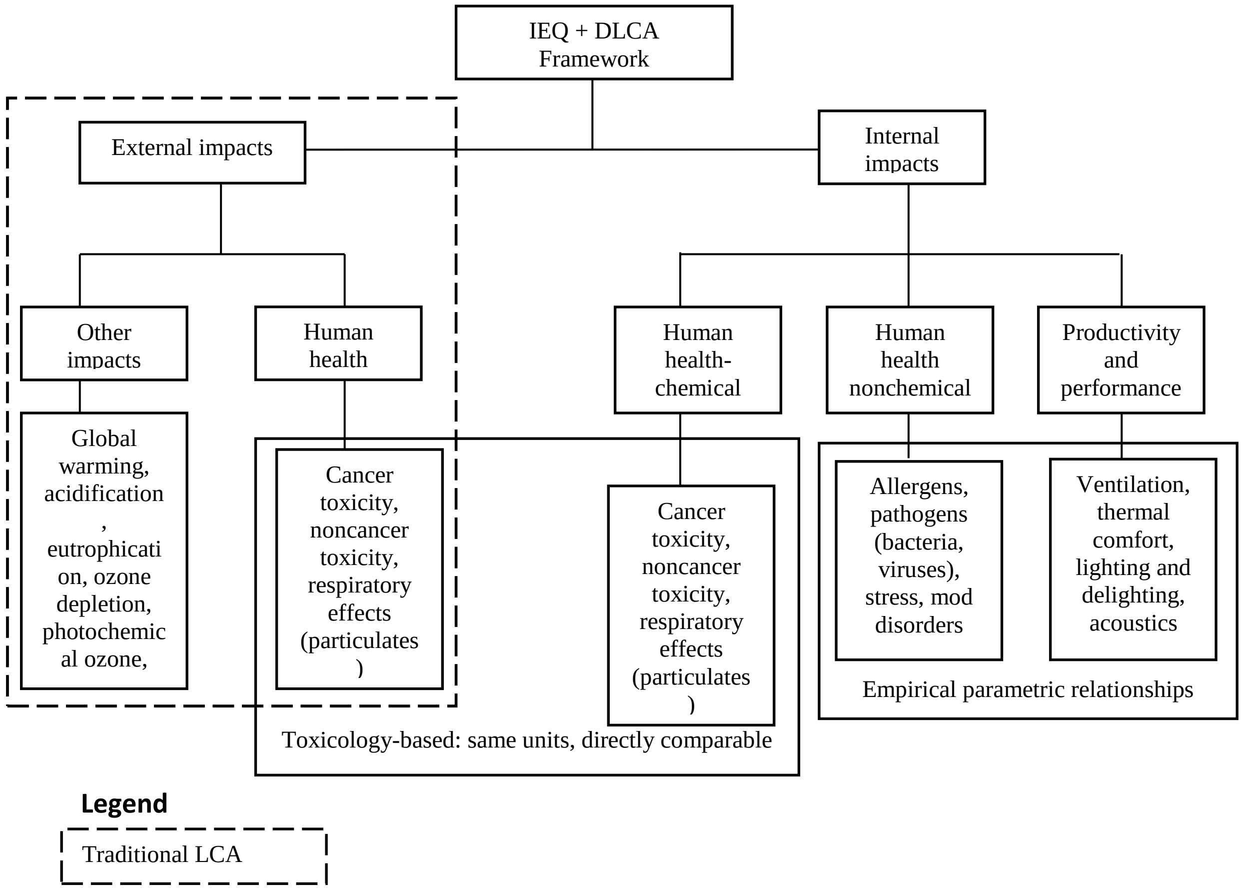


Fig.2.7: Indoor Environmental Quality and Dynamic Life Cycle Assessment (IEQ+DLCA) framework

Source: *Collinge, Landis, Jones, Shaefer and Bilec (2013), p.183.*

2.9.2 Model on Indoor Air Quality Risk Analysis

Indoor Air Quality (IAQ) is a major parameter in the evaluation of indoor environment. Vural (2004) applied risk analysis framework developed by National Research Council of United States of America (US-NRC) to evaluate the effect of air quality on indoor environment. The researcher used quantitative definition of risk as the product of the consequences of a specific incident and the probability of its occurrence over a time period. The framework consists of Risk assessment, Risk management and Risk communication as major aspects. Juxtaposing this approach unto relationships between variables of this study, the interaction between occupants and the indoor environment is taken as exposure to risk. Thus, the interaction, as source of risk, has two components namely: exposure to hazards (e.g. pollutants) and the intensity of workspace utilization as probability of occurrence.

Risk assessment entails evaluation of the indoor environment's physical contents and the activities of the occupants as they contribute to pollution. Scientific data and organization's policy determine acceptable level of pollutants based on standards established by regulating authorities e.g. EPA, ASHRAE, NIOSH, etc. The organization's policy will also be applied in risk management. Risk management decisions are thereafter communicated to all stakeholders.

The model considered only one of the IEQ parameters i.e. IAQ as a source of risk and did not show relationships between air quality, maintenance practice, the occupants' characteristics and intensity of workspace utilization. It is however possible to apply the model in evaluating, partially, the aforementioned relationships. For example, decisions taken at risk management level have effects on comfort of the users because responsibility to rectify, whenever standards are not met or when thresholds are exceeded, has to be assigned and monitored by the maintenance unit.

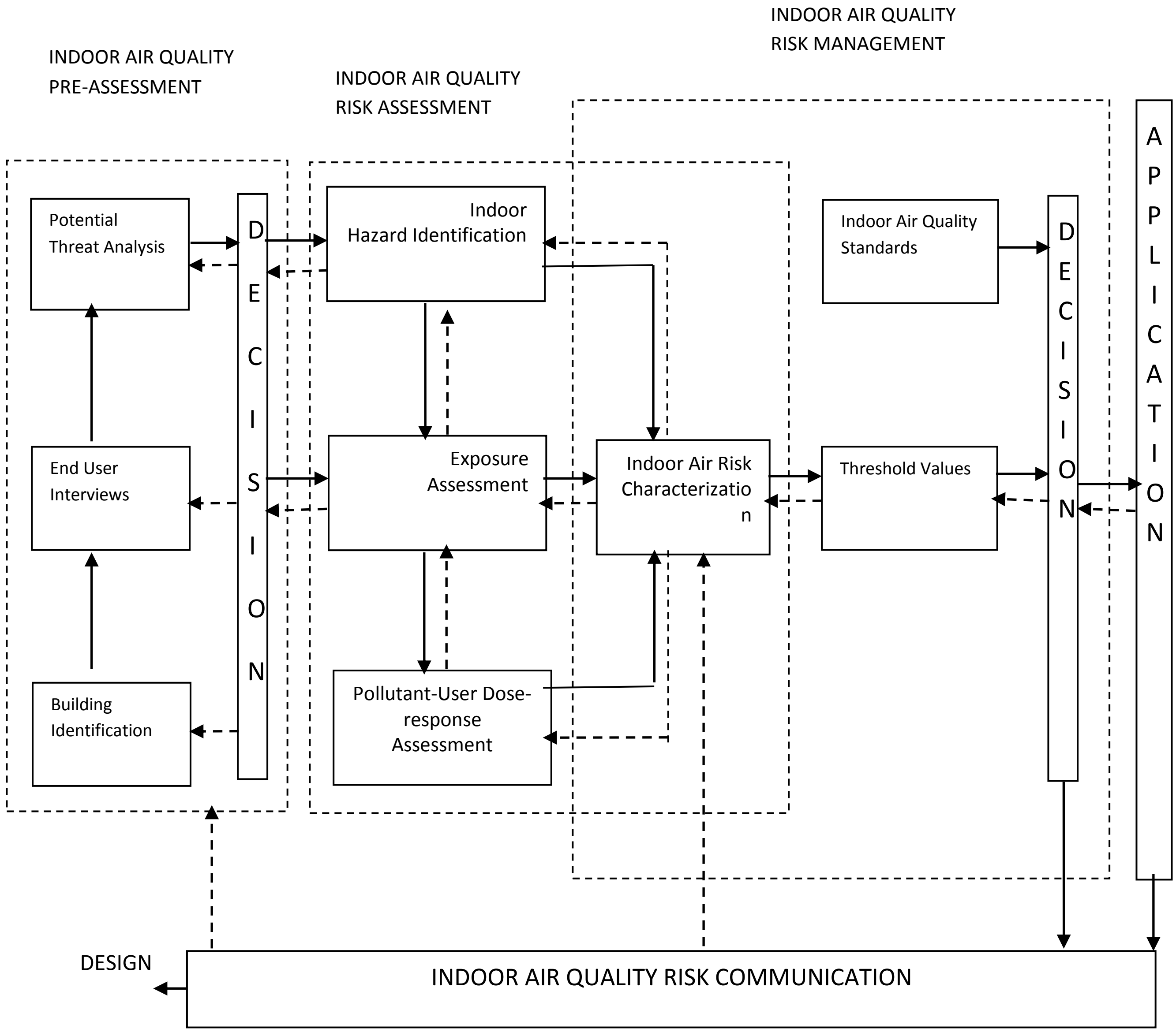


Fig.2.8: Indoor Air Quality Risk Analysis Model
Source: *Vural (2004), p.68*

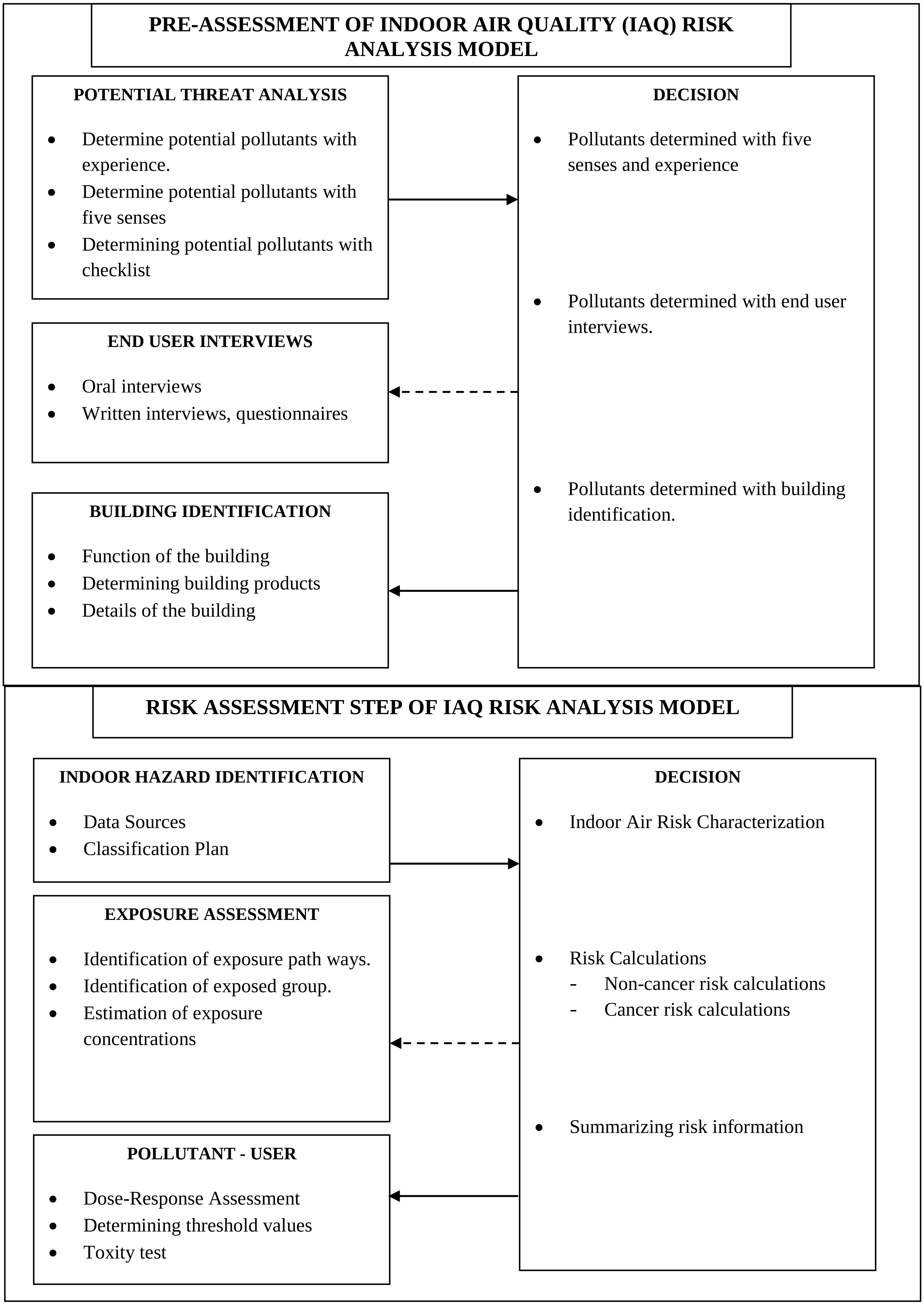


Fig.2.9a: Indoor Risk analysis model

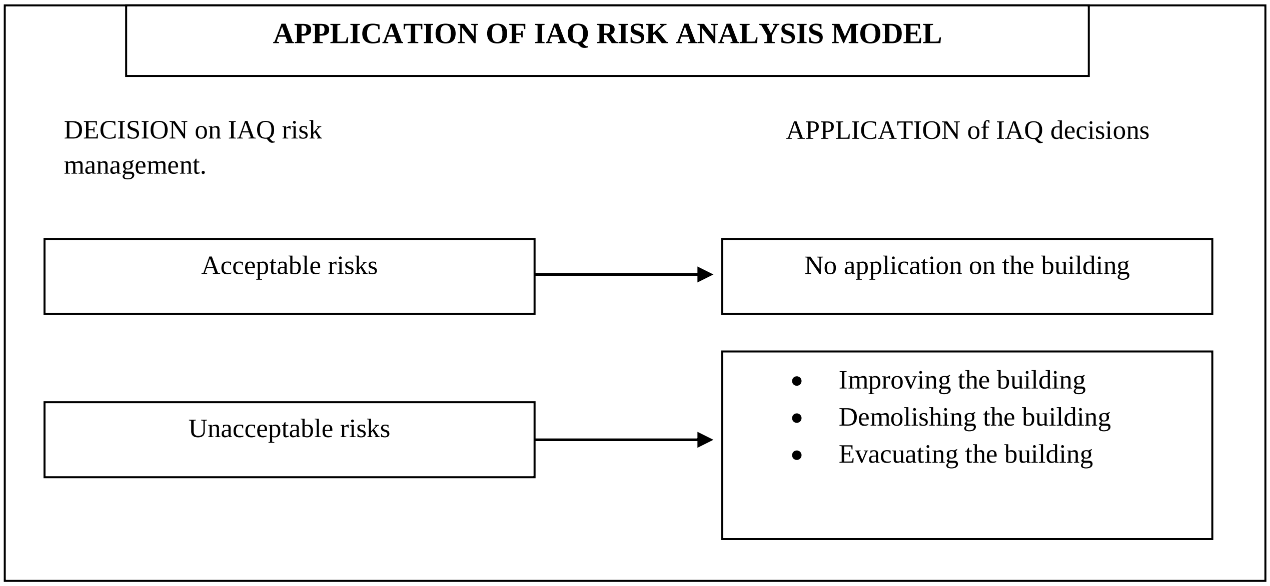


Fig.2.9b: Indoor Risk analysis model
Source: *Vural (2004), p.70*

2.9.3 Model on Outdoor and Indoor Characteristics of Building in Terms of Building Biology

The model developed by Ozturk and Balanli (2004) in Fig. 2.10 examined the outdoor and indoor characteristics of building in terms of building biology. Building biology is defined as a scientific field which attempts to prevent the negative effects, on people's lives, by identifying the relationships between the building, its environment and its users, while setting and controlling the rules to direct the design, construction and usage of building in terms of its users' health.

The constituent parts of the model are identification of building, identification of users, negative characteristics of the users, health problems, hazardous effects of the health problems on users, adverse conditions emanating from the health problems and related negative characteristics of the indoor and outdoor environments.

Relevant independent variables in the model are the indoor environment characteristics – physical and social. The physical indoor environment comprises dimensional and spatial features, visual features, auditory features, tactile features and atmospheric features. Social environment, on the other hand, consists of groups, norms and socialization of users within the indoor environment. The permanent and temporary characteristics of the user, as a variable, include biological, psychological and social. Space utilization and maintenance practice have not been considered in the model. However, contributions of the two variables to the comfort of the user and the quality of the indoor environment have been implied in the relationships depicted by the model. It is axiomatic that a well maintained indoor environment will encourage higher intensity ofworkspace utilization.

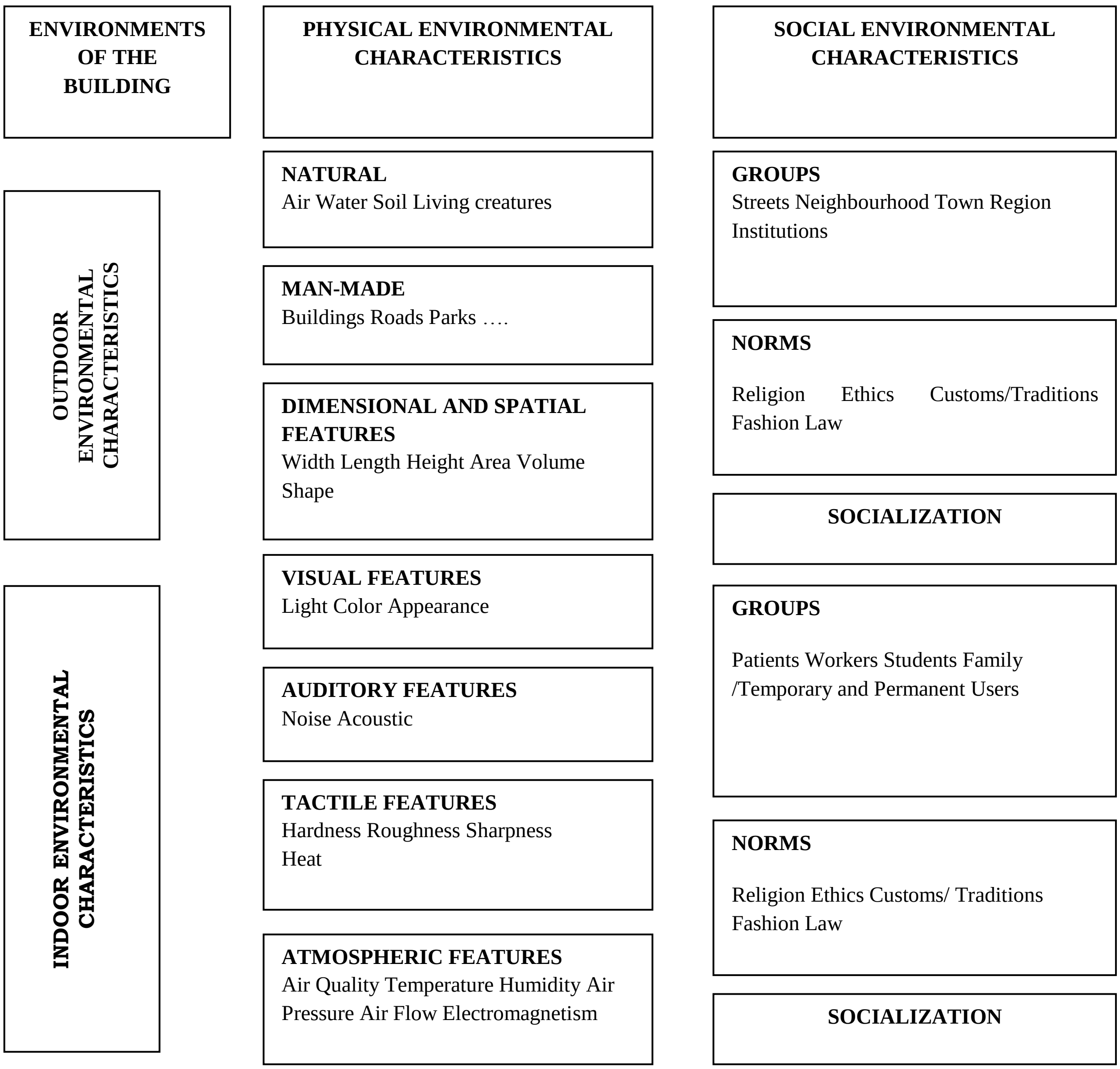


Fig. 2.10: Outdoor and indoor characteristics of building (in terms of building biology).
Source: *Ozturk and Balanli (2004), p.72*

The evolving chain of cause-and-effect relationships could be explored to determine the health problems originating from the indoor and outdoor environments of the building and examine further the adverse environmental features (of the building) causing specific health problem.

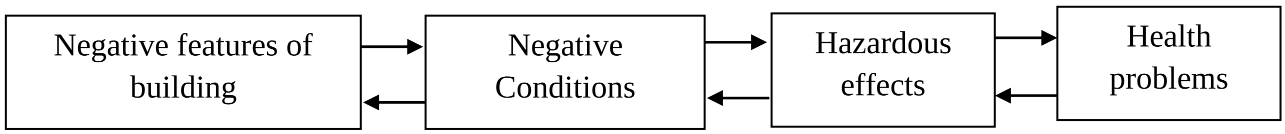


Fig.2. 11: Cause–and–Effect relationship between Building and Health problems
Source: *Ozturk and Balanli (2004), p.73*

The building will create an unhealthy indoor-environment when users fail to use the building for its designed functions or make changes to the functions without commensurate renovation. Other reasons include lack of regular and satisfactory maintenance and change in the physical or social features of the building. The model is useful in evaluating an occupied building in terms of building biology and information gathered will aid decision on rehabilitation of the building for the benefit of owners, users and other stakeholders.

As an extension of the building biology model, a system approach was further explored for the purpose of examining building related problems and their effects on occupants. The components are the purposes and objectives, the resources and the outputs. The model created improvement on previous models in terms of conception, relationships, problem solving and contribution to decision making. The desired environmental quality could be achieved by associating the system activities with the purposes, objectives, targets and resources as inputs of the system (Balanli & Ozturk, 1997).

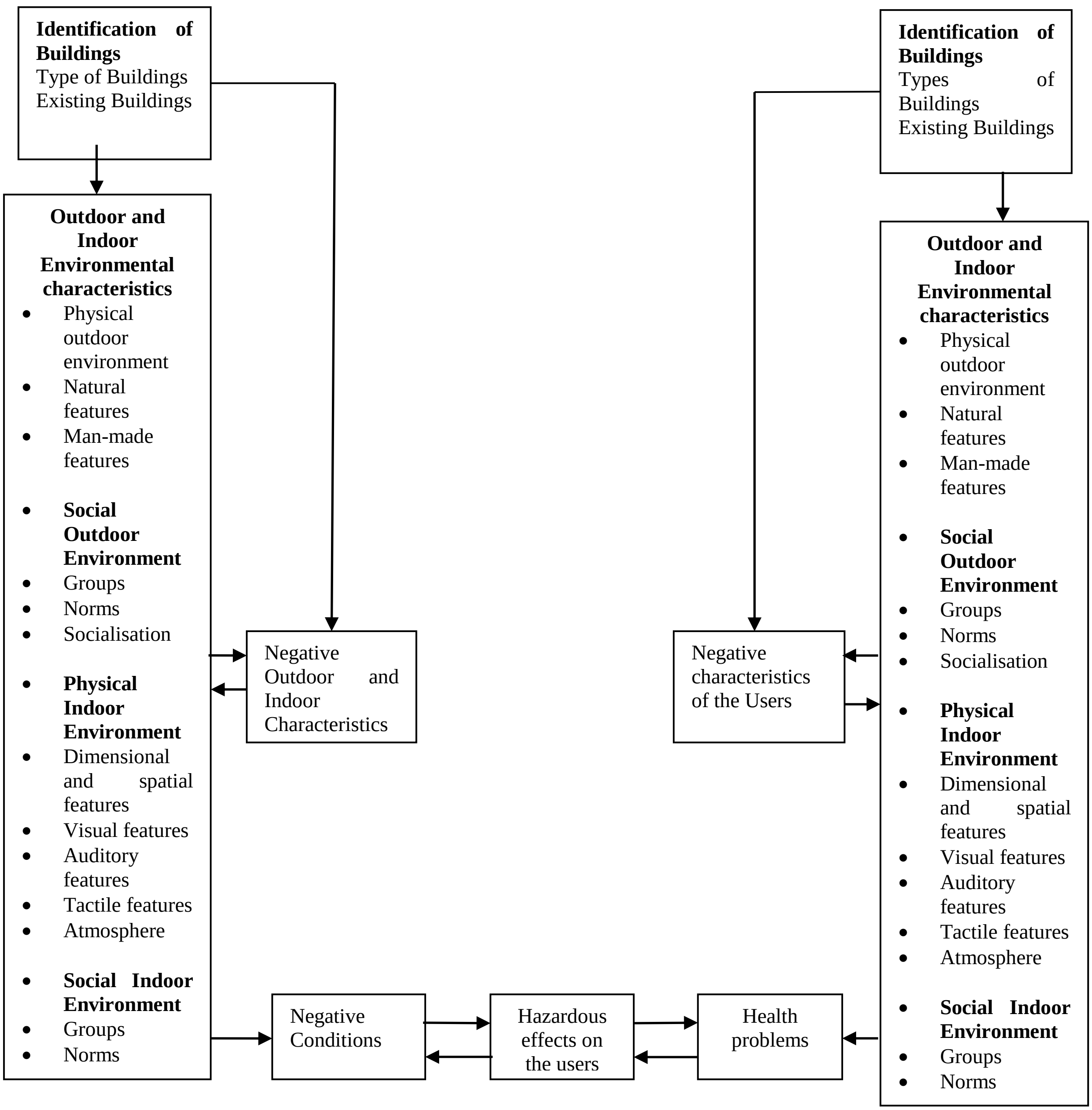


Fig. 2.12: Relationship between Outdoor and Indoor characteristics of building and the users
Source: *Balanli and Ozturk, (2004) p.4*

In the building biology system, knowledge and resources are supposedly well selected in designing, constructing and maintaining the building. Consequently the building is inspected and if satisfactory in performance, a healthy building as a product cum environment is experienced; otherwise the result is unhealthy building and/or environment. Such defects are fed back into the inputs for remediation in order to create healthy building and environment. The cause-and-effect relationship is depicted by input-output analysis of a typical system.

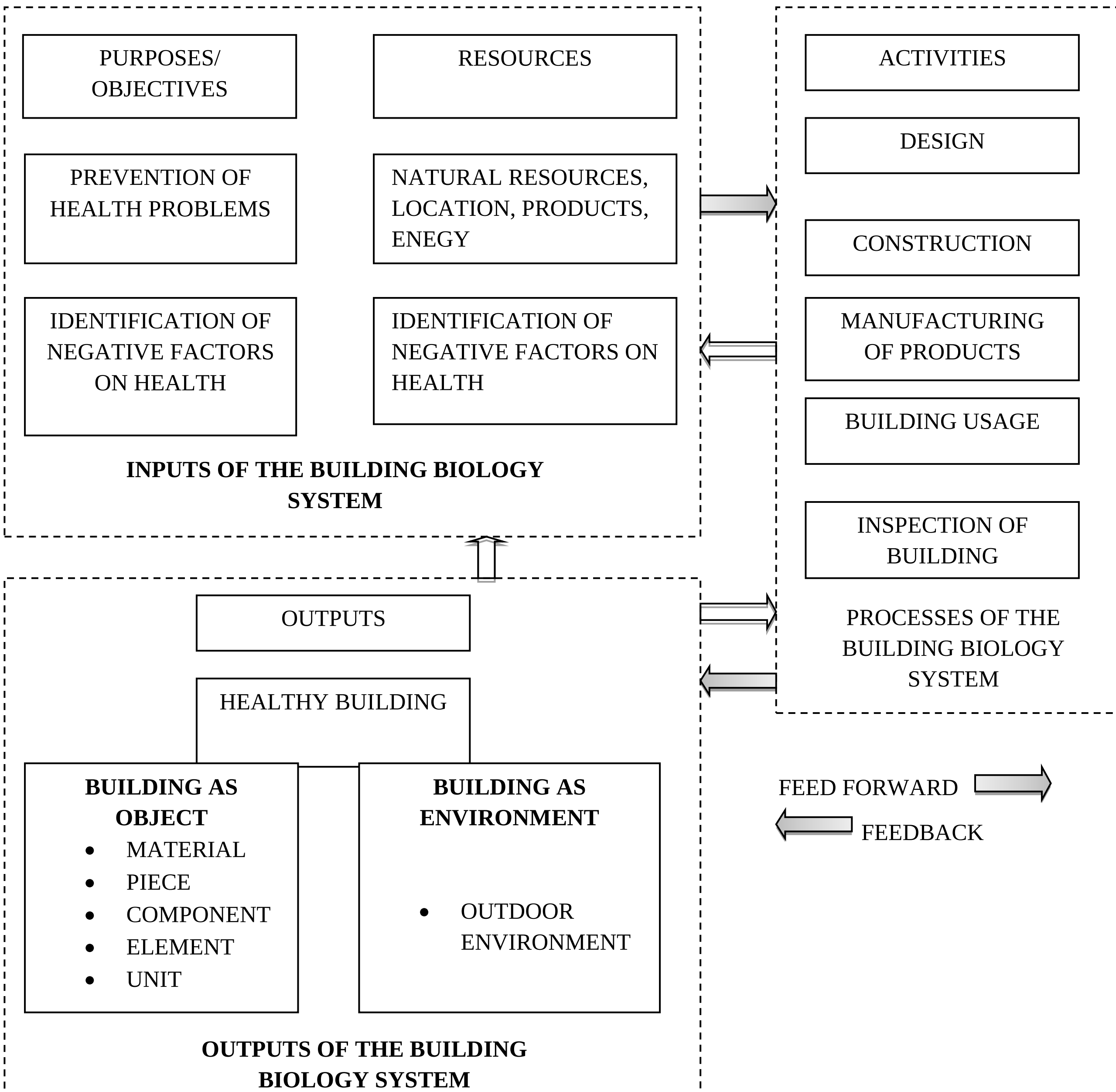


Fig.2.13: Model of Building Biology system
Source: *Ozturk and Balanli (2004) p.74.*

2.9.4 Maintenance Performance Measurement Framework

In the framework developed by Munchiri, Pintelon, Gelders and Martin (2011), significant elements and processes driving maintenance practice for satisfying corporate objectives in manufacturing, are indicated. Corporate objectives in relation with maintenance include but are not limited to plant life, plant safety and environment, plant functionality and maintenance cost as encapsulated in Fig.2.14.

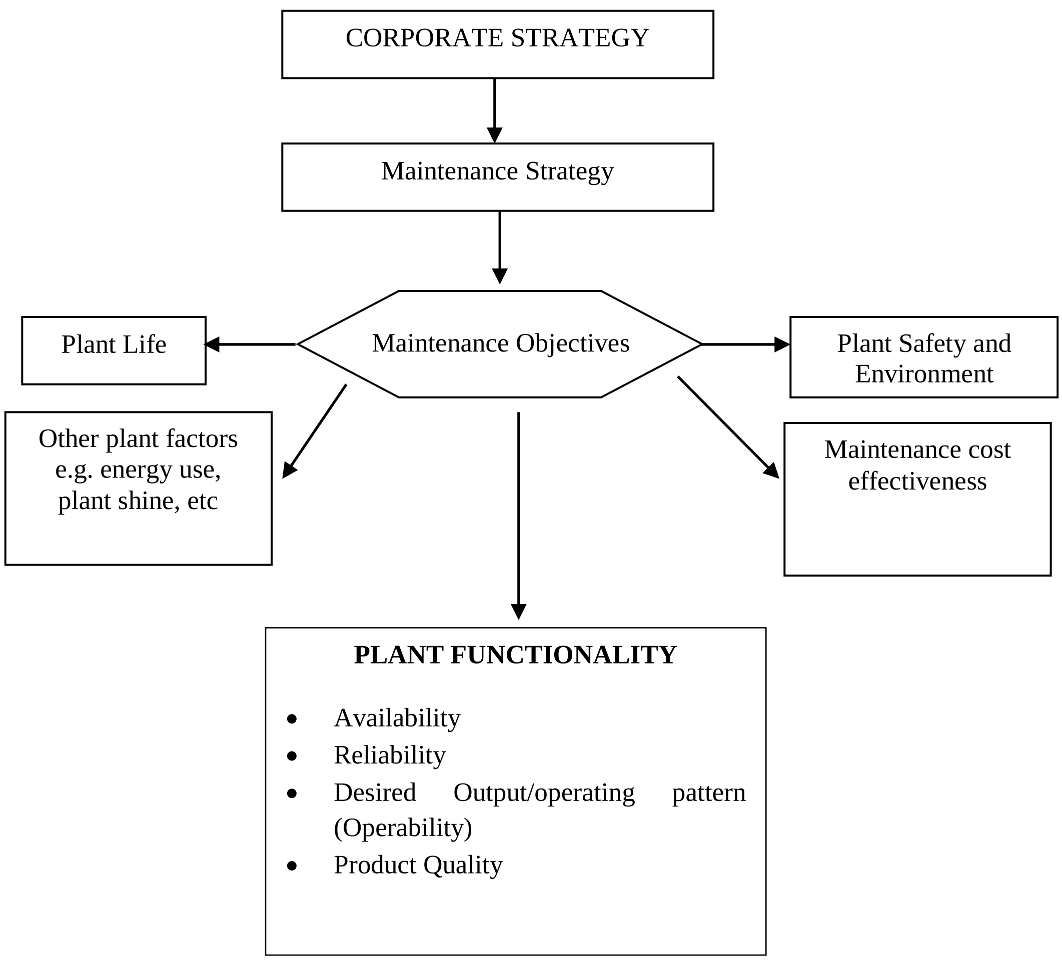


Fig. 2.14: Objectives of Maintenance department.
Source: *Muchiri et al. (2011), p.297*

The framework in Fig. 2.14 is based principally on alignment of maintenance objectives with manufacturing strategy. The framework indicate the essential link between maintenance objectives, maintenance effort/process and maintenance results (performance) as the dependent variables. It thus provide maintenance managers with a window for identifying and focusing on gaps between current and desired performance levels by directing human and material resources to essential improvement in performance of the building.

By considering relationship between performance driven maintenance objectives and output of maintenance (i.e. results), a system approach is indirectly implied. There is also the feedback loop between maintenance process and performance analysis. All the elements of the framework could be translated to maintenance practice directed towards indoor environmental quality (IEQ) e.g. corporate strategy translates to university's overall strategy, manufacturing performance requirements translate to functional performance requirements of building and maintenance objective could be acceptable IEQ. Maintenance results (performance) is therefore a function of maintenance strategy and maintenance effort/process i.e. maintenance practice.

Zalejska-Johnson and Wilhelmson (2013) examined the effect of perceived indoor environmental quality (IEQ) and influence of occupants' characteristics and building characteristics on overall satisfaction in Swedish residential buildings. Occupants' characteristics considered are gender, age, life style and health. Location, climate, building design and construction are the characteristics of building considered. Ordinal Logistic Regression (OLR) was used for analysis of the subjective data collected. Zalejska-Johnson and Wilhemsson (2013) used OLR for analysis because data generated were ordinal. The dependent variable was occupants' overall satisfaction while independent variables were occupants' characteristics and building characteristics. Results were reported in the form of Odds ratio - as likelihood of decreasing overall satisfaction if the predictor variable was increased by one unit while other variables are kept constant.

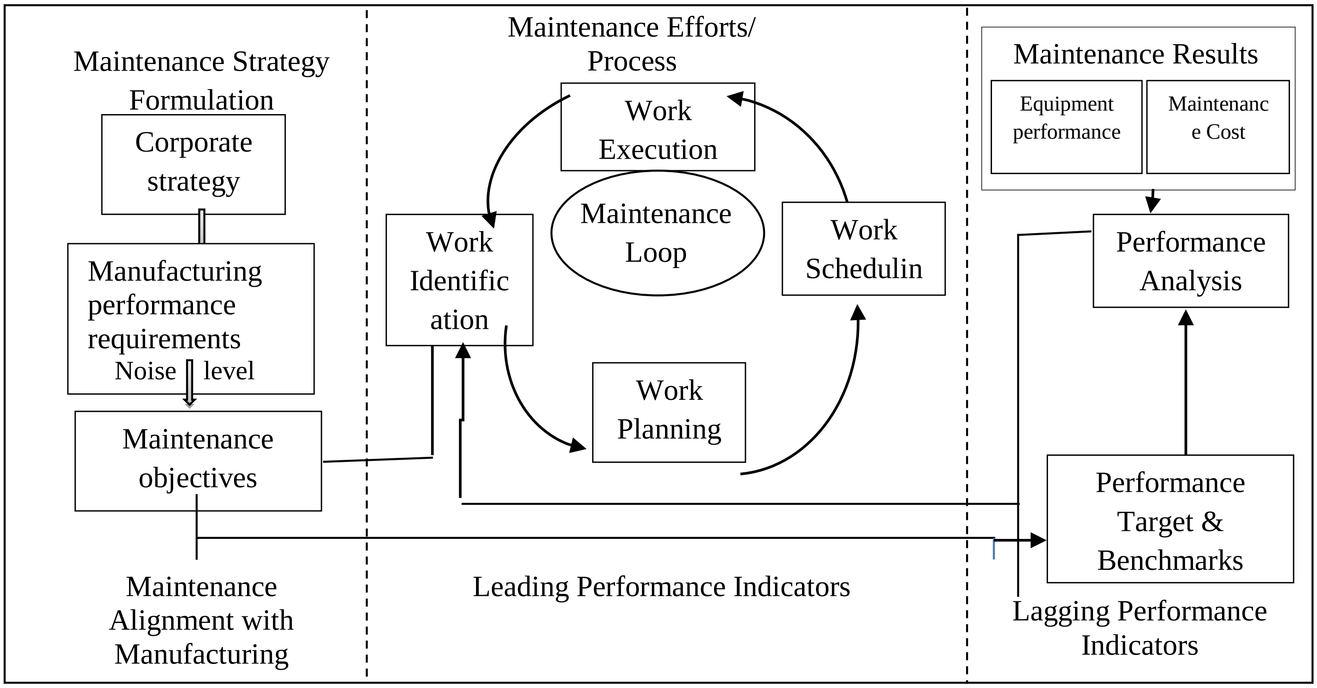


Fig 2.15: Maintenance performance measurement framework
Source: Muchiri, *et al*. (2011), p. 298

2.9.5 Model on Impact of Perceived IEQ on Overall Satisfaction in Swedish Dwellings

Main model gave overall satisfaction, the dependent variable as:

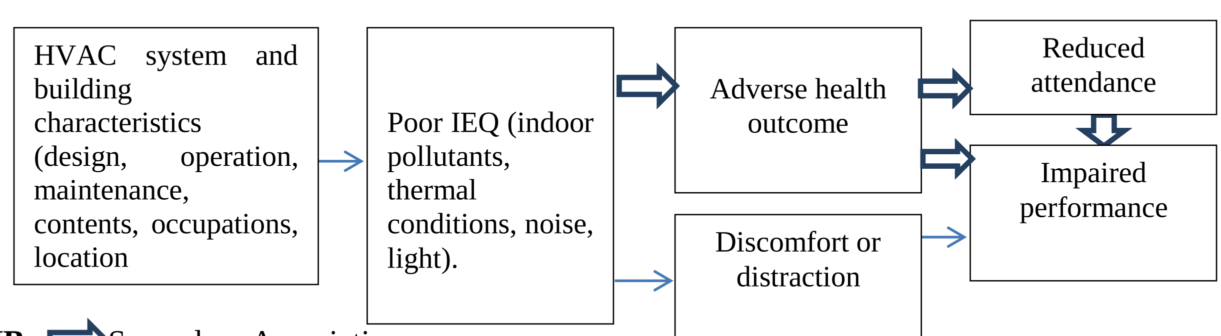
Overall satisfaction = β_1TC+ β_2 Air Q + β_3Sound Q

Where: TC =Thermal Comfort; Air Q = Air Quality; Sound Q = Sound Quality and, $\beta 1$, $\beta 2$, β_3= Coefficients.

Occupants in sampled buildings were found to be generally very satisfied. Satisfaction with air quality (O.R = 2.651), thermal comfort (O.R = 1.814) and sound quality (O.R = 1.56) had respective impact on overall satisfaction based on O.R. The highest impact was therefore attributed to satisfaction with air quality. Although only three IEQ parameters were considered, the type of data generated and method of analysis made the approach relevant to this study.

2.9.6Framework on Influence of IEQ on Performance of Students

A direct association between measured IEQ factors or building characteristics and the performance of students was summarized as shown in Fig.2.16. The IEQ factors considered included contaminants from outdoor (excluding radon, lead and asbestos), contaminant control processes like ventilation rate, indoor thermal parameters and characteristics of buildings. Lower outdoor air ventilation rates, responsible for higher concentration of pollutants indoors caused reduced performance among occupants including office workers. Day lighting was found to be related to improved performance in learning by students. There were no sufficient and consistent evidence for establishing relationship between indoor thermal quality or acoustics and performance of students. Space utilization has not been considered and contribution of maintenance towards improved IEQ was not accounted for either. The review has however identified useful scientific findings consistent with IEQ and users' relationship.



NB: ⇨ Secondary Association
Fig 2.16: Causal links relating IEQ in schools to performance and attendance of students
Source: Health and Mendell (2002), p. 26

2.9.7 Model on Relationship between Workspace Planning and Workspace Conflict in the Industrialized Building System (IBS) Project by Seman et al.(2015)

Based on the understanding that IBS enhances productivity,quality,cost reduction and efficient time management, Seman *et al*. (2015) investigated the relationship between factors of workspace planning and workspace conflict in Malaysia. Workspace conflict includes design conflict, congestion, safety issues, accessobstruction, work distractions and malfunction etc. Four independent variables -management, jobsiteplanning, resources and logistics and, project characteristics and external environment- were investigated as constituent factors responsible for workspace conflict. Relationship between the dependent variable (workspace conflict) and independent variables is depicted in Fig 2.17.

Finding of the research gave management and project characteristics and external environment as factors which created significant positive influence on workspace conflict. Evaluation of space utilization for construction activities may therefore be applied to this study because they both focused on performance of workspace.

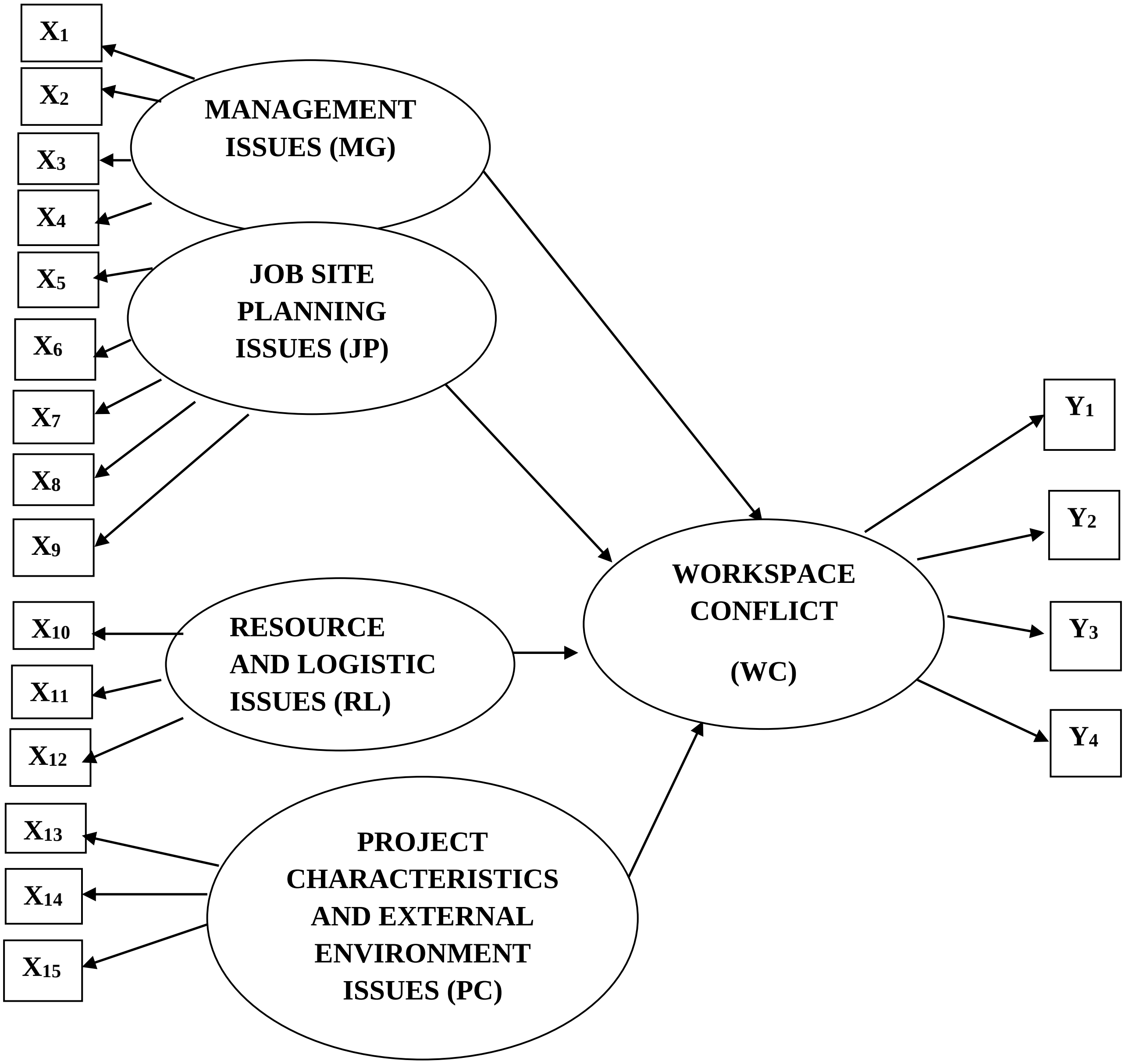


Fig.2.17: Model on relationship between Workspace planning and workspace conflict
Source: Seman et al. (2015), p. 140

Legend

Management issues (MGT)Jobsite Planning issues (JSP)

X_1 =Communication and Coordination.X_5 = Scheduling planning and space planning method
X_2 = Making decision and Team workX_6 = Equipment and labour use planning
X_3 = Safety planning and managementX_7 = Space sharing and construction method determination
X_4 = Competency and Experience of the technical team X_8 = Involvement of sub contractors in preparing for work planning and effective space
X_9 = Space use determination

Resource and Logistic issues (RL)Project characteristics and External environment issues (PC)

X_{10} = Labour and moral.X_{14} = Weather, order of change, time and budget - element of uncertainty.
X_{11} = Material, logistics and arrangement of facility X_{15} = Project design, complex construction site, size and location of site.
X_{12} = Availability of space and equipment
X_{13} = Availability of materials and labour

2.9.8 Conceptual Framework

Conceptualizing the research involves identification and clarification of the major research object as a set of contextual phenomena possessing peculiar characteristics individually and relational characteristics between themselves (Miller, 1978). Literature review, models and frameworks discussed so far have indicated characteristics of the external environment, indoor environment, the occupants, the building and the activities within the building as phenomena that influence the satisfaction of occupants with indoor environmental quality (IEQ). Workspaces installed within designated office buildings for lecturers to carry out official and social functions created existence of varied pattern of workspace utilization; either as individual or group of users. By implication, a building that is used for executing official duties and social interaction needs maintenance in order to preserve and satisfy its functionality, utility and value-adding requirements. The conceptual framework in Fig. 2.18 therefore indicates the interaction between workspaces, occupant-lecturers working within the workspaces and the indoor environment. The nature and outcome of interaction will determine lecturers'satisfaction with IEQ, intensity of workspace utilization for academic works and demand for maintenance.

The theoretical frameworks on impact of IEQ on whole-life cycle of a building by Collinge *et al.* (2013) and application of building biology for examining the effects of indoor and outdoor characteristics of buildings on health of occupants by Balanli and Ozturk (2004) are quite relevant. The aforementioned frameworks were supplemented by maintenance performance measurement model (Muchiri *et al*. 2011) and indoor risk analysis model (Vural, 2004). In addition, two models by Zalejska-Johnson and Williamson (2013) and Heath and Mendell (2002) which examined impact of perceived IEQ, occupants' characteristics and building characteristics on comfort and performance were considered. Model developed by Seman et al. (2015) on relationship between workspace planning and workspace conflict proved useful too. The seven theoretical frameworks have been used as basis for developing conceptual framework; so as to identify major aspects and practices driving maintenance towards monitoring and delivering desired IEQ and creating real-time comfort for lecturers.

Users' characteristics include biological, physiological, psychological and social characteristics which possess temporal and spatial variations (e. g. socialization, size of workspace, status, etc). Workspace characteristics, a subset of the indoor environment, entail varying physical indoor environment elements (dimensional and spatial features, visual features, auditory features, tactile features and atmospheric features) and the social environment of groups, norms and social interaction. Space utilization varies in purpose, capacity, frequency of use, period of use and number of users. Maintenance practice is dictated by and vary with intensity of use of workspace, physical environment of workspace, strategies adopted on maintenance, prioritization and programming of maintenance work, etc. Space conditioning may be passive (natural), active (mechanical) or mixed-mode for controlling atmospheric parameters of indoor environment like temperature, light and air-flow.The conceptual model of this study, depicted in Fig. 2.18, indicates independent variables as lecturers' characteristics, maintenance practice, workspace characteristics, IEQ and workspace utilization.

Lecturers' characteristics, maintenance practice and workspace characteristics are the three predictor variables determining the status of IEQ of the workspace while lecturers' characteristics create or dictate demand for desired IEQ, workspace characteristics, like insulation properties, act to satisfy the demand within coping capacity. Maintenance practice contributes by regulating performance of workspace in satisfying the demand of the occupant-lecturer, particularly when desired IEQ is not met.

Lecturers' characteristics in the framework include: age, gender, employment status, professional status, academic qualification, possession of physical challenges and period spent in the allocated workspace. These characteristics dictate and influence demand for acceptable IEQ in the workspace.

Maintenance practice has six major tasks namely: top management commitment, objectives, planning, organizing, controlling and feedback from lecturers' as users. These six major tasks have 78 sub-tasks which act together as deployed maintenance strategies.Workspace characteristics entail type of building, floor level, conditioning mode, size, layout, accessibility, direction faced by windows, and proximity of windows to external view.

IEQ in the workspace is broken down into spatial, acoustic, visual, thermal, furniture and furnishing, cleanliness and maintenance and, IAQ. The parameters of IEQ interact within the workspace to create holistic environmental quality and are perceived as such by the lecturer, while using the workspace, in expressing satisfaction or dissatisfaction.

The intensity of workspace utilization on each of the thirteen identified activities of lecturers depends on nature of the work, level of comfort desired and maintenance strategies adopted. The thirteen identified activities of lecturers in the workspace are formal reading, reading for leisure, formal writing, formal drawing, consultation by students, formal meeting with colleagues, marking scripts, social interaction with colleagues, internet surfing, watching television or video, eating, receiving guests unofficially and relaxation. By implication, intensity of workspace utilization indicates level of lecturers' satisfaction with IEQ - the dependent variable.

Lecturers' satisfaction, the dependent variable, is evaluated with respect to quality of workspace in terms of size and layout, acoustic condition, visual condition, thermal condition, quality of furniture and furnishing and the status of cleanliness and maintenance. Lecturers' perceived satisfaction or dissatisfaction depends on expectations and experience.

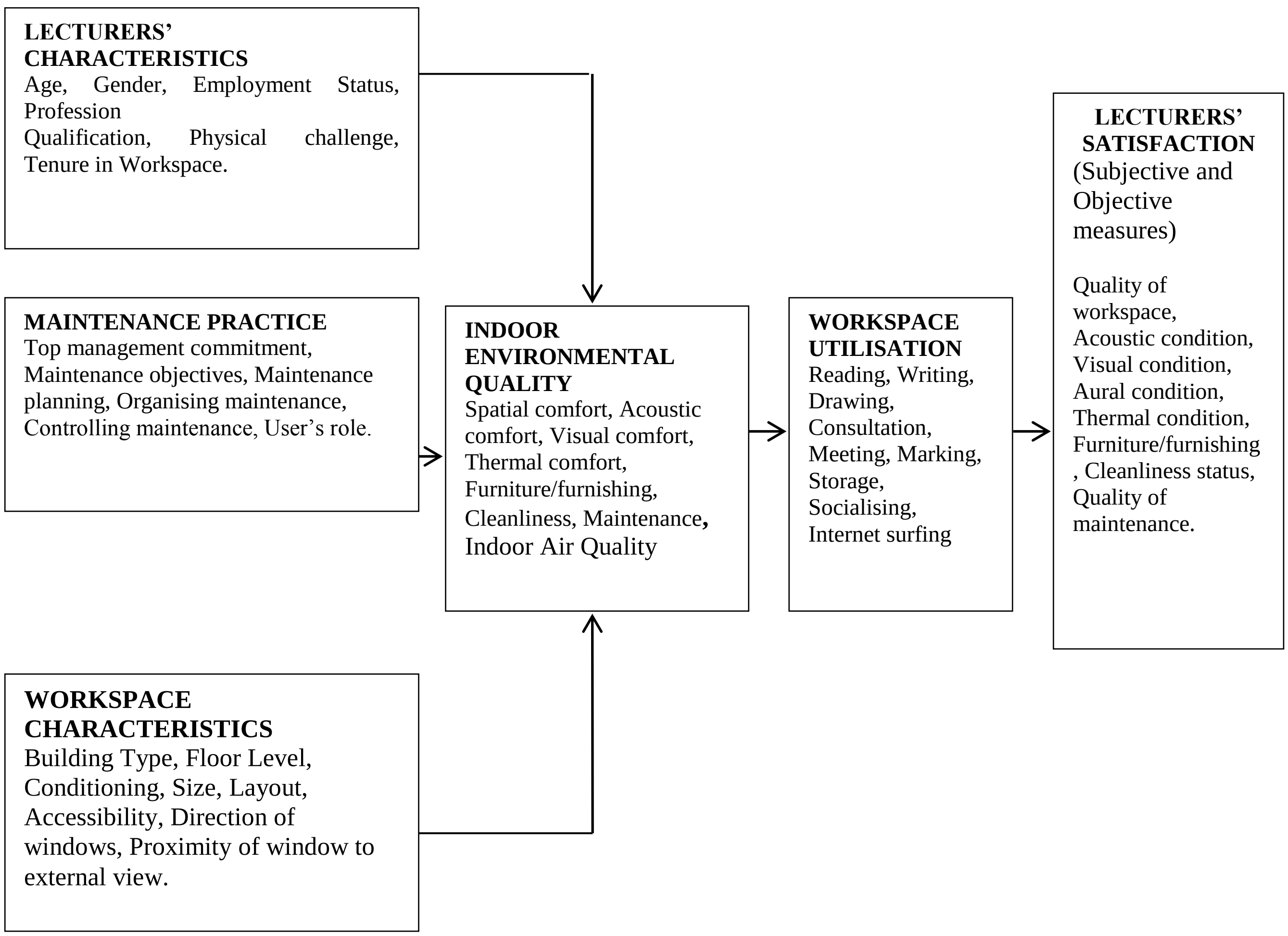


Fig.2.18: Conceptual model for predicting Lecturers' satisfactionwith IEQ in workspaces.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter contains description of the study area, research design, population, sampling and sample, instruments for data collection, methods used to collect data, reliability and validity tests on data collection instruments, statistical tools and methods of data analysis.

3.2 The Study Area

The study area, as shown in Fig. 3.1, is the North Central geopolitical zone of Nigeria.The zone comprises six states and the Federal Capital Territoy (FCT). The states are Benue, Kogi, Kwara, Nasarawa, Niger and Plateau. The population within the study area spread across three out of the six states in the zone as representative samples. Other factors considered are climate and location of public universities in the study area.

The climate of the three states (Niger, Kwara and Benue), in which the selected universities are located, is tropical and classified as Aw. Fig. 3.2 indicates Minna, Ilorin and Makurdi as locations of the three selected universities within the three states. Average annual temperature and rainfall in the locations are 27.5^{o}C and 1,229mm for Minna, 26.5^{o}C and 1,217mm for Ilorin and, 27.2^{o}C and 1,332mm for Makurdi.

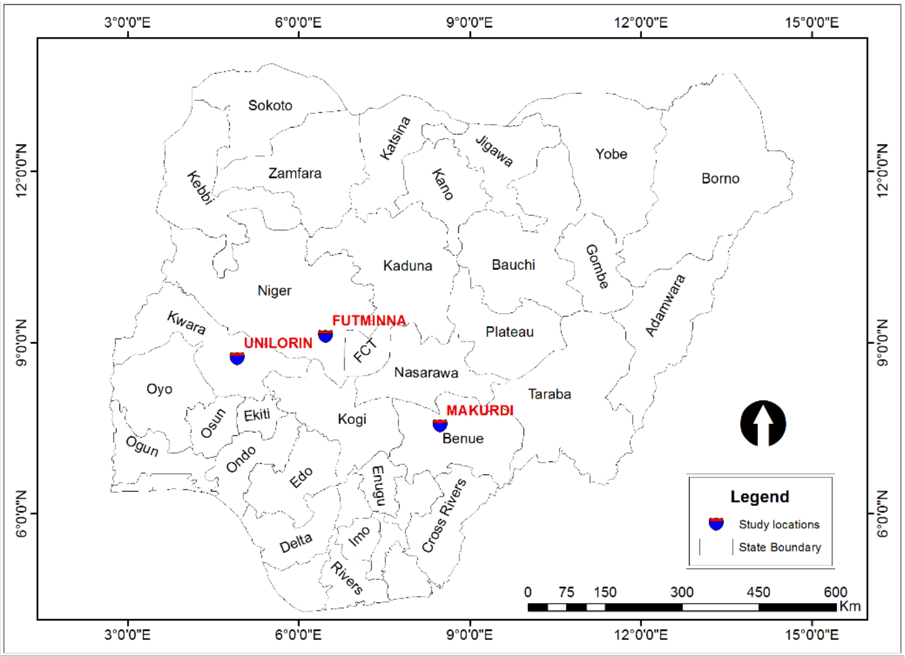


Fig. 3.1: Map of Nigeria indicating states and location of selected universities.

Source: Department of Geography, University of Lagos.

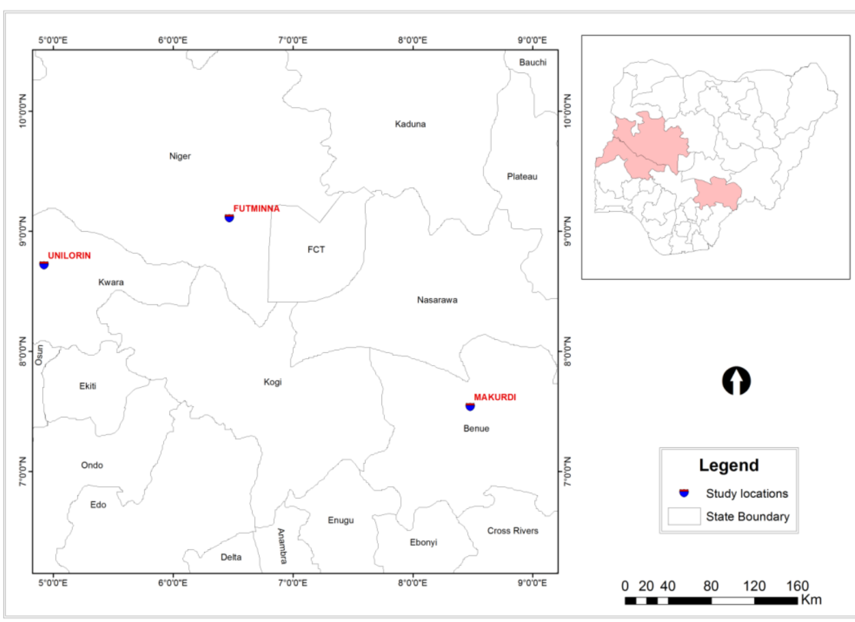


Fig. 3.2: Study locations in Kwara, Niger and Benue states.

Source: Department of Geography, University of Lagos.

3.3 Research Design

Slaunders, Lewis and Thornhill (2000, p.98) regard research design ‘as a broad plan of how the researcher intends to go about answering the research questions'. This study adopted an exploratory research approach so as to have greater understanding of the research variables. Specifically, a mixed method of data collection was employed, as inquiry strategy, to know “how” and “why’’ of maintenance practice directed towards creation of acceptable indoor environmental quality in workspaces of lecturers in Nigerian universities (Cresswell, 2007; Yin, 2009).

Adoption of mixed method, involving both qualitative and quantitative data, supplemented and enhanced the predominantly quantitative research on performance of maintenance management which had hitherto focused on physical buildings rather than the management processes and behavioural dimensions. The quantitative strategy focused on deduction, prediction, standardized data collection and statistical analysis while the qualitative focused on induction, discovery, exploration, and theory/hypothesis. Subjective data were obtained through questionnaire survey amongst sampled lecturers in the three universities selected within the study area. Objective data were collected through simple instrumentation to measurefive IEQ parameters (Temperature, Humidity, Acoustics, Lighting and Air-flow) in sample workspaces within offices of lecturers. The investigation entailed collection of primary data on perception of lecturers on IEQ parameters, workspace utilisation, maintenance practice and satisfaction in the three universitiesthrough the processes in Fig.3.3 adopted from Knight and Cross (2012, p.50).

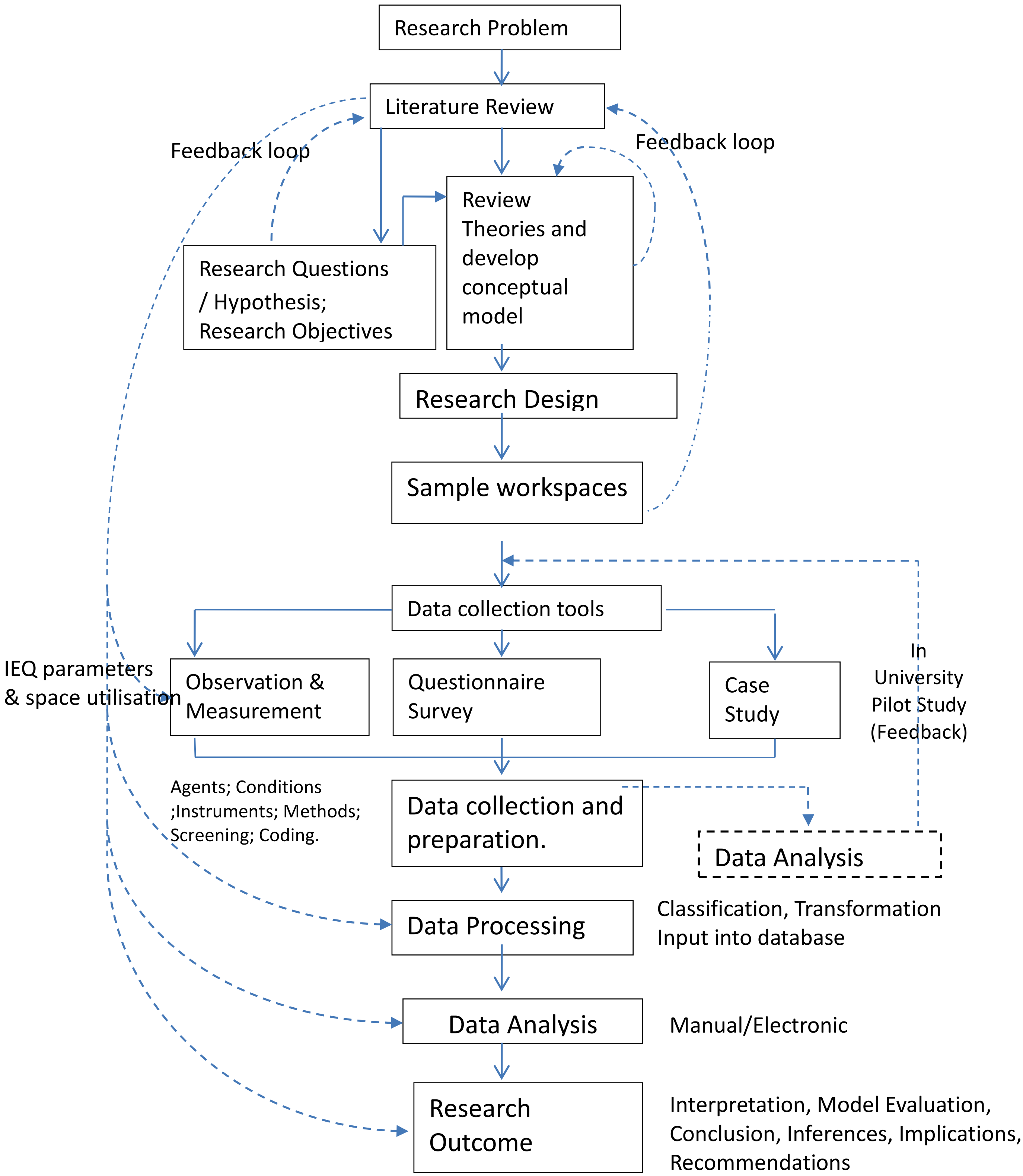


Fig. 3.3: Flowchart on Adopted Cyclical Approach to Research Tasks.

3.4 Research Philosophy

Research philosophy is the study of or creation of theories about basic things such as the nature of existence, knowledge and thought or about how people should live, work and relate with each other. In other words, existing objects and/or concepts have properties and relationships which need to be investigated in order to establish facts about reality. The two prevalent types are Ontology and Epistemology.

Ontological views are explanation about the nature and conception of reality in terms of basic categories and relationships (Sustrina, 2009). Chia (2002) described the Parmenidean context of ontology by stating that reality is composed of clear entities with identifiable clear discrete properties and characteristics. The Heraclitean context however viewed reality as inclusively processual; meaning that all things interact in a constant flux beyond human's sensation of their appearance.

Epistemology, as stated by Shakantu (2004, p.161), entails "how and what the researcher knows and the questions about how and what is possible to know". It thus describes what the researcher knows or assumes to know about the reality with assumptions on how knowledge should be acquired and accepted. Epistemology therefore looks at the theory of knowledge with reference to its methods, validation and possible ways of gaining knowledge in the assumed reality (Okolie, 2011).

Ontologically, this study is parmenidean and realist because the main objective of developing a predictive model (with clearly identified variables) provided reliable evidence to support generalization about lecturers' satisfaction with workspaces in their offices. Lecturers and workspaces are clear entities with identifiable discrete properties and characteristics.

Epistemologically, the study conforms with interprevist view and positivist paradigmically. Reality was socially constructed and given meaning by lecturers who were conscious purposive actors on issues concerning their offices and attached meanings to satisfaction with IEQin their offices based on experienced workspace utilization. Interprevism takes constructivism (or subjectivism) as the basis of understanding reality which was constructed and interpreted differently by individual lecturer.

3.5 Research Reasoning/Approaches

Sutrisna (2009) described research reasoning as a combination of the logic of the research, the role of existing body of knowledge derived from the literature reviewed, the ways and manner through which data were collected and the subsequent analysis of the data so collected. It is a thought process that determines the specific approaches and methods for collecting and analyzing data.

This research is contextually empirical and non-empirical because it involved the study of social settings (lecturers and their workspaces) in selected universities in Nigeria. Positivist and phenomenological paradigms of research are therefore suitable. Dimensions of the empirical research are deductive and inductive, quantitative and qualitative and, objective and subjective.

Deductive research entails the development of theoretical and conceptual frameworks which are subjected to tests through empirical observation (Gill & Johnson, 2002; Robson, 2011). Inductive research, on the other hand, is a study in which observation of empirical reality are documented and analysed to develop theory i.e. from individual specific observation to statements of general trends or laws (Collis & Hussey, 2003). Inductive research blends with phenomenology and subjectivism or interpretivism approaches while deductive research is more relevant in objectivist and positivist approach.

The deductive and inductive reasoning applied in this study was informed by extensive review of literature on the variables, as contained in chapter two, for formulating hypotheses and identifying major theories and concepts relevant to the objectives. Exploratory approach through the case-study of universities yielded information on and perception of lecturers on allocated workspaces, maintenance practice, indoor environmental quality and maintenance practice

3.6 Population of the Study

A population, which may be finite or infinite, may be described as the source of those observations from where a sample is selected for investigation (Hoel, 1976).Lecturers with allocated workspaces and relevant specializations in the three selected universities, constituted the target population of the study.Three sources explored in obtaining the list were Registry, Academic Staff Union of Universities (ASUU) and the Academic Planning Unit (APU).

At least 10% of the finite population must be studied (Ogolo, 1996). There are six Federal universities in North Central zone and the three selected represents 50%, which satisfies the 10% criterion for making generalization about the population.

Table 3.1: Population of Lecturers in the Selected Universities

University	Total number	Lecturers in relevant faculty
University of Ilorin.	1432	249
Federal University of Technology, Minna.	737	378
University of Agriculture, Makurdi.	650	260
Total	2,819	887

3.7 Sampling

This is the process of selecting representative items from the population in order to make generalization. The selected items are referred to collectively as sample from which inference can be drawn. The formula developed by Tabachnick and Fidell (2011) was used to determine sample size.δ

Three out of the six Federal Universities in the study area were chosen based on convenience sampling and spread in location. Lecturers were selected from three faculties in the three universities, by purposive sampling, based on their knowledge in major aspects of the study namely: environmental sciences, engineering and physical sciences.Convenience sampling was also used in selecting lecturers' workspaces for the measurement of IEQ parameters with instruments.

3.7.1 Sample Size

Shodhganga (2012) gave formula for determining sample size as:

$$n = \frac{Z^2 * N * \delta^2}{e^2(N-1) + Z^2\delta^2} \quad \ldots\ldots 3.1$$

Where n = sample size

N= Population size

e = Level of precision (5%)

Z = Value of standard normal variant at a given confidence level (1.96)

δ^2= Standard deviation of the population (0.5)

From Eqtn. 3.1: $n = \frac{1.96^2 * 250 * 0.5^2}{0.05^2(250-1) + 1.96^2 * 0.5^2}$

$= 151.68$

Considering low response rate in Educational and Social science research, Barlett, Kotrlik and Higgins (2001) suggested 65% anticipated response rate. By the sample size of 152 derived from Eqtn., minimum valid response of 99 questionnaires was expected.

3.8 Data Collection

Mixed method or multi-methodology employed in this study entails collection of both qualitative and quantitative data. Quantitatively, descriptive data on the characteristics of lecturers, characteristics of workspaces; indoor environmental quality, maintenance practice and workspace utilization by lecturers as they affect satisfaction in performance of assigned duties were required. Lecturers were therefore expected to identify and assess as perceived, the aforementioned variables in a structured questionnaire (Appendix I).The questionnaire was addressed to lecturers having allocated workspaces in Environmental Sciences and Engineering and Physical science faculties, in the three universities studied. The questionnaire was structured into five sections, namely: characteristics of lecturers and workspaces, workspace utilization, IEQ, maintenance practice and lecturers' satisfaction with allocated workspace. Perceptions were expressed in the questionnaires in 7-point likert scale namely: EH – Extremely High; VH – Very High; H – High; M – Moderate; L – Low; VL – Very Low; EL – Extremely Low.

Physical measurements of temperature, humidity, acoustics, lighting and air-flow were taken with instruments(Plates I-IV) and recorded four times in a day for five days, in each of the sampled thirty-eight workspaces. For each measurement, occupant-lecturers were asked to express satisfaction modes (as satisfied, indifferent, not satisfied) and preferences (as higher, equal or lower). The readings and responses of respective lecturer were recorded in a form (Appendix II). Data generated from the measurement of five IEQ parameters were recorded, analyzed and interpreted using descriptive and inferential statistics.

3.9 Research Instruments for Data Collection

Two instruments used for collection of primary data are questionnaire and hand-held electronic devices. The electronic devices are Digital Psychrometer (Plate I), Micro Sound Level Meter(Plate II), Digital Light Meter (Plate III) and Micro Processor Anenometer (Plate IV).

3.9.1 Questionnaire

A questionnaire was designed to elicit responses from lecturers, in a specific order, with the aim of achieving the objectives of this study. Responses were perception of lecturers on six major variables, depicted in the conceptual framework in Fig. 2.19, on appropriate Likert scale. The responses provided qualitative data which were analysed to answer research questions, test hypotheses, describe characteristics of lecturers and their workspaces, investigate relationships and develop predictive models on lectures' satisfaction. There were five sections containing twenty five questions on characteristics of lecturers and their workspaces in Section 'A', twenty one questions on workspace utilization in 'B'while twelve questions on IEQ were covered in Section C. Maintenance practice was categorized into six major tasks as top management commitment, maintenance objectives, maintenance planning, organizing maintenance, control of maintenance works and users' role. These six tasks were addressed in seventy eight questions. Questions on lecturers' satisfaction with workspaces were grouped into seven.

3.9.2 Electronic Devises

Objective assessment of IEQ was done through measurement of five parameters (Temperature, Humidity, Acoustics, Lighting and Air-flow) with instruments. The instruments used are Digital Psychrometer for measuring Temperature in degree Centigrade (^{O}C) and Humidity in Percentage (%), Micro Sound Level Meter for measuring ambient sound level in Decibel (dB), Digital Light Meter for measuring Luminance in Lux (Lux) and Micro Processor Anenometer for measuring Air Speed in Metre per second (m/s). The details on the instruments displayed in Plate I-IV are in Table 3.2. Type of instrument, the model, resolution, range of readings,level of accuracy and general remarks are stated on each instrument. The readings obtained as quantitative data were recorded on a template in Appendix II and processed for analysis accordingly.

Plate I: Digital Psychrometer.**Plate II:**Micro Sound Level Meter.

Plate III: Digital Light Meter **Plate IV:** Micro Processor Anenometer

Table 3.2: Instruments used for measurement of IEQ parameters

IEQ parameter	Type of Instrument	Model	Resolution	Range	Accuracy	Remark
Temperature (°C / °F)	Digital Psychrometer	Lx 1010 BS	0.1°C / 0.1°F	0 - 60°C 32 - 140°F	0.5°C or 0.9°F	Power switch Power LED
Humidity (%)	-do-	-do-	-do-	-do-	-do-	-do-
Acoustics (dBA)	Sound level meter	BK precision 732 NO 5CC	0.1dB	Low: 30 - 80dB Medium: 50 - 100 dB High: 80 - 130 dB Dynamic range=50dB	±1.5dB under specified conditions	Display with 0.1dB steps on 4 digits LCD display; conforms to the IEC 651 Type 2, ANSI S1.4 Type 2; 9V battery
Air-flow (m/s ; km/h)	Digital anemometer (with temperature measurement)	LX 1010 BS	0.1 0.1	0.4 – 30 m/s 1.4 – 108 km/h	±(2% + 1d) ±(2% + 3d)	4 X 1.55 AA Size battery
Lighting (lux)	Digital light meter	Precision Gold Maplin N76CC	1 lux	1 - 100000 (3 ranges) 20000 Lux range: reading X 10; 100000 Lux range:reading X 100	«« 10000 Lux: ±4%; rgd ±0.5% f.s	Repeatability: ±2% Test rate: 0.2 times/sec Photo detector

3.10 Validity and Reliability of Research Instrument

This section contains validation and reliability test on research instrument based on pilot study.Only the questionnaire, out of the two research instruments was tested.

3.10.1 Validity

Validity of research instrument confirms if the instrument measures what it is supposed to measure in terms of comprehension by the respondents and completeness in soliciting adequate information. The questionnaire was validated by the two academic supervisors of the researcher, two experts in academia, three experienced practitioners and ten senior colleagues on Ph.D study. Suggested modifications were incorporated in the questionnaire before its administration.

3.10.2 Reliability

Reliability test was conducted to determine consistency and accuracy of the research instrument in measuring the variables of research.A pilot study was therefore carried out in University of Ilorin, a second generation university, the oldest and largest in the study area, for the purpose of ascertaining adequacy of the instrument in content and expression vis-a-vis the research objective.The Cronbach alpha test of the pilot study was used to determine reliability of the research instrument by administering the questionnaire in University of Ilorin and analysing the responses of lecturers accordingly. Results of the test gave Cronbach alpha coefficients of 0.915, 0.754, 0.860, 0.955 and 0.732 on lecturers' satisfaction, workplace utilisation, IEQ, maintenance practice and lecturers' characteristics respectively. Considering the fact that 0.70 is the minimum acceptable value (Asika, 2004), the questionnaire administered proved reliable at 5% level of significance, with Cronbach alpha range of 0.732-0.955.

3.11 Statistical Tools for Data Analysis

Mean scores of responses were determined on workspace capacity utilisation and frequency of use on 13 identified activities of lecturers to generate data for satisfying Objective 1. Mean score was also used for the analysis of intensity of workspace utilization in the three universities. ANOVA, Kruskal Wallis test,Wilcoxon Signed Rank Test (WSRT) and Mann Whitney Utest were used to test hypotheses in respect of Objectives 1, 2, and 3. For example, Wilcoxin Signed Rank Test was used to test ifthere is no significant difference between the parameters of IEQ adjudged satisfactory and those adjudged unsatisfactory by respondents. Paired samples t-test was used to test if there is any significant difference between measured IEQ parameters perceived as satisfactory and unsatisfactory by lecturers. Measurements were taken on temperature, humidity, acoustics, airflow and lighting as IEQ parameters.

Mean score was used to assess and rank the maintenance tasks. Spearman rho correlation was employed in determining the relationship between maintenance practice and lecturers' satisfaction with IEQ. Spearman correlation was also used to determine relationship between workspace utilisation and lecturers'satisfaction with IEQ. Proportional odds Ordinal Logistic Regression (OLR) was employedininvestigating relationship between lecturers' satisfaction as dependent variable and the five predictor variables. Deduced OLR models in respect of qualitative and objective assessments were presented in the form of Odds ratios with Confidence intervals at 95%. A Wald test was also used to determine the statistical significance of each predictor variable in the regression models.

3.12 Definition and Measurement of Research Variables

The six variables of the study are predominantly ordinal but contain some nominal values on lecturers' and workspace characteristics. IEQ parametersmeasured with instruments were recorded in appropriate units as numerical continuous data.

3.12.1 General Information

V1. Respondents' institution: Respondents were asked to state the formal name of the institution in which they work.

V2: Location of institution. Respondents were asked to state the town and state in which the institution they work is located.

V3: Ownership of institution. This variable is meant to determine if the respondents 'institution is Federal (1) or State-owned (2).

V4: Gender: This determines the number of males and females in the sample. Male was coded 1 while female was coded 2.

V5: Age: This determines the age bracket within which respondents fell as at last birthday as: Less than 21years-1; 21-30years-2; 31-40years-3; 41-50years-4; 51-60years-5; above 60years-6.

V6: Employment status: Employment status: Graduate Assistant, Assistant Lecturer, Lecturer II, Lecturer I, Senior Lecturer, Associate Professor and Professor were assigned 1, 2, 3, 4, 5, 6 and 7 respectively.

V7: Faculty within which respondent was working: This indicates the faculty, school or college in which the respondent was working.

V8: Department: Department in a faculty within which respondent was working.

V9: Nature of employment: This was categorised and assigned values as Permanent/Tenure-1; Contract-2; Part-time-3; Others-4.

V10: Profession/Area of specialisation: Respondents were asked to state their area of specialisation in academics.

V11: Highest academic qualification: This was assigned value as follows: BSc/BA-1; MSc/MA-2; PhD-3; Others-4.

V12: Membership of professional body: Graduate-1; Associate-2; Corporate-3; Fellow-4.

V13: Physical challenges: Hearing-1; Sighting-2; Walking-3; Writing-4; Smelling-5; Talking-6; Feeling-7; Others-8.

V14: Work experience: 1-5years-1; 6-10years-2; 11-15years-3; 16-20years-4; above 20years-5.

V15: Tenure in present job: 1-5years-1; 6-10years-2; 11-15years-3; 16-20years-4; above 20years-5.

V16: Tenure in workspace: 1 -5years-1; 6-10years-2; 11-15years-3; 16-20years-4; above 20years-5

V17: Type of building: Bungalow-1; One-storey-2; Two-storey-3; more than two-stories-4

V18: Floor level: Ground floor-1; 1st floor-2; 2nd floor-3; other floors-4.

V19: Direction faced by external window: North-1; South-2; West-3; East-4.

V20: Distance from views: Less than 3.7m-1; more than 3.7m-2; not applicable-3.

V21: Description of workspace: Single occupant enclosed office-1; Shared office-2; Cubicle with high partition-3; Cubicle with low partition-4; Open office-5; Others-6.

V22: Type of conditioning: Passive/Natural-1; Active/Mechanical-2; Mixed-mode-3.

V23: Comfort required in workspace: Physical-1; Functional-2; Psychological-3; Social-3.

V24: Reasons for doing work elsewhere: Distractions-1; Remoteness-2; Poor IEQ; Unstable power supply-3; Poor internet service-4; Others-5.

V25: Preferred/Alternative workspace: Home-1; University library-2; Faculty library-3; Laboratory-4; Privately owned office-5; Others-6.

V26: Workspace utilisation: Product of workspace capacity utilisation and frequency of use translate to intensity of workspace utilisation. Thirteen activities of lecturers were identified for assessment. Each activity was assigned a value on capacity utilisation and frequency of use as: Extremely high-7; Very high-6; High-5; Moderate-4; Low-3; Very low-2; Extremely low-1.

V27: Satisfactory and Unsatisfactory IEQ in workspace: Thirteen IEQ parameters were assigned values for assessment of respondents as: Extremely high-7; Very high-6; High-5; Moderate-4; Low-3; Very low-2; Extremely low-1.

V28: Maintenance practice: Six major maintenance management tasks/processes having 78 subsets were assigned values as: Never-1; Rarely-2; Sometimes-3; Often-4; Very often-5.

V29: Satisfaction with IEQ: Lecturers' satisfaction with IEQ in workspace was measured based on seven IEQ parameters which were assigned values of: Extremely satisfied-7; Highly satisfied-6; Satisfied-5; Indifferent-4; Dissatisfied-3; Highly dissatisfied-2; Extremely dissatisfied-1.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Introduction

In this chapter, analysis of data collected from the field and discussion of findings are presented. Characteristics of respondents and their workspaces are presented in the first part. The remaining parts contain analysis of data in respect of objectives of the study in chronological order. The results of the tests of the hypotheses of the study are also reported in this chapter.

4.2 Characteristics of Respondents

Descriptive statistics on respondents is important because their satisfaction is the focus of this study.Analysis of the data collected on characteristics as presented on Table 4.1 was particularly useful in satisfying Objective three.

The majority (92.3%) of the respondents is male, while female (7.7%) constituted minority. 33% were within the Age bracket of 41-50 years, 30% in 31-40 years, 23% in 51-60 years, 9% in 21-30 years and 5% in 60 years and above.The respondents are distributed among the existing cadres of lecturers in the universities namely: Graduate Assistant (GA), Assistant Lecturer (AL), Lecturer 2 (L2), Lecturer 1 (L1), etc.The respondents were classified into three as GA and AL, LII and LI and, SL and above. The results show that 45 % were in employment as LII and LI, 31% as SL and above while 24% were in GA and AL. 96% were on Tenure appointment while 4% were on Contract/Visiting appointment. Ph.D and Master’s degree were held as highest academic qualifications by 47% and 44%, respectively.In terms of professional status, 38% of the respondents were Associates, 35% were Corporate, 15% were Graduate members and 10% were Fellows.

Table 4.1: Descriptive data on characteristics of respondents

Characteristics		Number	Percentage (%)
Gender	Male	156	92.30
	Female	13	7.70
	Total	169	100.00
Age	21-30 years	15	8.90
	31-40 years	51	30.20
	41-50 years	56	33.10
	51-60 years	38	22.50
	>60 years	9	5.30
	Total	169	100.00
Employment status	G.A. and A. L	41	24.26
	L II and LI	76	44.97
	S. L and above	52	30.77
	Total	169	100.00
Nature of Employment	Tenure	162	95.86
	Contract	6	3.54
	Others	1	0.60
	Total	169	100.00
Highest academic qualification	Bachelor's degree	15	8.88
	Master's degree	75	44.37
	Ph.D	79	46.75
	Total	169	100.00
Professional status	Graduate	25	14.79
	Associate	64	37.87
	Corporate	59	34.91
	Fellow	17	10.06
	Others	4	2.37
	Total	169	100.00
Physical challenge	Sighting	7	4.14
	Walking	1	0.59
	Writing	1	0.59
	Smelling	10	5.92
	Not affected	150	88.76
	Total	169	100.00
Period spent in workspace	1-5 years	125	73.96
	6-10 years	25	14.79
	11-15 years	9	5.33
	16-20 years	6	3.55
	>20 years	4	2.37
	Total	169	100.00

Only 11% of the 169 lecturers had physical challenges in sighting, walking, writing and smelling.Periods spent in allocated workspaces by respondents were 1-5 years by 74% (the majority), 6-10 years by 15%, 11-15 years 5%, 16-20 years 4% and above 20 years by 2%.

4.3 Characteristics of Workspaces

Workspaces for universities lecturers in the study area contain tables, chairs for lecturers and their guests, book shelves, file cabinets, computer and its accessories, bulletin board, refrigerator, etc. Installations for conditioning lecturers' workspaces include fans, air conditioners, electrical lighting and power sources, floor carpet, curtains, etc. These and other facilities are installed to create comfort for lecturers in executing assigned duties. In Table 4.2 are results of analysis of subjective data on characteristics of lecturers' workspaces in the three selected universities within the study area.

Table 4.2: Characteristics of Workspaces as perceived by respondents (Subjective data)

Characteristics		Number	Percentage (%)
Type of building	Bungalow	45	26.60
	One-storey	50	29.60
	Two-stories	60	35.60
	>Two stories	14	8.20
	Total	169	100.00
Floor level	Ground floor	83	49.10
	1st floor	46	27.20
	2nd floor	38	22.50
	Above 2nd floor	2	1.20
	Total	169	100.00
Direction faced by window	North	50	29.60
	South	40	23.70
	West	31	18.30
	East	48	28.40
	Total	169	100.00
Proximity to external environment	<3.7m	136	80.50
	>3.7m	10	5.90
	Not applicable	23	13.60
	Total	169	100.00
Type of workspace	Enclosed single user	56	33.10
	Enclosed shared	77	45.65
	Cubicle with high partition	10	5.90
	Cubicle with low partition	5	3.00
	Open office	21	12.35
	Total	169	100.00
Workspace Environmental Conditioning	Passive (Natural)	28	16.46
	Active (Mechanical)	44	26.22
	Mixed-Mode	97	57.32
	Total	169	100.00

The characteristics of 169 sample workspaces in Table 4.2 indicate adequate distribution within five types of office buildings namely: bungalow, one-storey, two-stories and above two-stories.The results indicate that 36% of the workspaces were in two-storey buildings, 30% in one-storey building 27% in bungalow and 8% in above two stories.49% of the workspaces were found in Ground floor, 27% in First floor, 23% in Second floor and 1% in higher than Second floor.

Locations of windows in cardinal directions and proximity to workspace affect IEQ in terms of day lighting, air flow and acoustics.Directions faced by windows were North (30%), East (28%), South (24%) and West (18%).The depth of any office containing more than two workspaces affects proximity to external environment but in this study 80% of workspaces were suitably located at less than 3.7m.Types of office workspaces were 46% shared and enclosed, 33% enclosed with single occupant-user, 12% open office with many users, 6% cubicle with high partition and 3% cubicle with low partition respectively.Environmental conditioning of the workspaces was in three modes namely: Passive, Active and Mixed- Mode. Fifty percent (57%) of the workspaces were in Mixed-Mode, 25% in Active while 16% were in Passive.

4.3.1 Characteristics of Workspaces Sampled for Measurement of IEQ Parameters

Objective data on 43 workspaces sampled for measurement of five IEQ parameters (Temperature, Humidity, Acoustics, Air-flow and Lighting) are presented in Table 4.3.

Table 4.3: Descriptive data on workspaces sampled for measurement of IEQ parameters (Objective data)

S/No.	Floor level	Floor area (m^2)	Users	Floor area/user	Status of Users	No. of doors	Size of Door(m)	No. of windows	Size of windows (m^2)	Window/floor ratio
1	1st	23.10	2	11.55	LI	1	0.9 X 1.20	5	3.24	0.14
2	1st	23.10	2	11.55	L I & L II	1	0.9 X 1.20	5	3.24	0.14
3	1st	23.10	2	11.55	L I	1	0.9 X 1.20	5	3.24	0.14
4	1st	23.10	2	11.55	L I & AL	1	0.9 X 1.20	5	3.24	0.14
5	Grd. Flr	23.10	3	7.70	L I	1	0.9 X 1.20	5	3.24	0.14
6	Grd. Flr	23.10	4	5.77	L I & AL	1	0.9 X 1.20	5	3.24	0.14
7	Grd. Flr	13.40	2	6.70	S.L	1	0.84 X 1.96	1	5.90	0.44
8	Grd. Flr	18.56	2	9.28	S.L	1	0.71 X 1.98	2	4.02	0.22
9	Grd. Flr	18.00	3	6.00	S.L	2	0.76 X 1.99	3	4.01	0.22
10	Grdflr	16.46	1	16.46	Prof.	1	1.64 X 0.82	3	3.15	0.19
11	Grd. Flr	16.50	2	8.25	L I & L II	1	0.9 X 1.20	6	6.84	0.40
12	2ndflr	23.10	3	7.70	G.A	1	0.9 X 1.20	4	5.76	0.25
13	Grdflr	16.46	3	5.48	S.L & L I	1	0.8 X 2.10	2	1.55	0.09
14	Grdflr	13.43	2	6.71	S.L & L I	1	0.8 X 1.96	2	1.55	0.11
15	Grdflr	16.50	2	8.25	S.L	1	1.64 X 0.62	3	3.15	0.19
16	Grdflr	21.35	5	4.27	LII & AL.	1	1.19 X 1.98	2	2.98	0.59
17	1st	16.70	1	16.7	Prof.	1	0.9 X 2.10	2	4.32	0.26
18	2nd	15.89	2	7.95	LI & LII	1	0.84 X 2.00	2	5.29	0.33

Distributions of workspaces sampled for measurement in Table 4.2 reveal 43 workspaces in 18 offices. Eleven offices were located at ground floor, five at first floor and the remaining two at second floor. The offices, having floor area ranging between 13.40 and 23.10m^2, contained majorly two lecturers. Size of workspace per lecturer, based on status, ranged between 4.27 and 16.7m^2. Size of window was 1.55 -6.84m^2 with window to floor area ratio of 0.09 to 0.59. Only one office allocated to a senior lecturer has two doors; the rest offices were having a door each.

4.4WorkspaceUtilisation by Lecturers

The first research objective is to evaluate the intensity of use of office workspaces by lecturers in sampled public universities within North Central geo-political zone of Nigeria. Intensity of workspace utilization is the product of capacity utilization (floor area) and frequency of use of workspace within available official time (period) on each of the identified thirteen (13) academic and social activities. To achieve the objective, the data collected through questionnaire survey on capacity utilization and frequency of use, expressed in percentages, were used to determine intensity of workspace utilization. The results in respect of the three universities combined and each of the universities are presented in Table 4.4. The mean percentage values on capacity, frequency and intensity in respect of each of the thirteen uses of the workspace are also indicated. Overall means in respect of workspace utilization by each university and the three universities combined are included.

The results in Table 4.4 reveal a capacity utilization of 54.69 – 64.09%, frequency of use of 59.08 – 65.76% and intensity of workspace utilization of 30.95-42.13%, in the three universities combined. Specifically, formal reading (42.13%), formal writing (40.94%) and internet surfing (40.19%) ranked 1st, 2nd and 3rdout of the thirteen identified uses of workspaces respectively. The overall intensity of workspace utilization by the three universitiescombined was 37.81%.

In University of Agriculture, Markudi utilisation ranged from 29.5 to 42.68% with formal drawing (42.68%), social interaction (42.68%) and receiving guests (40.01%) ranking 1st, 2nd and 3rd respectively. Federal University of Technology, Minna had utilization of 34.47 to 42.21% with relaxation (42.21%), social interaction (40.71%) and internet surfing (39.24%) ranking 1st, 2nd and 3rd respectively. Utilization in University of Ilorin ranged between 22.42 and 56.24%

with formal reading (56.24%), formal writing (55.32%) and consultation by students (53.47%) in 1st, 2nd and 3rd ranks.

In comparison, University of Ilorin had intensities close to those of the three universities combined in ranks. By percentage mean, University of Ilorin also had higher intensities of workspace utilization than the other two universities and the three universities combined. Based on SMG (2006) classification which gave <25% as poor utilisation, 25–35% as fair and >35% as good, University of Agriculture, Makurdi had good utilisation of workspaces on eight functions and fair utilisation on remaining five functions as indicated in Table 4.3. Federal University of Technology, Minna had good utilisation on ten functions and fair on remaining three. Lastly, University of llorin had good utilisation on nine functions, fair utilisation on two and poor on two functions of the lecturers. It is worthy of note that the intensity of workspace utilisation in the three universities combined agreed with fairly good category of classifications.

Results in Table 4.4 also reveal higher intensity of utilization by University of Ilorin on core academic functions (Formal reading, Formal writing, Internet surfing and Marking scripts) than the other two universities. Utilisation on Formal reading was 56.24% in Ilorin while Makurdi and Minna had 38.03% and 34.47% respectively. On Formal writing and Internet surfing, utilisations were 55.32%, 33.03%, 34.78% and 43.08%, 37.21%, 39.24% in Ilorin, Markurdi and Minna respectively. Consultation by students and Marking scripts followed similar trend as 53.47%, 35.43%, 34.84% and 40.97%, 33.03%, 36.15%. Lecturers in Markurdi and Minna used workspaces more on non-core functions like Social interaction, Reading for leisure, Receiving guests and Relaxation. University of Ilorin is one of Nigeria's second generation conventional universities having larger number of faculties and physical infrastructure than Markurdi and Minna - which are specialised universities. University of Ilorin is also closer to South West geo-political zone where concentration of higher education institutions and enrolment in university education are very high.

Table 4.4: Descriptive statistics on workspace utilisation by lecturers in selected universities

USE OF WORKSPACE	OVERALL (N=169)				MAKURDI (N=33)				MINNA (N=78)				ILORIN (N=58)			
	CU (%)	**FU (%)**	**WSU (%)**	**RANK**	**CU (%)**	**FU (%)**	**WSU (%)**	**RANK**	**CU (%)**	**FU (%)**	**WSU (%)**	**RANK**	**CU (%)**	**FU (%)**	**WSU (%)**	**RANK**
Reading related to assigned duties	64.07	65.76	**42.13**	1	63.20	60.17	**38.03**	6	55.68	61.91	**34.47**	13	75.86	74.13	**56.24**	1
Writing related to assigned duties	63.56	64.41	**40.94**	2	54.11	61.04	**33.03**	9	59.52	58.43	**34.78**	12	74.38	74.38	**55.32**	2
Internet surfing	62.72	64.07	**40.19**	3	64.06	58.09	**37.21**	7	59.52	65.93	**39.24**	3	66.26	65.02	**43.08**	4
Social interaction with colleagues	63.98	62.72	**40.13**	4	67.53	63.20	**42.68**	1	65.38	62.27	**40.71**	2	60.10	63.05	**37.89**	8
Formal meeting with colleagues	63.73	60.44	**38.52**	5	63.20	63.20	**39.94**	4	63.00	56.97	**35.89**	9	65.02	63.55	**41.32**	5
Consultation by students	63.56	64.41	**38.42**	6	59.30	59.74	**35.43**	8	56.78	61.36	**34.84**	11	75.12	71.18	**53.47**	3
Watching television/video	62.46	60.86	**38.01**	7	61.04	54.11	**33.03**	9	59.71	64.10	**38.27**	5	66.99	60.35	**40.43**	6
Reading for leisure	62.05	60.52	**37.55**	8	64.06	61.04	**39.10**	5	63.00	61.17	**38.54**	4	59.61	59.36	**35.39**	9
Marking students scripts/assignments	59.93	62.05	**37.19**	9	54.11	61.04	**33.03**	9	57.88	62.45	**36.15**	8	66.01	62.07	**40.97**	7
Drawing (formal)	60.18	60.27	**36.27**	10	67.53	63.20	**42.68**	1	58.24	62.45	**36.37**	7	58.62	55.67	**32.63**	10
Receiving guests (unofficial)	56.55	62.13	**35.14**	11	58.87	67.97	**40.01**	3	57.88	65.57	**37.95**	6	53.45	54.19	**28.97**	11
Relaxation	54.69	59.08	**32.31**	12	53.24	55.41	**29.50**	13	62.64	67.39	**42.21**	1	44.83	50.00	**<u>22.42</u>**	13
Eating	57.48	53.85	**<u>30.95</u>**	13	61.04	55.84	**<u>34.09</u>**	12	63.19	56.41	**<u>35.65</u>**	10	47.78	49.26	**23.54**	12
Overall Mean			**37.81**				**36.75**				**37.31**				**39.36**	

Note: CU = Capacity Utilisation; FU = Frequency of Use;

WSU = Workspace Utilisation (CU X FU/100)

4.4.1 Research Hypothesis One

Hypothesis one as re-stated below addresses the difference in intensity of workspace utilisation by lecturers in universities within the study area. Analysis of Variance (ANOVA) on overall utilisation and Kruskal Wallis test on specific use of workspaces are the statistical tools used for testing the hypotheses.The rule for accepting or rejecting either of the hypothesis is based on F statistic and the p-value.

Null Hypothesis (H_0)

There is no significant difference between intensities of workspace utilization by lecturers in universities in the study area.

Alternative Hypothesis (H_1)

There is significant difference between intensities of workspace utilization by lecturers in universities in the study area.

4.4.1.1 Test of Difference by ANOVA on Intensity of Workspace Utilization

A one-way Analysis of Variance (ANOVA) was conducted to explore the difference in intensities of workspace utilisation amongst the three universities - Federal University of Technology, Minna, University of Ilorin, Ilorin and University of Agriculture, Makurdi. As the result in Table 4.5 shows, there was no significant difference at the $p < 0.05$ level in the intensities of workspace utilisation by the three universities: $F(2, 36) = 0.507$, $p = 0.607$. The mean scores of Uni-makurdi (M=36.75, SD=4.09); FUT Minna (M=37.31, SD= 2.41) and Unilorin (M= 39.36, SD=11.06) did not differ from one another. Null hypothesis which states that there is no significant difference between intensities of workspace utilization by lecturers in the three universities was therefore accepted.

Table 4.5: Result of test of difference by ANOVA on intensity of workspace utilization

Parameter	NO.	Mean	Source of variation	Sum of Squares	Df	Mean Square	F	p-value
Workspace Utilisation								
Unimakurdi	33	36.75	Between Groups	48.997	2	24.499	0.507	0.607
Futminna	78	37.31	Within Groups	1739.677	36	48.324		
Unillorin	58	39.36						
Total	169			1788.674	38			

Peculiarities of the universities in terms of mandate could be responsible for the differences in intensities of workspace utilization by lecturers. University of Ilorin is conventional, Makurdi is specialized in agriculture while Minna is into technology.

4.4.1.2 Kruskal-Wallis Test on Difference on Specific Use of Workspace

Kruskal Wallis test was conducted to determine if significant differences exist in intensities of workspace utilization, amongst the three universities, on each of the thirteen uses of workspace by lecturers. Result of analysis of subjective data on workspace utilization by the three universities is in Table 4.6

As indicated in Table 4.6, there was significant difference at the $p < 0.05$ level, in intensity of workspace utilization on formal reading, formal writing, consultation (by students), formal meeting with colleagues, watching television/video, eating, receiving guests unofficially and relaxation. However, there was no significant difference in the intensity of workspace utilizationin five uses namely: reading for leisure, drawing (formal), marking scripts, social interaction with colleagues and internet surfing. An inspection of the mean ranks for the groups suggest that Unillorin, the oldest and largest university, had the highest optimum scores on formal reading, formal writing, consultation by students, formal meeting with colleagues marking scripts, internet surfing and watching television.

Table1 4.6: Kruskal-Wallis Test results on difference in workspace utilization

Use of Workspace	Universities	N	Mean	$\chi 2$	df	p-value	Difference
Reading related to assigned duties	Unilorin	58	113.86				
	Makurdi	33	76.21				
	FUT,Minna	78	67.26	31.62	2	0.000	Significant
Reading for leisure	Unilorin	58	85.43				
	Makurdi	33	87.20				
	FUT,Minna	78	83.75	0.12	2	0.941	Not Significant
Writing related to assigned duties	Unilorin	58	113.94				
	Makurdi	33	68.86				
	FUT,Minna	78	70.31	30.99	2	0.000	Significant
Drawing (Formal)	Unilorin	58	82.05				
	Makurdi	33	93.70				
	FUT,Minna	78	83.51	1.33	2	0.515	Not Significant
Consultation by students	Unilorin	58	109.59				
	Makurdi	33	73.48				
	FUT,Minna	78	71.58	22.41	2	0.000	Significant
	Unilorin	58	95.00				
Formal meeting with colleagues	Makurdi	33	90.15				
	FUT,Minna	78	75.38	5.84	2	0.047	Significant
Marking scripts	Unilorin	58	94.85				
	Makurdi	33	74.30				
	FUT,Minna	78	82.20	4.20	2	0.122	Not Significant
Social interaction with colleagues	Unilorin	58	82.91				
	Makurdi	33	87.56				
	FUT,Minna	78	85.47	0.20	2	0.903	Not Significant
Internet surfing	Unilorin	58	94.24				
	Makurdi	33	77.80				
	FUT,Minna	78	81.17	3.27	2	0.195	Not Significant
Watching television	Unilorin	58	91.60				
	Makurdi	33	67.09				
	FUT,Minna	78	87.67	5.73	2	0.048	Significant
Eating	Unilorin	58	72.72				
	Makurdi	33	90.00				
	FUT,Minna	78	92.02	5.62	2	0.049	Significant
Receiving guests (Unofficial)	Unilorin	58	72.82				
	Makurdi	33	94.82				
	FUT,Minna	78	89.90	5.74	2	0.046	Significant
Relaxation	Unilorin	58	61.28				
	Makurdi	33	75.80				
	FUT,Minna	78	106.53	30.02	2	0.000	Significant

On the other hand, Unimakurdi had on reading for leisure, formal drawing, social interaction with colleagues and receiving guests unofficially. Highest optimum score on eating and relaxation were recorded on FUTMinna. This result has corroborated result of analysis in Table 4.4 which ranked Unillorin highest on use of workspace for core academic functions. Remoteness and lack of adequate housing for lecturers in Unimakurdi and FUTMinna may be responsible for the suboptimal use of workspace for academic functions.

4.5 Comparison of IEQ Parameters Adjudged Satisfactory and Unsatisfactory

The second objective of the study is to assess lecturers' perception of IEQ parameters adjudged satisfactory and unsatisfactory.Subjective data from questionnaire survey and objective data from physical measurements were analysed using Mean Scores, Mann-Whitney U and Kruskal Wallis non-parametric tests and paired samples t-test respectively. The results of analysis are in Tables 4.7, 4.8, 4.9, 4.10 and 4.11

Table 4.7: Ranked means of Perceived IEQ parameters adjudged satisfactory and unsatisfactory

IEQ Parameter	Satisfactory			Unsatisfactory		
	MS	**SD**	**Rank**	**MS**	**SD**	**Rank**
Building integrity	5.83	1.13	1	4.32	1.16	4
Control facilities	5.47	1.18	2	4.18	1.37	5
Size of workspace	5.46	1.30	3	4.85	1.21	1
Conditioning facilities	5.37	1.22	4	4.06	1.31	6
Proximity to external window	5.36	1.20	5	4.38	1.32	3
Accessibility	5.28	1.28	6	4.77	1.07	2
Ease of interaction	5.23	1.26	7	3.85	1.46	11
Space layout	5.30	1.35	8	3.92	1.41	10
Furniture	5.13	1.28	9	3.93	1.31	9
Ventilation (Air-flow)	4.30	1.26	10	4.03	1.13	8
Indoor Air Quality (IAQ)	3.55	1.52	11	3.67	1.33	12
Acoustic quality	3.50	1.74	12	4.04	1.42	7
Thermal Quality	3.16	1.59	13	3.21	1.27	13

MS= Mean Score, SD= Standard Deviation

Table 4.7 indicates ranked mean scores of IEQ parameters adjudged satisfactory and unsatisfactory by lecturers in the study area. Building integrity (MS=5.83), Control facilities (MS=5.47) and Size of workspace (MS=5.46) ranked 1st, 2nd and 3rd as in respect of satisfactory.Level of satisfaction of lectures was very high by this result. Lecturers were highly dissatisfied with Size of workspace (MS=4.85) and Accessibility (MS=4.77) but moderately dissatisfied with Proximity to external environment (MS=4.38) an unsatisfactory parameters ranked similarly were Size of workspace (MS=4.85). Means scores of satisfactory IEQ parameters are generally higher than those perceived unsatisfactory.

Descriptive statistics on measurements of temperature, humidity, acoustics, lighting and air-flow in 43 sampled workspaces are presented in Table 4.8. Mean scores of satisfactory readings were highlighted for comparison with CIBSE benchmarks. Mean scores of satisfactory temperature and acoustic were higher than the maximum specified by CIBSE while humidity, air-flow and lighting were lower.

CIBSE's benchmark on temperature is 21- 23^{o}C, ASHRAE's is 24-28^{o}C while the design value for offices is 25^{o}C. Result of 22.5-56.8^{o}C obtained in this study has not met the aforementioned thresholds, particularly on maximum temperature in office workspace. Benchmarks on humidity are CIBSE's 40-70% and ASHRAE's 20-70% while 19.5-94.8% was recorded in this study.Maximum benchmark of 70% was exceeded by 35% on humidity. Percentage difference on each of the measured IEQ parameters and the respective CIBSE benchmarks are shown in Table 4.9. Wong, Mui and Hui (2007) did similar study in Hong Kong and obtained 18-25^{0}C, 45-72dBA and 200-1600lux on temperature, acoustics and lighting respectively. There is difference in expectations between tropical and temperate countries on comfort. For example, Nicol and Humphreys deduced from field studies carried out in the United Kingdom, India, Iraq and Singapore that temperatures well above 30^{0}C were taken as comfortable in certain locations (Liping & Hien, 2007).

Table 4.8: Descriptive statistics on measured IEQ parameters

Parameter	No.	Total Score	Mean Score	Standard Deviation	Range	CIBSE Benchmarks
Temperature (ºC)						
Satisfactory	148	4,450.51	**30.07**	3.45	22.50- 56.80	
Indifferent	257	7,602.96	29.58	2.28	22.35- 35.25	
Unsatisfactory	205	6,070.25	29.61	2.31	22.50- 37.00	21 - 23ºC
Total	610					
Humidity (%)						
Satisfactory	120	7,133.16	**59.44**	17.47	19.50- 94.80	
Indifferent	284	17.024.28	59.94	14.82	21.55- 91.25	
Unsatisfactory	227	13,496.20	59.45	14.20	27.95- 94.80	40 - 70%
Total	631					
Acoustic (dBA)						
Satisfactory	90	5,739.54	**63.77**	9.61	42.10- 88.90	
Indifferent	288	18,051.65	62.68	9.49	26.65- 88.90	
Unsatisfactory	251	14,496.18	61.73	9.65	27.30- 86.25	30 - 35 dBA
Total	629					
Air Flow (m/s)						
Satisfactory	131	36.70	**0.28**	0.86	0.00- 4.20	
Indifferent	120	27.40	0.23	0.81	0.00- 7.00	
Unsatisfactory	215	85.60	0.39	1.37	0.00- 9.00	0.10 - 0.30m/s
Total	466					
Lighting (Lux)						
Satisfactory	102	21.132.00	**207.17**	193.17	12.00- 915.00	
Indifferent	318	47,844.80	150.45	165.95	9.90- 950.00	
Unsatisfactory	210	47,260.20	225.05	206.09	1.80- 961.00	500 Lux
Total	630					

Similar study carried out on hospital buildings in Jos by Nimlyal, Kandar and Sediadi (2015) revealed ranges in readings of temperature, humidity, sound and lighting as 29.25–35.25^{0}C, 56.45–65.75%, 65.48 –75.73dBA and 215.6 –399.2lux respectively.

Table 4.9: Differences between measured IEQ parameters and CIBSE benchmarks

IEQ parameter	Reading		CIBSE Benchmark		Percentage Difference	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Temperature - ^{0}C	22.50	56.80	21	23	7.00	147.00
Humidity - %	19.50	94.80	40	70	-51.25	35.00
Acoustics - dBA	42.10	88.90	30	35	40.33	154.00
Airflow - m/s	0.00	4.20	0.1	0.3	100.00	1,300.00
Lighting – lux	12.00	915	-	500	N/A	83.00

CIBSE: Chartered Institution of Building Services Engineers

Mean scores of readings on Temperature, Humidity, Acoustic, Air flow and Lighting were compared with CIBSE Benchmarks. The differences, expressed in percentages on minimum and maximum readings/benchmarks are shown in Table 4.8. The differences on minimum and maximum are: Temperature (7%; 147%), Humidity (-51.25%; 35%), Acoustic (40.33; 154), Airflow (100%; 1,300%) and Lighting (N/A; 83%).

4.5.1 Research Hypothesis Two

Hypothesis formulated to satisfy objective two is tested in this section. Qualitative and quantitative data from questionnaire survey and measurement with instruments were analysed using Wilcoxon Signed Ranks Test (WSRT) and Paired samples t-test as statistical tools respectively.Acceptance and rejection of hypotheses were based on p-values generated by analysis.The research hypotheses are:

Null Hypothesis (H_0)

There is no significant difference between preceived IEQ parameters adjudged satisfactory and unsatisfactory by lecturers.

Alternative Hypothesis (H_1)

There is significant difference between perceived IEQ parameters adjudged satisfactory and unsatisfactory by lecturers.

4.5.1.1Wilcoxon Signed Rank Test (WRST) on difference in IEQ parameters

Wilcoxon Signed Ranks Test (WSRT) was conducted to assess the difference between IEQ parameters adjudged satisfactory and unsatisfactory by lecturers using subjective data.

Table 4.10: Wilcoxon Signed Rank Test results on difference in IEQ parameters adjudged satisfactory and unsatisfactory by respondents

IEQ Parameter	z-value	p-value	Difference
Acoustic Quality	-2.008	0.045	Significant
Indoor Air Quality (IAQ)	-1.232	0.218	Not Significant
Thermal Quality	-0.837	0.403	Not Significant
Air Flow (Ventilation)	-5.474	<0.0001	Significant
Furniture	-7.073	<0.0001	Significant
Space Layout	-7.526	<0.0001	Significant
Size of Workspace	-7.595	<0.0001	Significant
Installed Conditioning Facilities	-7.165	<0.0001	Significant
Lighting (Illumination)	-.650	<0.0001	Significant
Ease of Interaction	-4.074	<0.0001	Significant
Accessibility	-8.121	<0.0001	Significant
Building Integrity	-8.144	<0.0001	Significant
Environmental Control Facilities	-8.202	<0.0001	Significant
Proximity to External Window or Wall for Viewing	-7.754	<0.0001	Significant

Result of analysis in Table 4.10 shows two out of the parameters had p-value greater than 0.05 which implies acceptance of null hypothesis and lack of statistically significant difference between satisfactory and unsatisfactory IEQ parameter. Thus, there was no significant difference on indoor air quality z (-1.232), p = 0.218 and thermal quality z (-0.837), p = 0.403. There was, however, significant difference in respect of acoustic quality z (-2.008), p =0.045, air-flow z (-5.474), p <0.0001, furniture z (-7.073), p <0.0001, space layout z (-7.526), p <0.0001, size of workspace z (-7.595), p<0.0001, installed conditioning z (-7.165), p<0.0001, lighting z (-7.650), p<0.0001, ease of interaction z (-4.074), p<0.0001, accessibility z (-8.121), p<0.0001, building integrity z (-8.144), p<0.0001, control facilities z (-8.202), p<0.0001, and proximity to external window z (-7.754), p<0.0001.

Descriptive data on 18 sampled offices containing 43 workspaces of lecturers are in Table 4.3. Instruments were used to measure five IEQ parameters (Temperature, Humidity, Acoustics, Lighting and Air-flow) in the workspaces. Lecturers were mainly male (95%) with size of their workspaces varied between 4.27 and 11.55 m2. All the workspaces were contained in enclosure of block work and provided with doors and windows as indicated in the table. It is worthy of note that the window to floor ratio ranged between 0.11 and 0.59.

4.5.1.2 Paired Samplest-test on difference between Measured IEQ Parameters in Workspaces

Paired samples t-test was conducted to assess the difference between IEQ parameters adjudged satisfactory and unsatisfactory by lecturers using objective data (measurement).

Results of paired samples t-test in Table 4.11 indicate that statistically significant difference did not exist between satisfactory and unsatisfactory measured IEQ parameters namely: Temperature, Humidity, Acoustics, Air-flow and Lighting. This is because p-value on each parameter is greater than 0.05. The significant (2-tailed) value (0.683) on all the five parameters combined (i.e general) was also above the required cut-off of 0.05, which interprets to lack of statistically significant difference between the measured satisfactory and unsatisfactory IEQ parameters in sampled workspaces of lecturers.Eta squared gave the magnitude of the differences as less than 1% generally. This result could be attributed to lack of thresholds on IEQ parameters in Nigeria.

Table 4.11: Result of t-test on difference between measured IEQ parameters in lecturers' workspaces

Parameters paired Difference	*N	Mean	S.D	t-value	DF	p-value	
Temperature (^{0}C)							
Satisfactory	205	29.61	2.31	-1.501	351	0.134	Not Significant
Unsatisfactory	148	30.07	3.45				
Humidity (%)							
Satisfactory	227	59.46	14.20	0.011	344	0.992	Not Significant
Unsatisfactory	119	59.44	17.54				
Acoustic (dBA)							
Satisfactory	252	61.73	9.63	-1.720	339	0.086	Not Significant
Unsatisfactory	89	157.29	88				
Airflow (m/s)							
Satisfactory	214	0.40	1.370	0.897	343	0.370	Not Significant
Unsatisfactory	131	0.28	0.865				
Lighting (Lux)							
Satisfactory	210	225.05	206.09	0.733	310	0.464	Not Significant
Unsatisfactory	102	207.18	193.18				
Overall							
Satisfactory	1108	74.43	117.90	-0.409	1695	0.683	Not Significant
Unsatisfactory	589	79.27	359.58				

***N = Number of Readings**

4.6 Effects of Lecturers' Characteristics and Workspace Characteristics on Lecturers' Satisfaction with IEQ

This section addresses objective three. Descriptive data on lecturers' and workspace characteristics in Tables 4.1 and 4.2 and perceived IEQ adjudged satisfactory in Table 4.7were used to investigate. Mann-Whitney U and Kruskal Wallis non-parametric tests are the statistical tools employed.

4.6.1 Hypothesis Three

Null Hypothesis (H_0)

There is no significant difference in lecturers' satisfaction with IEQ on the basis of lecturers' characteristics

Alternative Hypothesis (H_1)

There is significant difference in lecturers' satisfaction with IEQ on the basis of lecturers' characteristics.

4.6.1.1 Test of Difference in Satisfaction with IEQ on the Basis of Lecturers' Characteristics

Mann-Whitney U and Kruskal Wallis tests were conducted to assess the difference in satisfaction with IEQ parameters based on lecturers' characteristics using subjective data. Statistically significant difference is established on any IEQ parameter having p-value less than 0.05.

Table 4.12: **Results ofMann-Whitney U andKruskal Wallis tests on Difference in satisfaction with IEQ on the basis of lecturers' characteristics**

Lecturers' Characteristics		IEQ parameters	N	Mean	χ2	Df	p-value	Difference
Gender	Male	Acoustic quality (Noise)	156	87.67				
	Female		13	53.00	598.00	1	0.010	*Significant
	Male	Visual comfort	156	87.34				
	Female		13	56.92	649.00	1	0.021	Significant
	Male	Indoor Air Quality (IAQ)	156	87.36				
	Female		13	56.65	645.00	1	0.013	Significant
	Male	Ventilation (Airflow)	156	86.93				
	Female		13	61.81	712.50	1	0.048	Significant
	Male	General Cleanliness	156	87.24				
	Female		13	58.12	664.50	1	0.029	Significant
Age	21 - 30 years	Size of workspace	15	56.93				
	31 - 40 years		51	69.81				
	41 - 50 years		58	89.22				
	> 50 years		38	91.29	12.01	3	0.007	Significant
	21 - 30 years	Acoustic quality (Noise)	15	80.17				
	31 - 40 years		51	62.48				
	41 - 50 years		58	84.59				
	> 50 years		38	98.79	15.28	3	0.002	Significant
	21 - 30 years	Adjustability of furniture	15	73.73				
	31 - 40 years		51	67.88				
	41 - 50 years		58	85.23				
	> 50 years		38	93.13	8.09	3	0.044	Significant
Qualification	B.Sc.	Acoustic quality (Noise)	15	65.97				
	M.Sc.		51	75.51				
	Ph.D.		58	96.20				
	Others		38	132.00	11.98	3	0.007	Significant
Tenure in Workspace	1 - 5 years	Acoustic quality (Noise)	60	72.67				
	6 - 10 years		43	85.23				
	11 - 15 years		23	76.09				
	16 - 20 years		13	100.62				
	> 20 years		28	105.18	11.83	4	0.019	Significant
	1 - 5 years	Adjustability of furniture	60	72.01				
	6 - 10 years		43	89.12				
	11 - 15 years		23	74.89				
	16 - 20 years		13	103.50				
	> 20 years		28	100.27	11.16	4	0.025	Significant

*Significant at $p < 0.05$

The results of the tests in Table 4.12 indicate statistically significant difference at $p < 0.05$ in lecturers' satisfaction with five measured IEQ parameters on the basis of lecturers' characteristics. Alternative hypothesis which states that there is significant difference in lecturers' satisfaction with IEQ on the basis of lecturers' characteristics is therefore accepted. With respect to gender, Mann-Whitney U test revealed statistically significant difference in satisfaction with acoustic quality (p= 0.01), visual comfort (p=0.021), indoor air quality (p= 0.013), air-flow (p= 0.048) and general cleanliness (p= 0.029).

On age factor, Kruskal Wallis test revealed statistically significant difference on satisfaction with size and lay-out of workspace (p= 0.007), acoustics (p= 0.002) and adjustability of furniture (p= 0.044).In thesame vein academic qualification had significant difference on acoustics only (p= 0.007) while there was statistically significant difference in satisfaction with acoustic quality based on tenure spent in workspace by lecturers (p= 0.019) and adjustability of furniture (p= 0.025). The null hypothesis was therefore rejected in respect of the aforementioned relationships. The third research question has therefore been answered with respect to the effects of lecturers' characteristics on satisfaction with IEQ.

4.6.2 Research Hypothesis Four

Null Hypothesis (H_0)

There is no significant difference in lecturers' satisfaction with IEQ on the basis of workspace characteristics.

Alternative Hypothesis (H_1)

There is significant difference in lecturers' satisfaction with IEQ on the basis of workspace characteristics.

4.6.2.1 Differences in Lecturers' Satisfaction with IEQ on the Basis of Workspace Characteristics

Difference in lecturers' satisfaction with IEQ on the basis of workspace characteristics was investigated using Kruskal Wallis non-parametric test. Statistically significant difference was established by determining any IEQ parameter having p-value less than 0.05.

Results of the Kruskal Walis test in Table 4.13 indicate significant difference at $p < 0.05$ in lecturers' satisfaction with perceived IEQ parameters on the basis of workspace characteristics. There was significant difference in satisfaction with size of workspace based on type of building in which workspace is situated. Floor level created significant difference in satisfaction with air-flow, furniture and furnishing and cleaning services. Direction faced by window affected only ease of interaction. Type of office caused significant difference in satisfaction with size of workspace and air-flow.The null hypothesis which states that there is no significant difference in lecturers' satisfaction with IEQ on the basis of workspace characteristics was also rejected by this result. The third research question has also been answered by results of test of hypothesis above – effects of workspace characteristics on satisfaction of lecturers with IEQ.

Table 4.13: Results of Kruskal Wallis test on differences in lecturers' satisfaction with IEQ on the basis of workspace characteristics

Workspace Characteristics	IEQ parameters	N	Mean	χ2	Df	p-value	Difference
Type of building	Size of workspace						
Bungalow		45	71.00				
One-Storey		50	92.28				
Two-Storey		60	82.91				
> Two-Storey		12	103.71	7.60	3	0.046	*Significant
Type of building	Visual Comfort						
Bungalow		45	75.82				
One-Storey		50	88.37				
Two-Storey		60	80.87				
> Two-Storey		12	112.12	6.89	3	0.045	Significant
Floor Level	Ventilation (Air Flow)						
Ground Floor		83	78.77				
First Floor		46	97.40				
Second Floor		38	79.21	5.54	2	0.046	Significant
Floor Level	Furniture and Furnishing						
Ground Floor		83	72.70				
First Floor		46	92.47				
Second Floor		38	98.42	10.34	2	0.002	Significant
Floor Level	Cleaning Service						
Ground Floor		83	75.86				
First Floor		46	90.30				
Second Floor		38	94.16	5.32	2	0.047	Significant
Direction faced by Window	Ease of Interaction						
North		50	92.69				
South		40	69.21				
West		31	89.55				
East		48	87.21	6.92	3	0.045	Significant
Type of Office	Size of Workspace						
Enclosed Office (Single)		56	96.19				
Enclosed Shared		77	79.60				
Cubicle with High Partition		10	79.35				
Cubicle with Low Partition		5	115.10				
Open Office		21	70.48	8.73	4	0.048	Significant
Type of Office	Ventilation (Air Flow)						
Enclosed Office (Single Occupant)		56	100.49				
Enclosed Shared		77	80.53				
Cubicle with High Partition		10	67.20				
Cubicle with Low Partition		5	85.90				
Open Office		21	68.36	11.33	4	0.023	Significant

*Significant at $p < 0.05$

4.7 Relationship between Maintenance Practice and Lecturers' Satisfaction

Objective four and the related research question is addressed in this section through test of the fifth hypothesis. Descriptive statistics on maintenance practice tasks in Table 4.14 and lecturers' satisfaction with perceived IEQ in Table 4.7 were used to investigate relationship between the two variables.The statistical tools used for analysis was Spearman rho correlation. Relationship between the two variables having p-value less than or equal to 0.05 was taken as statistically significant.

Table 4.14: Descriptive statistics on maintenance practice tasks

Maintenance Task/Process	MS	SD	Rank
Top Management Commitment			
Maintenance strategies	4.02	0.83	1
Alignment of maintenance policy with university's mission	3.71	0.91	2
Maintenance objectives	3.66	1.08	3
Maintenance policy/priorities	3.64	0.98	4
Responsibilities/assigned duties	3.28	1.25	5
Maintenance Objectives			
Prevent failure/deterioration	4.04	0.97	1
Health and safety	3.96	0.88	2
Habitability and availability	3.94	0.91	3
Statutory compliance	3.75	0.99	4
Extend life of building	3.73	0.91	5
Recovery from failure	3.65	1.00	6
Maintain value of building	3.55	1.08	7
Update knowledge and skill	3.46	1.09	8
User focused service	3.46	1.09	8
Maintenance Planning			
Classification of building by:			
Occupant/Users' status	3.51	1.29	1
Purpose/Function	3.45	1.08	2
Value	3.34	1.12	3
Age	3.29	1.17	4
Size e.g. floor area	3.00	1.18	5
Faculty/Department	2.98	1.30	6
Priority rating			
Urgent work	3.52	1.18	1
Essential work	3.31	1.12	2
Desirable work	3.23	1.09	3
Basis of priority rating			
Function of building	3.40	1.11	1

Maintenance Task/Process	MS	SD	Rank
Statutory compliance	3.38	1.02	2
Risk associated with failure	3.35	1.23	3
Scope/Cost of defects	3.34	1.10	4
Status of Occupant/User	3.32	1.11	5
Method of data collection on defects			
Safety precautions incorporated in plans	3.83	1.00	1
Inspection by maintenance unit	3.63	1.18	2
Resources are specified in plans	3.54	0.81	3
Complaints from user/occupant	3.53	1.16	4
Condition survey	3.44	1.23	5
Planning based on university's guidelines	3.42	1.16	6
Qualified staff prepare plans	3.34	1.04	7
Short, medium & long-term planning	3.30	1.23	8
Execution time predetermined	3.18	0.99	9
Maintenance Task/Process	**MS**	**SD**	**Rank**
Statutory requirements	3.16	1.05	10
Consultant's report	2.96	1.15	11
Frequency of tasks predetermined	2.83	1.15	12
Organising Maintenance			
Initiation of maintenance work through:			
Centralised maintenance in a unit/dept.	4.19	1.00	1
Functional heads exist on specific aspect	3.73	0.84	1
Adequate provision of resources	3.79	0.94	2
Users' request/report	3.65	0.98	2
Assignment of work to skilled workers	3.58	1.03	3
Committee's report	3.52	1.03	4
Outsourcing of special tasks	3.40	0.92	5
Resources and time are evaluated	3.35	1.04	6
Implementation of plans	3.23	1.28	7
Work order is prepared with details	3.19	1.04	8
Routine inspection	3.15	1.30	9
Work calendar is prepared	3.10	1.08	10
Control of Maintenance Works			
Adequate instructions	3.63	0.89	1
Cost evaluation & budget control	3.48	0.95	2
Involvement of workers in decision making	3.46	0.90	3
Optimisation tools used in decision making	3.30	0.91	4
Health & safety guidelines	3.20	1.09	5
Monitoring response time	3.04	1.01	6
Maintenance manuals	2.96	1.15	7
Supervision of maintenance works			
Labour procurement & monitoring	3.71	0.71	1
Test materials, equipment & facilities	3.61	0.83	2
Equipment & facilities functioning	3.60	0.88	3
Documentation	3.56	1.09	4
Finance resources & tasks	3.55	0.83	5

Maintenance Task/Process	MS	SD	Rank
Material procurement, storage & usage	3.52	1.05	6
Health & safety provisions	3.45	0.85	7
Job analysis	3.43	0.90	8
Technology-e.g. I.C.T	3.35	1.07	9
Driving & tracking performance	3.29	1.06	10
Updating competence-Training	3.24	1.07	11
Recording & analysis of performance	3.20	1.06	12
Users' Role			
Supplying information on performance of building	3.44	1.05	1
Giving necessary support to workers	3.36	1.21	2
Initiating maintenance work	3.24	1.15	3
Inspection of maintenance work	3.10	1.23	4
Feedback on executed work	2.88	1.17	5
Certifying executed work	2.84	1.30	6
Keep & refer to maintenance manual	2.82	1.17	7

In Table 4.14, ranked means of 78 perceived maintenance practice tasks were classified into 6 main groups as top management commitment, maintenance objectives, maintenance planning, organizing maintenance, control of maintenance and users' role. Lecturers' satisfaction with perceived IEQ parameters, are shown in Table 4.7. Maintenance strategies (MS=4.02), alignment of maintenance policy with university mission (MS=3.71) and maintenance objective (MS=3.66) are the top three tasks on top management commitment. These results indicate that top management in the universities studied is more committed to maintenance strategies, alignment of maintenance policy with university mission and maintenance objective. These are the top three tasks of top management commitment.

Maintenance objectives given priority attention by the universities are prevention of failure (MS=4.04), health and safety (MS=3.96) and, habitability and availability (MS=3.94). These three objectives are essential for installing desirable IEQ in workspaces of lecturers. Statutory compliance as maintenance objective was not given priority by respondents because standards and regulations on IEQ have not been established in Nigeria.

On maintenance planning, the universities considered data collection on defects as most important. In specific terms, data collection on required safety precautions (MS=3.83), inspection by maintenance unit (MS=3.63) and specification of resources (MS=3.54) are essential inputs for maintenance planning in the universities.

Maintenance work is organised majorly through centralised decision making (MS=4.19), provision of adequate resources (MS=3.79) and specialist functional heads (MS=3.73). Universities studied do not have the centralised organization based on faculties, maintenance functions and, number or location of buildings. In large universities like University of Ilorin, centralization may affect effectiveness and efficiency of the maintenance unit. Appointment of desk officers in charge of specific units of universities on maintenance functions could be applicable strategy in smaller universities like FUTMinna.

In respect of control of maintenance works, labour procurement and monitoring (MS=3.71), adequate instructions (MS=3.63) and test equipment and facilities (MS=3.61) ranked 1st, 2nd and 3rd in assessment. Control is about specifying standard to be achieved in executing maintenance work and monitoring to ascertain if execution will yield desired result. Testing is to confirm if set standard is achieved during or at completion of maintenance works. The essential components of the control function have been encapsulated in adequate instruction, monitoring and testing in this study.

Users of workspaces (lecturers) are expected to supply of performance data (MS=3.44), give support to workers executing maintenance works (MS=3.36) and initiate maintenance works (MS=3.24). Supply of performance data is required by the maintenance unit for establishing gap between expected and actual performance.Supply of such data by user-lecturer will facilitate inspection, supervision and provision of essential support during execution of maintenance work.

4.7.1 Research Hypothesis Five

Null Hypothesis (H_0): There is no relationship between maintenance practice and lecturers' satisfaction with IEQ.

Alternative Hypothesis (H_1) : There is relationship between maintenance practice and lecturers' satisfaction with IEQ.

4.7.1.1 Test of Relationship between maintenance practice and lecturers' satisfaction

Relationship between maintenance practice and lecturers' satisfaction was investigated using Spearman rho correlation analysis as statistical tool.Relationship having p-value less than or equal to 0.05 was taken as statistically significant.

Table 4.15 contains result of analysis of relationship between maintenance practice and lecturers' satisfaction with IEQ. Maintenance practice contains 78 variables while lecturers' satisfaction with perceived IEQ has 7 variables which translate to 546 relationships. The first column contains maintenance tasks having significant relationships with IEQ parameters. The seven IEQ parameters are at the column heads. The table presents results in matrix format with only 33 statistically significant relationships derived from the analysis indicated in bold.

Top management commitment had significant relationship with size and layout of workspace, acoustic quality, visual quality, furniture and furnishings, as well as cleanliness and maintenance. Maintenance objective had significant relationship with visual quality alone, while maintenance planning had with acoustic quality, visual quality, thermal quality, furniture and furnishings, as well as cleanliness and maintenance. Organising maintenance had significant relationship with each of the seven IEQ parameters while controlling maintenance had with visual quality only.

Table 4.15: Correlation between maintenance practice and lecturers' satisfaction (N=169).

Maintenance practice tasks	Indoor Environmental Quality (IEQ) parameters						
	Size & layout of workspace	**Acoustic quality**	**Visual quality**	**Air quality**	**Thermal quality**	**Furniture & furnishings**	**Cleanliness & maintenance**
Top Management Commitment							
Spearman rho	0.162*	0.184*	0.253**	-	-	0.175*	0.187*
p-value	0.035	0.017	0.001	-	-	0.023	0.015
Maintenance Objectives							
Health and Safety							
Spearman rho	-	-	0.209*	-	-	-	-
p-value	-	-	0.006	-	-	-	-
Maintenance Planning							
Building classification							
Spearman rho	-	-	0.170*	-	-	-	-
p-value	-	-	0.027	-	-	-	-
Priority rating (Urgency)							
Spearman rho	-	0.195*	0.178*	-	0.172*	0.170*	0.203**
p-value	-	0.011	0.020	-	0.025	0.027	0.008
Basis of priority rating							
Spearman Rho	-	-	0.170*	-	-	-	-
p-value	-	-	0.027	-	-	-	-
Data Collection Methods							
Spearman rho	-	0.193*	0..203**	-	-	-	-
p-value	-	0.012	0.008	-	-	-	-
Resource Requirements							
Spearman rho	-	-	0.265**	-	-	-	-
p-value	-	-	0.001	-	-	-	-
Planning by Qualified Staff							
Spearman rho	-	-	0.159*	-	-	-	-
p-value	-	-	0.039	-	-	-	-
Short, Medium & Long Term Plan							
Spearman rho	0.224*		0.155*	0.152*		0.184*	
p-value	0.003		0.044	0.049		0.017	
Organising Maintenance							
Initiation of Maintenance							
Spearman Rho	-	-	0.193*	-	-	-	-
p-value	-	-	0.012	-	-	-	-
Centralised Maintenance							
Spearman rho	0.163*	-	0.162*	-	-	-	0.157*
p-value	0.034	-	0.035	-	-	-	0.042
Specialisation of Unit Heads							
Spearman rho	0.256**	0.173*	0.237**	0.165*	0.250**	0.214**	0.178*
p-value	0.001	0.025	0.002	0.032	0.001	0.005	0.020
Controlling Maintenance							
Supervision							
Spearman rho	-	-	0.160*	-	-	-	-
p-value	-	-	0.037	-	-	-	-

****Correlation is significant at the 0.01 level (2-tailed);*Correlation is significant at the 0.05 level (2-tailed)**

The result has revealed positive but weak relationships between maintenance practice and lecturers' satisfaction with IEQ. Organising maintenance has dominating effect on all the seven IEQ parameters by virtue of specialisation of unit heads. In maintenance planning, the universities gave more attention to acoustic quality, visual quality, thermal quality, furniture and furnishing and, cleanliness and maintenance. Top management of the universities is much more committed to size and layout of workspace, acoustic quality, visual quality, air quality, thermal quality, furniture and furnishing and, cleanliness and maintenance.

Generally maintenance unit in the universities studied gave more attention to visual quality but less to size and layout of workspace, acoustic quality, furniture and furnishing and, cleanliness and maintenance. Least attention is given to air quality and thermal quality.

4.8 Relationship between Workspace Utilisation and Lecturers' Satisfaction with IEQ

Objective five addresses relationship between workspace utilisation and lecturer's satisfaction with IEQ. The relationship was investigated using descriptive statistics on the two variables contained in Tables 4.4 and 4.7. The statistical tool used for analysis was Spearman rho correlation. Relationship between the variables having p-value less than or equal to 0.05 was taken as statistically significant.

4.8.1 Research Hypothesis Six

Null Hypothesis (H_0): There is no significant relationship between workspace utilisation and lecturers' satisfaction with IEQ.

Alternative Hypothesis (H_1): There is significant relationship between workspace utilisation and lecturers' satisfaction with IEQ.

4.8.1.1 Investigation ofrelationship between workspace utilisation and lecturers' satisfaction

Relationship between workspace utilisation and lecturers' satisfaction was investigated using Spearman rho correlation analysis as statistical tool. Relationship having p-value less than or equal to 0.05 was taken as statistically significant.

Table 4.16 contains results of the test of the sixth research hypothesis on relationship between workspace utilisation and lecturers' satisfaction with IEQ. Only six out of the ninety-one relationships investigated were significant at $p \leq 0.05$. Significant relationships were found between formal reading and indoor air quality ($r = 0.1816$; $p=0.0181$), internet surfing and visual quality ($r=0.1892$; $p=0.0138$), internet surfing and air-quality ($r=0.2534$; $p=0.0009$), internet surfing and thermal quality ($r=0.1909$; $p=0.0129$), relaxation and furniture/furnishing ($r=0.1729$; $p=0.0245$) and, relaxation and cleaning/maintenance ($r=0.1567$; $p=0.0419$). All the six significant relationships imply rejection of the null hypothesis albeit they were weak but positive.

By this result, workspace utilisation for internet surfing has been assessed by university lecturers to depend on visual quality, air quality and thermal quality of the indoor work environment. Out of the thirteen uses of workspace identified, internet surfing was considered germane and satisfying demand for commensurate IEQ in this regard will lead to higher productivity. Universities studied therefore need to give appropriate attention to the three IEQ parameters. Relationship established in this study between relaxation in workspace and the two IEQ parameters is an attestation to the inevitable installation of appropriate furniture, furnishings, cleanliness and maintenance for the comfort of lecturers.

Table 4.16: Correlation between workspace utilisation and lecturers' satisfaction

Use of Workspace	Indoor Environmental Quality (IEQ) Parameters						
	Size & Layout of Workspace	Acoustic Quality	Visual Quality	Air Quality	Thermal Quality	Furniture & Furnishings	Cleanliness & Maintenance
Reading (Formal)							
Correlation	0.0763	-0.0135	0.0812	**0.1816**	0.0717	0.0445	0.0730
p-value	0.324	0.861	0.294	**0.018**	0.354	0.565	0.345
Reading for leisure							
Correlation	-0.0999	-0.1247	-0.0556	-0.0579	0.0668	-0.0418	-0.0405
p-value	0.196	0.106	0.473	0.454	0.388	0.589	0.601
Writing (Formal)							
Correlation	0.0418	-0.0031	0.0255	0.0785	-0.0081	-0.0510	-0.0496
p-value	0.589	0.968	0.742	0.310	0.917	0.510	0.522
Drawing (Formal)							
Correlation	-0.1338	-0.1097	-0.0754	0.0659	-0.0395	-0.0659	-0.0111
p-value	0.083	0.156	0.330	0.394	0.610	0.394	0.886
Students' consultation							
Correlation	0.1428	0.0756	0.0624	0.1067	0.0918	0.1226	0.0735
p-value	0.064	0.328	0.420	0.167	0.235	0.112	0.342
Formal meeting							
Correlation	0.0209	0.0398	0.0902	0.0918	0.1295	0.0468	0.0376
p-value	0.788	0.607	0.244	0.235	0.093	0.546	0.627
Marking scripts							
Correlation	0.1504	0.0638	0.1388	0.1226	0.0677	0.0507	0.0449
p-value	0.050	0.410	0.072	0.112	0.382	0.513	0.562
Social interaction							
Correlation	0.0394	0.0309	0.0207	0.0735	0.1338	0.1374	0.094
p-value	0.611	0.690	0.789	0.342	0.083	0.075	0.224
Internet surfing							
Correlation	0.1246	0.0809	**0.1892**	**0.2534**	**0.1909**	0.1414	0.0824
p-value	0.106	0.295	**0.014**	**0.001**	**0.013**	0.067	0.287
Watching Television/Video							
Correlation	0.0227	0.0252	0.0249	0.0715	0.1137	0.0996	0.0566
p-value	0.769	0.7449	0.748	0.355	0.141	0.198	0.465
Eating							
Correlation	-0.1021	-0.0393	-0.0481	-0.1449	-0.1009	0.0113	0.0710
p-value	0.187	0.612	0.578	0.060	0.191	0.885	0.359
Receiving guests							
Correlation	-0.0331	0.0849	0.0622	0.0226	-0.0165	0.0693	0.0031
p-value	0.670	0.272	0.422	0.771	0.832	0.370	0.969
Relaxation							
Correlation	0.0919	0.0655	0.0673	0.0533	0.0806	**0.1729**	**0.1567**
p-value	0.235	0.397	0.385	0.492	0.297	**0.025**	**0.042**

4.9 Predictive Models on Satisfaction of Lecturers with IEQ in Workspaces

In developing predictive models on lecturers' satisfaction with IEQ in workspaces, data from questionnaire survey and measurements of five IEQ parameters were analysed using Ordinal Logistic Regression (OLR). Subjective data on the five predictors were derived from previous analysis: workspace utilisation in Table 4.4, IEQ in Table4.7, lecturers' characteristics in Table 4.1, workspace characteristics in Table 4.2 and maintenance practice in Table 4.14. Summary of objective data from measurement of IEQ parameters are in Table 4.8. Data on the outcome variable(lecturers' satisfaction)which has seven-level measurement from extremely dissatisfied to extremely satisfied are in Table 4.7.

The two categories of data were used in developing three types of predictive models through Ordinal Logistic Regression (OLR). The results of the OLR are presented in the form of Odds Ratios (OR) or exponentiated coefficients, with the Confidence Interval (CI) at 95% level. Parameter estimates table in Appendix VI indicates coefficients (β), standard errors (SE), wald test statistics, p-values, 95% confidence interval of the coefficients and variables which are significant or insignificant statistically.

Wald indicates if the coefficient (β) of a predictor is significantly different fro zero. The predictor is likely making significant contribution to prediction of the outcome (Y) if β is different from zero.

$$\text{Wald} = \frac{\beta}{SE} \text{ ....………………………… } 4.1$$

Odds Ratios are interpreted as the likelihood of contribution to lecturers' satisfaction if a predictor variable is increased by one unit while the other variables are kept constant. Odds of an event occurring is the probability of its occurrence divided by the probability of the event not occurring. When O.R > 1, itmeans the odds of the outcome occurring increases as the predictor increases; the obverse holds too.Statistical significance of each predictor variable in the model was tested by the Wald test (Sheater, 2009).

Pseudo $R^2$is a measure of how much the badness of fit improves as a result of the inclusion of a predictor variable. R^2 varies between 0 (predictor can not predict the outcome) and 1 (predictor can predict outcome variable perfectly). Cox and Snell, Nagelkerke and Mc Faden are the three pseudo R-square obtained from SPSS output. Mc Faden is the Default pseudoR^2, proportion of the variation in the equation when only the intercept is in the model, without covariates. Three variants of the OLR models are presented in order to establish differences and compare result of analysis based on subjective and objective data. The three predictive models are:

1. Model based on subjective data from questionnaire survey.

2. Model based on objective data with IEQ treated as a composite.

3. Model based on objective data with IEQ broken down into its constituent parts.

4.9.1 OLR Model based on Subjective Data from Questionnaire

Data generated from questionnaire survey were used for predicting lecturers' satisfaction. The statistical tool used is Ordinal Logistic Regression (OLR). Variables having p-value less than or equal to 0.05 were taken as statistically significant.

Table 4.17: OLR predicting likelihood of lecturers' satisfaction based on subjective data

Variable	β (S.E)	Wald	P	Odds Ratio	95% CI for Estimate Lower	Upper	Remark
Workspace utilization	0.000 (0.000)	0.244	0.621	1.000	0.000	0.001	Not Significant
IEQ	0.016 (0.011)	2.315	0.128	1.016	-0.005	0.037	Not Significant
Lecturers' characteristics	0.146 (0.059)	6.181	0.013	1.157	0.031	0.260	Significant
Workspace characteristics	0.047 (0.067)	0.491	0.483	1.048	0.084	0.177	Not Significant
Maintenance practice	0.030 (0.012)	6.756	0.009	1.030	0.007	0.053	Significant

Note: R^2= .261(Cox & Snell), .261 (Negelkerke) and .047 (McFaden)

Model parameters χ^2 (5, N =58) = 1809.55, p=0.004 (p< .05)

Derived model is, $\mathbf{Y_{us}}$**= 0.016 IEQ + 0.146 LC + 0.047 WC + 0.030 MP…………….. 4.2**

Result of analysis in Table 4.17, indicates the full model, χ^2 (5, N=58) = 1809.55, p < .05, containing two of the five predictors which are statistically significant. The two predictors are Lectures' characteristics and Maintenance practice having O.R of 1.157 and 1.03 respectively. The strongest predictor of lectures' satisfaction was lecturers' characteristics. By this result, lecturers' charcteristics is 15.7% more likely to contribute to lecturers' satisfactioncontrolling for all other factors in the model. The Odds ratio of 1.00 in respect of workspace utilization means the parameter is likely and as well unlikely to contribute to lecturers' satisfaction.

The model has explained 26.1% (Cox & Snell; Nagelkerke)of the variation in lecturers' satisfaction and classified 96% of cases correctly using 58 valid responses as indicated in the Case Processing Summary in Appendix VI.

Table 4.18: OLR Model fitting information

Model	-2log Likelihood	Chi-square	Df	Significance
Intercept only	373.532			
Final	356.040	17.542	5	0.004

Table 4.18 contains log-likelihood for the intercept and final model as fitting information showing whether the model is parsimonious. A log likelihood of 356.040, Chi square statistic value of 17.542 and p-value of .004 (.004<5%) interprets to rejection of the null hypothesis– that

the data do not fit the model prescribed. This means that the model is significant and it describes the data appropriately.

Table 4.19: Goodness-of-Fit test

	Chi-square	Df	Significance
Pearson	1809.552	1648	0.003
Deviance	356.040	1648	1.000

The Pearson Chi-square results with statistic of 1809.552 and a p-value of 0.003 as presented in Table 4.19tests whether the predicted values from the model differ significantly from the observed values. Pearson coefficient statistics is significant ($p = .003<.05$) suggesting that the predicted are significantly different from the observed while the Deviance having $p>.05$ negates to establish good fit of the model. The data collected therefore fits the OLR model predicted for this study. The total variability of about 26.1% of lecturers' satisfaction is explained by the predictor variables. The statistic was shown by the Nagelkerke and the Cox and Snell. Generally, the interpretation is that 26.1% of variability in Lecturers' satisfaction was accounted for by Lecturers' characteristics and Maintenance practice.

Result of the analysis reveals that lecturer's characteristic is the most important out of the five predictors contributing to lecturers' satisfaction with workspace. Maintenance practice is the second predictor.

4.9.2 Model based on Subjective Data with measured IEQ treated as a Composite

Mean scores of measurements of Temperature,Humidity,Acoustics,Air flow and Lighting, taken with instruments, were analysed using OLR based on lecturers' perception as satisfactory and unsatisfactory. Responses in respect of the measurements of five IEQ environmental parameters were combined as a composite with the other four predictors. Five models were derived from this approach. The best model in Table 4.20, with details in AppendixVI, was selected based onmodel parameters like β, Wald statistics, O.R., pseudo R-square and p-values.

Table 4.20: OLR Predicting Likelihood of Lecturers' Satisfaction basedmeasured IEQ as Composite

Variable	β (S.E)	Wald	P	Odds Ratio	95% CI for Estimate Lower	Upper	Remark
Indoor Env. Quality	- 0.009 (0.003)	7.610	.006	-1.009	-0.015	0.003	Significant
Workspace utilization	0.003 (0.001)	7.149	.007	1.003	0.001	0.005	Significant
Workspace characteristics	0.345 (0.142)	5.916	.015	1.412	0.067	0.623	Significant
Lecturers' characteristics	-0.200 (0.109)	3.347	.067	-1.221	-0.414	0.014	Not Significant
Maintenance practice	0.012 (0.018)	0.480	.488	-1.023	-0.023	0.048	Not Significant

Note: Pseudo R^2 = .413(Cox & Snell) & .462 (Negelkerke)
Model χ^2 = 35.969, DF = 70, p = .085 (p >.05)

Derived model: Y_{US}= - 0.009 IEQ + 0.003 WU + 0.345 WC - 0.200 UC + 0.012 MP………4.3

In the result of analysis in Table 4.20, the full model containing all the five predictors explained 41% of the variation in lecturers' satisfaction and three of the predictors (IEQ, Workspace utilisation and Workspace characteristics) made significant contribution to the model. The strongest predictor of satisfaction with IEQ in workspace is Workspace characteristics, recording Odds ratio of 1.412 which implies that Workspace characteristics is 41.20% more likely to contribute to satisfaction of lecturers in workspaces than other predictors in the model.

Findings from this analysis indicate Workspace characteristics as the strongest predictor contributing to lecturers' satisfaction. Contribution from the remaining four predictor variables is negligible.

4.9.3 Model based on Subjective Data with measured IEQ broken into its Constituents

IEQ was broken down into its five measured parameters and analysed by proportional odds Ordinal Logistic Regression (OLR). Five models were also derived from this approach. The best model in Table 4.21, with details in Appendix VI, was selected on the basis of pseudo R^2, O.R. and p-value obtained.

Table 4.21: OLR predicting likelihood of lecturers' satisfactionwith IEQ constituents

Variable	β (S.E)	Wald	P	Odds Ratio	95% CI for Estimate		Remark
					Lower	Upper	
Workspace utilization	0.003 (0.001)	5.12	.024	1.003	0.000	0.005	Significant
IEQ -1	1.875 (0.841)	4.97	.026	6.521	0.226	3.525	Significant
IEQ -2	0.441(0.152)	8.39	.004	1.554	0.143	0.739	Significant
IEQ -3	7.667 (3.510)	4.77	.029	2.166	0.788	14.547	Significant
IEQ -4	1.004(0.330)	10.03	.002	2.840	0.398	1.690	Significant
IEQ -5	0.003 (0.004)	0.59	.441	1.003	0.004	0.010	Not Significant
Workspace Characteristics	0.681 (0.205)	11.05	.001	1.976	0.280	1.083	Significant
Lecturers' Characteristics	0.459 (0.159)	8.37	.004	1.582	0.148	0.770	Significant
Maintenance Practice	0.097 (0.031)	9.75	.002	1.102	0.036	0.157	Significant

Note: R^2= .86 (Cox & (Snell), .87 (Nagelkerke), .36 (McFaden): **Model** χ^2 (216) = 621.185, p< .05; p = .000

Derived model: Y_{us}**= 0.003WU + 1.875**IEQ_1 **+ 0.441**IEQ_2 **+ 7.667**IEQ_3 **+ 1.004**IEQ_4 **+ 0.003** IEQ_5 **+ 0.681WC + 0.459UC+ 0.097MP……………………………4.4**

The result of analysis in Table 4.21 indicates the full model containing all the five predictors with IEQ split into its five measured parameters (temperature-IEQ_1, humidity-IEQ_2, acoustic -IEQ_3, lighting-IEQ_4 and air flow-IEQ_5). The model explained 86.5% of the variation in lecturers' satisfaction based on perceived temperature and only one of the predictors (IEQ5-Air Flow) has not made significant contribution to the model. The strongest predictor of satisfaction is Workspace characteristics, recording an odd ratio of 1.976; which implies that Workspace characteristics is 97.6% more likely to contribute to satisfaction with IEQ in workspace than other predictors in the model.

Result of analysis in the model indicates Workspace characteristics as the strongest predictor in making contribution to lecturers' satisfaction. Individual contribution of the four of the five environmental IEQ components are Lighting – 84%, Humidity – 55%, Temperature – 52% and Acoustics – 16.6% respectively.

This result has revealed that only Workspace characteristics determine lecturers' satisfaction in workspaces. It then means that Workspace characteristics might have been given wide meaning by respondents because all the five measured IEQ parameters could be moderated by the characteristics of the workspace.

4.10 External Validation of the Models

Validity means that the conclusions drawn on inference are true, relative to the perspective of the research design. External validity is the degree to which one can generalize from a specific study's findings based on a population sample to the general population (Paulson, 2007). Validation was done through determination of the Mean Absolute Percentage Error (MAPE) of responses to 34 sample questionnaires. This is done for the purpose of evaluating the sustability of the predictive OLR models, developed in this study, in wider similar environment e.g. universities in other geo-political zone of Nigeria. The two OLR models assessed are the one based on subjective data and the other based on combination ofsubjective with objective data in which measured environmental IEQ was treated as a composite.

Cross validation method was used because of the challenges envisaged in collecting fresh data as supported by Snee (2015). Thirty four (34) questionnaires were therefore set aside for this purpose. MAPE was determined by finding the difference between the perceived and the predicted values of the variables in the models, divided by the perceived and expressing the result in percentage (Melorose, Perroy & Careas, 2015).

$$MAPE = \frac{Percieved - Predicted}{Perceived} x\ 100\% \qquad 4.5$$

Table 4.22: Data on Validation of Model I

Sample No	PerceivedValue	Predicted Value	Absolute % error
1	0.452051	0.387332	14.32%
2	0.580869	0.528411	9.03%
3	0.544947	0.624131	14.53%
4	0.662814	0.628167	5.23%
5	0.65036	0.574712	11.63%
6	0.605829	0.569358	6.02%
7	0.598404	0.366768	38.71%
8	0.706861	0.67647	4.30%
9	0.616972	0.774296	25.50%
10	0.548543	0.392465	28.45%
11	0.767416	0.794474	3.53%
12	0.617985	0.461185	25.37%
13	0.691763	0.56686	18.06%
14	0.6966	0.880017	26.33%
15	0.776031	0.837594	7.93%
16	0.615101	0.41339	32.79%
17	0.436318	0.501798	15.01%
18	0.677782	0.491248	27.52%
19	0.613327	0.521103	15.04%
20	0.635486	0.521971	17.86%
21	0.481463	0.419107	12.95%
22	0.693867	0.555787	19.90%
23	0.624218	0.710824	13.87%
24	0.667244	0.784806	17.62%
25	0.597447	0.499775	16.35%
26	0.725812	0.784125	8.03%
27	0.611126	0.616406	0.86%
28	0.484028	0.530608	9.62%
29	0.728127	0.644987	11.42%
30	0.501995	0.410994	18.13%
31	0.534623	0.477905	10.61%
32	0.502571	0.411502	18.12%
33	0.557321	0.449364	19.37%
34	0.544541	0.450118	17.34%
Mean Absolute Percentage Error (MAPE)			15.92%

Table 4.23: Data on Validation of Model II

Sample No	PerceivedValue	Predicted Value	Absolute % Error
1	0.470533	0.5035689	7.02%
2	0.283243	0.3176292	12.14%
3	0.355697	0.5181231	45.66%
4	0.300521	0.3892806	29.54%
5	0.393297	0.3413398	13.21%
6	0.300276	0.5064235	68.65%
7	0.49735	0.4214554	15.26%
8	0.377781	0.3191743	15.51%
9	0.327573	0.2831462	13.56%
10	0.280598	0.4546554	62.03%
11	0.420615	0.2180998	48.15%
12	0.33268	0.3346768	0.60%
13	0.540161	0.6174297	14.30%
14	0.400672	0.3972542	0.85%
15	0.629398	0.7648265	21.52%
16	0.535728	0.5747178	7.28%
17	0.411594	0.6010306	46.03%
18	0.419551	0.5249227	25.12%
19	0.359203	0.3912858	8.93%
20	0.477738	0.4163484	12.85%
21	0.508721	0.5479901	7.72%
22	0.464249	0.4929882	6.19%
23	0.482719	0.5321464	10.24%
24	0.300799	0.3153674	4.84%
25	0.579356	0.5052582	12.79%
26	0.410803	0.461152	12.26%
27	0.364231	0.3191003	12.39%
28	0.320895	0.1993297	37.88%
29	0.343638	0.3868596	12.58%
30	0.394215	0.4814153	22.12%
31	0.278059	0.3078584	10.72%
32	0.543005	0.3315436	38.94%
33	0.479997	0.4916957	2.44%
34	0.330215	0.4388243	32.89%
	Mean Absolute Percentage Error (MAPE)		20.36%

The results of validation of the two models are in Tables 4.22 and 4.23. As indicated in the tables, predicted outcome for the thirty-four sample cases on each model was close to the precieved lecturers' satisfaction. The two models having scored MAPE of 15.92% and 20.36% respectively are therefore assessed to perform satisfactorily if and when applied in similar environment.

4.11 Discussion of Findings

Overall intensity of workspace utilisation by the three universities combined was 37.81%. University of Ilorin recorded higher intensity of 39.36% while the remaining two universities had 36.75% and 37.31% respectively. This overall intensity, possibly a benchmark, falls within good use as classified by SMG (2006).Overall space utilisation of 22.85% on lecture room was achieved by University of Technology, Malaysia (Abdullah, Ali, Sipam, Awang, Rahman, Shika & Jibril, 2012). It is possible to achieve higher level of utilisation with improved IEQ of workspaces of lecturers in the three universities studied.

Out of the thirteen uses of workspace by lecturers, significant difference on workspace utilisation was found on formal reading, formal writing, consultations by students, formal meeting with colleagues, watching television/video, eating, receiving guests unofficially and relaxation. This is as a result of differences in structure, programmes, provision of residential accommodation and location of lecturers' offices. It is however worthy of note that core academic functions scored high on utilisation especially in University of Ilorin.

Building integrity, environmental control facilities and size of workspace were the main IEQ parameters adjudged satisfactory by lecturers. Out of the fourteen IEQ parameters there was no significant difference between perceived IAQ and thermal quality adjudged satisfactory and unsatisfactory by lecturers. There was no significant difference on perception of lecturers on satisfactory and unsatisfactory five measured environmental parameters i.e. temperature, humidity, acoustics, air-flow and lighting. Lack of thresholds on IEQ parameters in Nigeria could be responsible for this outcome.

CIBSE’s benchmark on temperature is 21- 23ºC, ASHRAE’s is 24-28ºC while the design value for offices is 25ºC. Result of 22.5-56.8ºC obtained in this study is different from the aforementioned thresholds, particularly on maximum temperature in office workspace. Benchmarks on humidity are CIBSE’s 40-70% and ASHRAE’s 20-70% while 19.5-94.8% was recorded in this study. Maximum benchmark of 70% was exceeded by 35% on humidity. Wong, Mui and Hui (2007) did similar study in Hong Kong and obtained 18-25^{0}C, 45-72dBA and 200-1600lux on temperature, acoustics and lighting respectively. There is difference in expectations between tropical and temperate countries on comfort.

Gender, age, qualification and tenure of lecturers in workspace affect their satisfaction with acoustic quality, visual comfort, IAQ, air-flow, size of workspace, adjustability of furniture and cleanliness in allocated workspaces. Type of building, floor level, direction faced by window, office type are workspace characteristics having effects on lecturers’ satisfaction with size of workspace, visual comfort, air-flow, furniture and furnishing, cleaning service and ease of interaction in the workspaces. Consideration of lecturers’ characteristics and workspace characteristics on IEQ represents balancing demand with supply in terms of human needs for comfort. While lecturers’ characteristics represent the demand side the workspace characteristics satisfy the dictate of human desire for functional comfort in the workspaces through performance of related elements. Vural (2004) on model of IAQ risk analysis agrees with this analogy characteristics of users of a building and the building itself were also considered by Ozturk and Balenli (2004) as a cause and effect relationship between building and health problems.

Positive weak correlation between maintenance practice in the universities studied and lecturers’ maintenance satisfaction indicate inadequate attention units gave more attention to visual quality but less to size and layout of workspace, acoustic quality, furniture and furnishing, cleanliness and maintenance. Two important IEQ parameters which demand commensurate attention in tropical climates like Nigeria and given least attention are IAQ and thermal quality: for example, ratio of window to flow area in offices ranged between 0.09 and 0.59 and against 0.40 required.

Workspace utilisation on formal reading, internet surfing and relaxation by lecturers is affected by IAQ, visual quality, thermal quality, furniture and furnishing, cleanliness and maintenance. These IEQ parameters are essential for creating conducive and comfortable indoor environment for academic works in lecturers' workspaces.

The OLR predictive models in respect of qualitative and quantitative assessments gave workspace characteristics, lecturers' characteristics and maintenance practice as major predictors of satisfaction generally. Lecturers' characteristics create demand for comfort in workspaces and this is satisfied through provisions in the workspace which culminate into workspace characteristics. The characteristics of lecturers and workspaces are moderated by maintenance practice in tune with dymanics of workspace utilisation for core and non-core academic functions by lecturers. The third model derived from combination of subjective and objective data corroborated this assertion by identifying temperature and lighting as significant predictors of lecturers' satisfaction. Temperature and lighting are subset of workspace characteristics and are subjected to moderation through maintenance practices.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study attempted providing answers to a series of questions related to lecturers' satisfaction with indoor environmental quality in workspaces within their allocated offices. Workspace utilization by lecturers and maintenance practice in the universities studied were jointly investigated as concurrent and *sine qua non* moderators of IEQ. Subjective and objective data collected were analyzed appropriately and the summary of major findings is as follows;

Intensity of Workspace Utilisation in Offices of Lecturers

Workspace utilization of 38% on thirteen identified activities, in the three universities combined, was fairly above the minimum benchmark of 25% classified as poor utilization by the Space Management Group (SMG).University of Ilorin however, recorded better utilization (i.e. >35%) on reading related to assigned duties, writing related to assigned duties and consultation by students. Specifically, significant differences on intensities of workspace utilization, between the sampled universities, were clearly established statistically on eight out of the thirteen uses.Findings are:

i. There are no standards, regulations or guidelines on environmental conditioning of workspaces of university lecturers.

ii. Thirteen uses of workspace by university lecturers in the study area were identified.

iii. Intensity of workspace utilisation varies within each university and among the universities studied on the thirteen uses by lecturers.

iv. Intensity of workspace utilization on core academic functions like formal reading, formal writing and internet surfing is higher in University of Ilorin when compared with each of the other two universities.

Difference between IEQ adjudged Satisfactory and Unsatisfactory in Workspaces by University Lecturers

Wilcoxon Signed Rank Test (WSRT) established lack of statistically significant difference between IEQ adjudged subjectively as satisfactory and unsatisfactory by lecturers in respect of Indoor Air Quality (IAQ) and thermal quality. Significant difference was however found in the remaining twelve variables of IEQ. With regard to measurements taken on five IEQ parameters in sampled workspaces, paired samples t-test established lack of statistically significant differences between satisfactory and unsatisfactory temperature, humidity, acoustics, lighting and air-flow (i.e. all the five measured parameters). A comparison of satisfactory readings with CIBSE benchmarks however revealed differences of 7 to 100% on minimum and 35 to 1,300% on maximum benchmarks. .

i. Lecturers are highly satisfied with the environmental quality of workspaces allocated to them.
ii. Measured temperature, humidity and acoustics in lecturers' workspaces are higher than the CIBSE's set standards for acceptable IEQ in offices while those of air-flow and lighting were lower.
iii. There is marginal difference between measured IEQ parameters perceived satisfactory and the unsatisfactory parameters.

Effects of Lecturers' Characteristics and Workspace Characteristics on Lecturers' Satisfaction

Test of hypothesis revealed significant effect of lecturers' characteristics (gender, age, qualification and tenure in workspace) on lecturers' satisfaction with seven IEQ parameters namely: acoustics, visual comfort and IAQ. Similarly, workspace characteristics (type of building, floor level, type of office and direction faced by window) had significant effect on six IEQ parameters namely: size of workspace, visual comfort and cleaning services.

i. Enclosed shared office is the most common type of workspace in universities in the study area.
ii. Workspace varies in size and conditioning for work and comfort of lecturers in the universities.
iii. Environmental conditioning of lecturers' workspaces is predominantly the mixed-mode type.
iv. Lecturers' characteristics affect satisfaction of lecturers with IEQ in workspaces.
v. Workspace characteristics have effects on lecturers' satisfaction with IEQ in workspaces.

Relationship between Maintenance Practice and Lecturers' Satisfaction

Lecturers played no role in ensuring desirable IEQ in their workspaces through the maintenance unit of the universities. There is also very low positive correlation between maintenance practice and IEQ in respect of size and layout of workspace, acoustic quality, visual quality, air quality, thermal quality, furniture and furnishings and, cleanliness and maintenance.

i. Lecturers agreed that top management commitments, maintenance objectives, maintenance planning, organizing maintenance, control maintenance works and users' role are maintenance practice tasks in the universities.
ii. Performance of maintenance practice tasks affects satisfaction of lecturers with IEQ in their workspaces.
iii. Expected roles of lecturers in ensuring maintenance of desirable IEQ in workspaces are not manifested.

Relationship between Workspace Utilization and Lecturers' Satisfaction

i. There is weak positive correlation between IEQ and workspace utilisation by lecturers for reading related to assigned duties, internet surfing and relaxation. There is no correlation between IEQ and workspace utilization for formal reading and internet surfing which are core academic functions. Core academic functions require suitable environmental condition for productivity and comfort of lecturers. Positive relationship between relaxation and commensurate furniture and furnishing and, cleanliness and maintenance is an essential requirement for the comfort of lecturers.
ii. Lecturers' satisfaction with IEQ was affected by intensity of workspace utilisation on core academic functions.
iii. Workspace utilisation for non-core academic functions depends on quality of furniture, furnishing, cleanliness and maintenance.

Predictive Models on Lecturers' Satisfaction with IEQ in Workspaces

Odds ratio derived from Ordinal Logistic Regression (OLR) was used to predict lecturers' satisfaction. Model based on subjective data gave lecturers' characteristics and maintenance practice as major predictors of satisfaction On the other hand, model based on objective data, with IEQ treated as composite, gave workspace characteristics as the major predictor. Workspace characteristics also became the strongest predictor when IEQ was broken down into its constituents of five measured parameters.

i. Significant relationship exists between the variables of lecturers' characteristics, workspace characteristics, maintenance practice, indoor environmental quality, workspace utilisation and lecturers' satisfaction.
ii. Prediction of lecturers' satisfaction based on subjective assessment can be expressed by Ordinal Logistic Regression (OLR) equation $Y_{us} = 0.016 \text{ IEQ} + 0.146 \text{ UC} + 0.047 \text{ WC} + 0.030 \text{ MP}$. Lecturers' characteristics and maintenance practice are the two variables contributing significantly to lecturers' satisfaction.

iii. Prediction of lecturers’satisfaction based on measurements, with instruments and treating IEQ as a composite, may be expressed by OLR equation $Y_{us} = 0.009\ IEQ + 0.003\ WU + 0.345\ WC - 0.200\ UC + 0.012\ MP$. Workspace characteristics is the only variable making significant contribution to lecturers’ satisfaction.

iv. Prediction of lecturers' satisfaction based on measurements, with IEQ broken into its constituents (temperature, humidity, acoustics, air-flow and lighting), may be expressed by OLR equation $Y_{us} = 0.003WU + 1.875IEQ_1 + 0.441IEQ_2 + 7.667IEQ_3 + 1.004IEQ_4 + 0.003IEQ_5 + 0.681WC + 0.459UC + 0.097MP$.

5.2 Conclusion

From the findings above, the following conclusions are deduced:

i. The extent to which office workspaces satisfy the desired comfort of lecturers in carrying out assigned dutiesbeyond commissioning is reflected by intensity of workplace utilization. Intensity of workspace utilisation on core academic functions is also a reflection of productivity.This study has revealed fair utilisation of workspaces by lecturers on core academic functions.

ii. The provision and use of workspace for assigned duties by lecturers in the universities studied is not uniform.

iii. Satisfactory IEQ parameters are too close or similar in some cases to the unsatisfactory ones as perceived by lecturers. This outcome of the research may be caused by lack of awareness or policy guidelines on thresholds. National Universities Commision (NUC) and Environmental Protection Agency (EPA) need to collaborate in establishing and implementing thresholds, regulations and guidelines on IEQ in offices of university lecturers.

iv. Environmental design of office buildings for lecturers by the Physical Planning and Development Unit (PPDU) of universities is important for ensuring desired IEQ. Specifications in such design will be required in construction, operation and maintenance of office buildings of lecturers in conformity with the comfort requirements.

v. Lack of University management's commitment to IEQ is revealed by non-significant relationship between maintenance practice and satisfaction of lecturers with major parameters of IEQ in their offices.

vi. Insignificant relationship between workspace utilization and satisfaction of lecturers could be attributed to either lack of maintenance or performance of assigned duties elsewhere because of remoteness and lack of residential accommodation for lecturers in universities' campuses.

vii. Characteristics of lecturers and maintenance practice make major contributions to lecturers' satisfaction by subjective assessment. The two variables are however closely related because characteristics of lecturers determine expectations while maintenance practice deploys appropriate strategies to regulate and create balance between satisfactory and poor IEQ in workspace.

viii. By objective assessment only Workspace characteristicsmakes major contribution to lecturers' satisfaction.

5.3 Recommendations

Based on the conclusions above, the following recommendations are made:

i. Considering the fact that standards and regulations on IEQ have not been installed in Nigeria, findings of this study could be used as baseline data for initiating environmental design and performance evaluation of office workspaces of university lecturers.

ii. Thirteen uses of workspace by lecturers. as identified in this study. could be classified into core and non-core academic functions for the purpose of prioritization in initiating and executing maintenance works.

iii. Factors responsible for variation in intensity of workspace within each university and among the universities need be investigated and addressed in order to optimize use of workspace.

iv. Lecturers' satisfaction with environmental quality of workspaces based on subjective assessment contradicted their responses to measured IEQ parameters. This contradiction arose because of lack of thresholds and benchmarks on IEQ parameters in Nigeria. Findings of this study could be used as template for developing such standards.

v. Size and conditioning of lecturers' workspaces should be based more on functions rather than status.

vi. Conditioning workspace of lecturer for desirable IEQ should be made commensurate with lecturer's characteristics.

vii. Retrofitting the workspace to make its characteristics blend with desirable IEQ demands adequate monitoring and evaluation of feedback from lecturers-especially where shortfall occurs between the expected and actual IEQ in workspace. This is a responsibility to be taken up by the maintenance unit.

viii. Lecturers' role on monitoring and maintenance of IEQ in workspaces could be enhanced through appointment of Desk officer in each faculty of the universities. The Desk officer will liaise between the lecturers and maintenance unit of the university on IEQ issues.

ix. Lectures' characteristics, workspace characteristics and maintenance practice are the three major factors affecting IEQ in workspaces. Commensurate attention should be given to these factors in environmental design of new buildings, of new offices and maintenance of the existing stock.

The study proposes Ordinal Logistic Regression (OLR) model for predicting lecturers' satisfaction with IEQ in workspaces in Nigerian universities.

5.4 Contributions to Knowledge

The contributions made to the body of knowledge by this study include:

i. The study developed models for predicting lecturers' satisfaction with IEQ in workspaces from five variables, namely: Lecturers' characteristics, Workspace characteristics, Maintenance practice, Indoor Environmental Quality and Workspace utilization. The models are applicable in performance evaluation of existing buildings, environmental design of new buildings and in monitoring compliance with statutory indoor environmental quality standards and regulations when established.

ii. Intensity of workspace utilization on thirteen activities of lecturers was determined based on capacity utilization and frequency of use. The intensity is useful as an index for setting National standards and guidelines on use of workspace in Nigerian universities.

iii. Development of a conceptual framework for assessing satisfaction of university lecturers with IEQ in their workspaces. This model may be adopted by other researchers in future.

iv. Physical measurement of five environmental IEQ parameters revealed lack of compliance with global standards like CIBSE's. This contribution to knowledge is important because measurement could be monitored and evaluated scientifically as changes occur in pattern of use of wokspace. Data generated for measurement could also be stored and used for sensitivity analysis in intiating strategies on pro-active maintenance e.g. assessing effects of changes on IEQ status of a building.

v. In the hierarchy of comfort, the threshold of habitability of abuilding is always satisfied at the commissioning stage. Beyond commissioning, the occupied bulding requires monitoring for maintaining IEQ status commensurate with the requirements of changes in utilisation, occupancy, climate, technology, etc. the dynamics of workspace utilisation therefore revolves around five factors- users, building elements, installed IEQ, human activities and climate. This study has brought into focus the relationships between these contextual variables and their effects on lecturers' satisfaction, individually and collectively.

vi. Lecturers' characteristics were shown to have effect on their satisfaction with IEQ in workspaces. This finding is expected because lecturers' chracteristice are the basis for the demand of desirable IEQ in workspaces-the supply side of the equilibrium. Any defect in this variable could be remedied through deployment of appropriate maintenance strategies.

vii. Workspaces utilisation by lecturers has been shown to have little effect on lcturers' satisfaction with IEQ. This may be due to the fact that only lecturers in one of the three universities use workspaces intensively for core academic functions. Remoteness of campuses and lack of residential accommodation for lecturers on campus also contributed to current status in utilisation of workspaces by lecturers.

5.5 Suggested Areas for Future Research

Factors influencing lecturers' satisfaction and the structure created by causal effects between the related variables were not included in the scope of this study. Factor analysis, Fussy set theory and structural modeling may be used to explore relationship between IEQ and the factors. This will throw more light on whether one variable is related or causally linked to a specific variable or group of variables.

Findings of this study could be applied in developing effective and sustainable design for localized climatic conditions and acceptable comfort for achieving improved performance of academic buildings and lecturers in Nigerian universities.

There is need to ascertain, in clear terms, the relationship between subjective assessment and objective physical measurement of IEQ parameters, where practicable. This has not been accomplished because appropriate tools and equipment for required measurements on each IEQ parameter were not completely available. For example, radiant temperature, activity level and clothing on thermal quality, day lighting on visual quality, contaminants on IAQ and sound privacy on acoustics were not measured. The relationship is needed for determining the extent and causes of variation or similarity. Such relationship could be used to interprete measurements interchangeably between subjective and objective assessments.

An investigation into causes of discrimination in pattern of use which affects utilization, beyond IEQ, requires research attention. Related to this is the conditioning mode of the office – whether passive, active or mixed mode.

REFERENCES

Abbaszadeh, S., Zagreus, L., Lehrer, D.,& Huizenga, C. (2006). Occupant satisfaction with indoor environmental quality in green buildings. *Healthy Buildings III*, 365-370.

Abdullah, S., Alli, H., Sipan, I., Awang, M., Rahman, M., & Jibril, J.*et al.* (2012). Classroom Management: measuring Space Usage. *Proceedia: Social Behavioural Sciences 65*, 931-936.

Adebayo, S. (1991). A study of maintenance management of public buildings in Nigeria. Unpublished PhD thesis, Department of Building, University of Lagos, Lagos state, Nigeria

Adenuga, O. (2008). Evaluation of maintenance management practice in public hospital buildings in South-West, Nigeria. Unpublished PhD thesis, Department of Building, University of Lagos, Lagos state, Nigeria

Ahmadfauzi, A. (2005). Pengurusan Sumber Fizikal IPT: Pengurusan Ruang. *Jurnal Teknologi E, 43*(E), 15 – 28.

Ajala, E. (2012). The influence of workplace environment on workers' welfare, performance and productivity. *The African Symposium: An online Journal of the African Educational Research Network 12*(1), 141 – 149.

Al-horr, Y., Arif, M., Katafygiotou, M., Mazroei, A., Kaushik, A., & Elsarrag, E. (2016). Impact of indoor environmental quality on occupant well-being and comfort: A review of literature. *International Journal of Sustainable Built Environment, 5*, 1 – 11.

Arens, E., Tengfang, X., Miura, K., Zhang, H., Fountain, M.,& Bauman, F. (1998). A study of occupant cooling by personally controlled air movement. *Energy and Buildings 27*(1), 45 – 59.

Armitage, L., Murugan, A.,& Kato, H. (2011). Green offices in Australia: a user perception study. *Journal of Corporate Real Estate, 13*(*3)*, 169-180.

Armstrong, J.,& Walker, A. (2006). Health, comfort & productivity. In: Green Buildings: Project planning & cost estimating, United States of America.

Arslankaya, S., & Atay, H. (2015). Maintenance management and lean manufacturing practices in a firm which produces dairy products. *Procedia Social and Behavioral sciences* 207, science direct, 214-224.

Asante-Duah, K. (1993). *Hazardous Waste Risk Assessment*. Boca Raton, Florida: CRC Lewis Publishers.

ASHRAE (1989). *Energy efficient design of new buildings except low-rise residential buildings. ASHRAE Standard 90.1*. Atlanta, GA: American Society of Heating, Refrigerating and Air Conditioning Engineers.

ASHRAE (1994). *Safety code for mechanical refrigeration. ASHRAE Standard 15.* Atlanta, GA: American Society of Heating, Refrigerating and Air Conditioning Engineers.

ASHRAE (1999). *Ventilation for Acceptable Indoor Air Quality. ANSI/ASHRAE 62*, Atlanta, GA: The American Society of Heating, Refrigerating and Air-conditioning Engineers.

ASHRAE (2001). *Energy standard of buildings except low-rise residential buildings, ASHRAE Standard 90.1*. Atlanta, GA: American Society of Heating, Refrigerating and Air Conditioning Engineers.

ASHRAE (2004). *Ventilation for Acceptable Indoor Air Quality. ASHRAE Standard 62.1*. Atlanta, GA, American Society of Heating, Refrigerating and Air Conditioning Engineers.

Asika, N. (2004). *Research Methodology: a process approach.* Lagos: Mukugamu and Brothers Enterprises.

Asika, N. (2005). *Research methodology in behavioral sciences.* Lagos: Longman Publishing Limited.

Ayr, U., Grillo, E.,& Martellotta, F. (2001). An experimental study on noise indices in air conditioned offices. *Applied Acoustics, 62*(6), 633 – 643.

Baayen, R. (2008). *Analysing Linguistic data: a Practical Introduction to Statistics using R.* New York: Cambridge University Press.

Bako-Biro, Z., Wargocki, P., Weshler, C., & Fanger, P. (2004). Effects of pollutions from personal computers on perceived air quality, SBS symptoms and productivity in offices. *Indoor Air*, *14*(3), 178 – 187.

Balanli, A.,& Öztürk, A. (1997). A systematic approach to solve building biology related problems'. *Healthy Buildings/IAQ Congress.* September 27- October 2, 1997, Washington.

Balanli, A.,& Ozturk, A. (2004). A conceptual model to examine buildings in terms of building biology. *Architectural Science Review 47*(2), 97 – 102.

Barrett, P., Zhang, Y., Moffat, J., & Kobbacy, K. (2013). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning. *Building and Environment. 59*, 678 – 689.

Bayer, C., Crow, S.,& Fischer, J. (1999). Causes of indoor air quality problems in schools. *Energy division Oak Ridge National Laboratory. ORNL/M-6633*, p.44.

Becker, F. (1981). *Work Space: Creating Environments in Organizations*. New York: Praeger Publishers Inc.

Berglund, B.,& Lindvall, T. (1995). (Eds.). Community noise. *Archives of the Center for Sensory Research, 2(*1), 1 – 195.

Best, R. (2010). Specifying and sourcing materials for a best practice education building. In: Zachar, J., Claisse, P., Naik, T. and Ganjian, E. (Eds.). *Proceedings of Second International Conference on Sustainable Construction materials and Technologies*, June 28-30, Ancona, Italy.

Best, R.,& Purdey, B. (2012). Assessing occupant comfort in an iconic sustainable education building. *Australian Journal of Construction Economics and Building, 12(3)*, 55-65.

Brager, G., & Dear, J. (2001). Climate, comfort & natural ventilation: A new adaptive comfort standard for ASHRAE Standard 55. *Proceedings: Moving Thermal Comfort Standards into the 21st Century*, Windsor, UK.

Brennan, T., & Turner, W. (1999). Indoor air quality primer: What factors and conditions cause indoor air quality problems and what can you do to stop them? *Heat Piping Air Cond. 71*(5), 5.

Brown, Z., & Cole, R. (2009). Influence of occupants' knowledge on comfort expectations and behaviour. *Build Res Inf. 37*(3), 227 - 245.

Bruce, R. (2008). How much can noise affect your workers' productivity. *Retrieved February 29, 2012 from http://www.office-sound-masking.com/2008/02/29.*

Bruyère, S. (2002). Health benefits and workplace accommodations: Perspectives from HR professionals. *SCI Life (publication of the National Spinal Cord Injury Association),* 28–30.

Burnett, J. (2005). Indoor Air Quality Certification Scheme for Hong Kong Buildings. *Indoor and Built Environment*, *14*(3-4), 201 – 208.

Buys, F., & Nkado, R. (2006). A survey of maintenance management systems in South African tertiary educational institutions. *Construction Management and Economics*, 24(10), 997-1005.

Chandrasekar, K. (2011) Workplace environment and its impact on organisational performance in public sector organisations, Alagappa University, Karaikudi, India. *International Journal of Enterprise Computing and Business Systems 1*, 1 – 20.

Chapins, A. (1995). *Workplace and the performance of workers.* Reston: USA.

Chia, R. (2002). The production of management knowledge: Strategies for reducing cost and improving service, London: Pitman publishing.

Chu, W., & Warnock, A. (2002). Measurements of sound propagation in open offices. *National Research Council Canada, Institute for Research in Construction.* IR-836.

Chute, C. (2003). *Terminology mapping and agreement logic.* Personal communication to Institute of Medicine's committee on Data Standards for Patient Safety.

Clark, V., & Creswell, J. (2015). *Understanding research: A consumer's guide.* Pearson Higher Ed.

Clements-Croome, D. (2011). *The interaction between the physical environment and people. In: S. A. Abdul-Wahab (Ed.), Sick building syndrome in public buildings and workplaces. Berlin: Springer. 239 – 260.*

Cochran, W. (1997). *Sampling Technqiues*, (3rd Ed). New York: John Wiley and Sons Inc.

Collinge, W., Landis, A., Jones, A., Schaefer, L., & Bilec, M. (2013). Indoor environmental quality in a dynamic life cycle assessment framework for whole buildings: Focus on human health chemical impacts. *Building and Environment, 62*, 182 – 190.

Collis, J.,& Hurrey (2003). Business research: A practical guide for undergraduate and postgraduate students. 2nd edition. Basingtoke: Macmillan.

Costa, R. (1989). Architecture in black Africa between development and tradition. *Journal of Solar Wind Energy, 6*(4), 383 – 387.

Creswell, J. (2007). *Qualitative inquiry and research design: Choosing among five approaches (2nd* Ed*.)*. Thousand Oaks, CA: Sage publications.

Creswell, J., & Clark, V. (2007). *Designing and Conducting Mixed Methods of Research*. London: Sage publications.

Daisey, J., Angell, W., & Apte, M. (2003). Indoor air quality, ventilation and health symptoms in schools: An analysis of existing information. *Indoor Air, 13*(1), 53 – 64.

Dale, E. (1984). Management: theory and practice (4th ed.). International student ed. Auckland; Singapore : McGraw-Hill.

Dean, J., & Sharfman, M. (1996). Does decision process matter? A study of strategic decision-making effectiveness. *Academy of Management Journal, 39* (2), 368 – 396.

Dessouky, Y., & Bayer, A. (2002). A simulation and design of experiment modeling approach to analyze facility maintenance costs. *Computers and Industrial Engineering, 43*(3), 423 - 436.

Dessouky, Y.,& Bayer, M. (2012). A simulation and design of experiments modelling approach to minimise building maintenance costs. *Computer and Industrial Engineering, 43*(1), 423-436.

Dewulf, G.,& Van Meel, J. (2003). Democracy in Design. In: Best, R., Langston, C. and De Valence, G. (Eds). *Workplace Strategies and Facilities Management: Building in Value*. Oxford: Butterworth Heinemann.

Dilani, A. (2004). Design and Health III: Health Promotion through Environmental Design. Stockholm. Sweden: *International Academy for Design and Health.*

Downie, M. (2005). Efficiency Outcomes from Space Charging in UK Higher Education Estates. *Property Management*, *23*(1), 33-42.

Drahonovska, H. (2005). Light and lighting. In: Roston, J. (Ed), *Sick Building Syndrome: Concepts, Issues and Practice.* Taylor & Francis e-Library. London: E & FN SPON, Chapman & Hall.

Duffuaa, S., Raouf, A., & Campbell, J. (2000). *Planning and control of maintenance systems.* New York: John Wiley & Sons Inc.

Eckel, P. (2002). Decision rules used in academic program closure: Where the rubber meets the road. *The Journal of Higher Education*, *73*(2), 237-262.

EN 12464 (2007). Light and lighting - Lighting of work places - Part 1: Indoor work. CEN, Brussels.

EN 15251 (2007). Indoor environmental input parameters for design and assessment of energy performance of buildings-addressing indoor air quality, thermal environment, lighting and acoustics. CEN, Brussels.

European Standards (2009). EN-13306, Maintenance Terminology. Available at: www.en-stanard.eu/csn-en-13306-maintenance-tuminilogy/(accessed Jan. 31, 2011).

Evans, G., & Cohen, S. (1987). Environmental stress. In: Stokols, D. & Altman, I. (Eds.), *Handbook of Environmental Psychology 1,* 571 – 610. New York: Wiley.

Evans, G.,& Johnson, D. (2000). Stress and open-office noise. *Journal of Applied Psychology 85*(5), 779 – 783.

Fanger, P., & Christensen, N. (1986). Perception of draught in ventilated spaces. *Ergonomics, 29*(2), 215 – 235.

Fanger P., Lauridsen, J., Bluyssen, P. et. al. (1988). Air pollution sources in offices and assembly halls quantified by the olf unit. *Energy and Buildings, 12*, 7 – 19.

Fink, I. (2002). Classroom use and utilization. *Facilities Manager18(3),* 13-24.

Fish, W., Black, G.,& Brunner, G. (2011). Benefits and Costs of Improved IEQ in US. Offices. *Indoor Air* (2011). 21 (5), 357-367.

Fisk, W. (2001). Estimates of potential nationwide productivity and health benefits from better indoor environments: an update. In: Splenger, J., Samet, J. M., McCarthy, J. F. (Eds) *Indoor Air Quality Handbook,* New York: McGraw-Hill, 1 – 36.

Fromme, H., Diemer, J., Dietrich, S., Cyrys, J., Heinrich, J. & Lang, W. et al. (2008). Chemical and morphological properties of particulate matter (PM10, PM2.5) in school classrooms and outdoor air. *Atmospheric Environment, 42*, 6597 – 6605.

Frontczak M., & Wargocki P. (2011). Literature survey on how different factors influence human comfort in indoor environments. *Building and Environment, 46,* 922–937.

Frontczak, M. (2012). *Human comfort and self-estimated performance in relation to indoor environmental parameters and building features.* Unpublished PhD Thesis, Technical University of Denmark.

Frontczak, M., Schiavon, S., Goins, J., Arens, E., Zhang, H.,& Wargocki, P. (2012). Qualitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. *Indoor Air, 22*(2), 119 - 131.

Gabbar, H., Yamashita, H., Suzuki, K.,& Shimada, Y. (2003). Computer-aided RCM-based plant maintenance management system. *Robotics and Computer Integrated Manufacturing 19*(20), 449 – 458.

Galasiu, A., & Veitch, J. (2006). Occupant Preferences and Satisfaction with the Luminous Environment and Control Systems in Daylit Offices: a Literature review. *Energy and Buildings,* 38, 728 – 742.

Gill, J.,& Johnson, P. (2012). Research methods for managers. London: Sage publications.

Givoni, B. (1998). Effectiveness of mass and night ventilation in lowering the indoor daytime temperatures. Part I: 1993 experimental.

Godish, T. (1995). *Sick buildings; Definition, diagnosis and mitigation.* Boca Raton, FL: Lewis Publishers.

Goyal, R., & Khare, M. (2009). Indoor-outdoor concentrations of RSPM in classroom of a naturally ventilated school building near an urban traffic roadway. *Atmospheric Environment 43,* 6026 – 6038.

Griffin, R. (1994). *Principles of air quality management.* Boca Raton, FL: Lewis Publishers.

Gump, P., & Ross, R. (1977). "What's happened in schools of open design?" Unpublished manuscript, Department of Psychology, University of Kansas.

Hall, R., Hardin, T., & Ellis, R., (1995). School indoor air quality best management practices manual [Washington D. C.] Distributed by ERICClearinghouse, http://www.eric.ed.gov/contentdelivery/servlet /ERICServlet?accno=ED439598. 2015.

Hassanain, M., Froese, T., & Vanier, D. (2003). Framework model for asset maintenance management. *Journal of Performance of Constructed Facilities 17*(1), 51 – 64.

Hassanain, M.,& Mudhei, A. (2006). Post-occupancy Evaluation of Academic and Research Library Facilities. *Structural Survey,* 24(3), 230-9.

Hayslett, M., & Wildemuth, B. (2004). Pixels or pencils? The relative effectiveness of Web-based versus paper surveys. *Library & Information Science Research 26*(1), 73 – 93.

Heath, G., & Mendell, M. (2002). Do indoor environments in schools influence student performance? A critical review of the literature. *Indoor Health and Productivity Project (IHP), Ernest Orlando Lawrence Berkley National Laboratory*. LBNL - 49567.

Hedge, A. (2000). Where are we in understanding the effects of where we are? *Ergonomics 43*(7), 1019-1029.

Heerwagen, J., Kampschroer, K., Powell, K.,& Loftness, V. (2004). Collaborative knowledge work environments. *Building Research and Information, 32*(6), 510-528).

HEFCW (2002). *Space Management: A Good Practice Guide*. Swansea: University of Wales.

Hier, T., & Biddison, G. (1996). Performance & productivity: The space management mandate. *Facilities Manager*. *12* (2), 16-23.

Hillier, B.,& Hanson, J. (1984). *The Social Logic of Space*. Cambridge: Cambridge University Press.

Hinks, J.,& Mcnay, P. (1999). The creation of a management-by-variance tool for facilities management performance assessment, *Facilities 17*(1/2), 31 - 35.

HKEPD (2003). *Environment Hong Kong*. Hong Kong: Environmental Protection Department.

Hoel, D. (1976). Statistical exploration methods for estimating risks from animal data. *Annals of the New York Academy of Sciences 271*, 418 – 420.

Huang, L., Zhu, Y., Ouyang, Q., & Cao, B. (2012). A study on the effects of thermal, luminous, and acoustic environments on indoor environmental comfort in offices, *Building and Environment*, *49*, 304-309.

Huizenga, C., Abbaszadeh, S., Zagreus, L.,& Lehrer, D. (2006). Occupant Satisfaction with Indoor Environmental Quality in Green Buildings. *Proceedings of Healthy Buildings*, Lisbon, III: 365-370

Humphries, M. (2005). Quantifying occupant comfort: Are combined indices of the indoor environment practicable? *Building Research and Information, 33*(4), 317-325.

Ibrahim, I., Yusoff, W.,& Bilal, K. (2012). Space Management: a Study on Space Usage Level in Higher Education Institutions. *Social and Behavioural Sciences, 47*, 1880-1887.

Ibrahim, I., Yusoff, W.,& Sidi, N. (2011). An Effective Management Use of Lecture Room by Space Charging Model. *International Journal on Social Science, Economics and Art, 1*(2), 131–138

Ibrahim, I., Yussof, W., & Sidi, S. (2011). *A comparative study on elements of space management in facilities management at higher education institutions.* Paper presented at International Conference on Sociality and Economics Development. Singapore

Indoor Air Quality Management Group (IAQMG). (1999). *The government of the Hong Kong Special Administrative Region: Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places*.

IPMVP (2001). Concepts and options for determining energy and water savings. *International Performance Measurement and Verification Protocol.*

Jansz, J. (2011). Sick building syndrome identification and risk control measures. In: S. A. Abdul-Wahab (Ed.), *Sick building syndrome in public buildings and workplaces* (533 – 588). Berlin: Springer.

Jensen, K., & Arens, E. (2005). *Acoustical Quality in Office Workstations as Assessed by Occupant Surveys.* Proceedings, Indoor Air, Sept. 4-9, Beijing, China.

Jones, A. (1999). Indoor air quality and health. *Atmos Environ, 33*(28), 45

Katzev, R. (1992). The impact of energy-efficient office lighting strategies on employee satisfaction and productivity. *Environment and Behaviour 24*(6), 759 – 778.

Kim, J., &Dear, R. (2012). Nonlinear relationships between individual IEQ factors and overall workspace satisfaction. *Build Environ 49*, 33 – 40.

Knapp, H., & Kirk, S. (2003). Using pencil and paper, internet and touch-tone phones for self-administered surveys: Does methodology matter? *Computers in Human Behavior 19*(1), 117 – 34.

Knight, S., & Cross, D (2012). Using contextual constructs model to frame doctoral research methodology. *International Journal of Doctoral Studies 7*, 39 – 62.

Korpi, A., Takki, T., Virta, M., Kosonen, R., & Villberg, K. (2011). *Solving indoor environmental problems: What can be found out through individual measurements?*In: S. A. Abdul-Wahab (Ed.), Sick building syndrome in public buildings and workplaces (pp. 439 – 452). Berlin: Springer.

Kortum, E. Leka, S.,& Cox, T. (2011). Perceptions of psychosocial hazards, work-related stress and workplace priority risks in developing countries. *Journal of Occupational Health 53*, 144 – 155.

Kothari, C. (2013). *Research Methodology*. New Delhi: New Age International (P) Limited Publishers.

Larsen, L., Adams, J., Deal, B., Kweon, B.,& Tyler, E. (1998). Plants in the workplace: The effect of plant density on productivity, attitude and perceptions. *Environment and Behaviour 30*(3), 261 - 281.

Lateef, O., Khamidi, M.,& Idrus, A. (2010). Building maintenance management in a Malaysian university campuses: a case study. *Australasian Journal of Construction Economics and Building, 10*(1/2), 76 - 89.

Lavy, S., Garcia, J., & Dixit, M. (2010). Developing a categorization matrix of Key Performance Indicators (KPIs): a literature review. In: *Proceedings of the CIB - W70 International Conference in Facilities Management: FM in the Experience Economy*, Sao Paulo.

Leaman, A.,& Bordass, B. (2007). Are users more tolerant of green buildings? *Building Research and Information*, *35*(6), 662 - 673.

Leather, P., Pyrgas, M., Beale, D., & Lawrence, C. (1998). Windows in the Workplace. Sunlight, View, and Occupational Stress. *Environment & Behavior, 30*(6), 739 – 762.

Lee, M., Mui, K., Wong, L., Chan, W., Lee, E., & Cheung, C. (2012). Student learning performance and indoor environmental quality (IEQ) in air-conditioned university teaching rooms. *Building and Environment 49*(3), 238 – 244.

Loosemore, M., & Hsin, Y. (2001). Customer-focused benchmarking for facilities management. *Facilities 19*(13)

Mahdavi, A.,& Kumar, S. (1996). Implications of indoor climate control for comfort, energy and environment. *Energy and Buildings 24*(3), 167 – 177.

Mallory-Hill, S., van der Voost, T., & Van Dortmost, A. (2004). Evaluation of innovative workplace design in the Netherlands. In: Preiser, W. F. E. & Vischer, J. (Eds), *Assessing building performance* (pp. 160–169). London: Elsevier Science Publishers.

Malmgvist, T., & Glaumann, M. (2009). Environmental Efficiency in Residential Buildings – A Simplified Communication Approach. *Building and Environment.* 44(2009) 937 – 947.

Marans, R., & Spreckelmeyer, K. (1982). Evaluating open and conventional office design. *Environment and Behaviour 14*(3), 333 – 351.

Marczyk, G., DeMatteo, D.,& Festinger, D. (2005). *Essentials of research design & methodology*. New York: John Wiley & Sons Inc.

Marquez, A.,& Gupta, J. (2006). Comtemporary Maintenance Management: process, framework and supporting pillars. *The International Journal of Management Science, Omega*, *34*, 313 – 326.

Mayo, E., (1933). The Human Problems of an Industrial Civilisation, Macmillan, 2nd edn Harvard University, 1946.

McCoy, J., & Evans, G. (2005). *Physical Work Environment*. In: Barling, J., Kelloway E.K. & Frone, M. R. (Eds.). Handbook of Work Stress: Thousand Oaks, C. A.: Sage

McGregor, W., & Then, D. (1999). *Facilities Management and the Business of Space*. Kent: Butterworth-Heinemann.

McGregor, W., & Then, D. (2001). *Facilities Management and the Business of Space*. Butterworth – Heinemann Oxford, U. K.

Meckler, M. (1996). *Improving indoor air quality through design, operation and maintenance.* Lilburn, GA: The Fairmont Press, Inc.

Melorose, J., Perroy, R. & Careas, S. (2015). Implementation of the Global Efficiency Equipment in the Machining Sector. Statew. Vol. 1, Statewide Agricultural Land Use Baseline, 163-172.

Mendell, M., Fisk, W., Kreiss, K., Levin, H., Alexander, D., Cain, W. Girman, J. Hines, C., Jensen, P., Milton, D., Rexroat, L., & Wallingford, M. (2002). Improving the health of workers in indoor environments: priority research needs for a national occupational research agenda. *Am J Public Health 92*(9), 1430 – 1440.

Mike, A. (2010). Visual workplace: How you see performance in the planet and in the office. *International Journal of Financial Trade, 11*(3), 250 - 260.

Miller, J. (1978). *General psychological and sociological effects of noise.* In E.C. Carterette & M.P. Friedman (eds.), Handbook of Perception. Vol. VI: Hearing. New York: Academic Press.

Milton, D., Glencross, P., & Walters, M. (2000). Risk of sick leave associated with outdoor air supply rate, humidification, and occupant complaints. *Indoor Air 10*(4), 212 - 221.

Minior, S., Hanafin, N., & Bringhurst, F. (2004). Research Space Management-A Dynamic Process for Optimal Space Utilization and Strategic Planning. *Massachusetts General Hospital*.

Mital, A., McGlothlin, J., & Faard, H. (1992). Noise in multiple workstation open-plan computer rooms: Measurements and annoyance. *Journal of Human Ergology 21*, 69–82.

Molhave, L. (1991). Volatile organic compounds, indoor air quality and health. *Indoor Air 1,* 357 – 376.

Molhave, L. (2003). Biomarkers and other substitute measures in indoor air sciences. *Indoor air,* 13, 369-370.

Moloney, J. (2011). *Designing kinetics for architectural facades: state change.* Abingdon, Oxon; New York: Routledge.

Muchiri, P., Pintelon, L., Gelders, L.,& Martin, H. (2011). Development of maintenance function performance measurement. Framework and indicators. *International Journal of Production Economics 131*(1), 295 – 302.

NAO. (1996). *Space Management in Higher Education: A Good Practice Guide*. London: National Audit Office. Pursglove,

Nasir, A., Musa, A., Che-Ani, A., Utaberta, N., Abdullah, N., & Tawil, N. (2011). Identification of Indoor Environmental Quality (IEQ) Parameter in Creating Conducive Learning Environment for Architecture Studio. *Procedia Engineering, 20*, 354-362.

National Universities Commission, NUC. (2004). *Report on the Performance of the Federal University System in Nigeria*. Paper Presented at the Special Meeting Convened by the Minister of Education. December, 12.

Nicol, J.,& Humphreys, M. A. (2002). Adaptive Thermal comfort and Sustainable Thermal Standards for Buildings. *Energy and Buildings*, 34(6), 563-572.

Nieuwenhuijsen, M. (ed) (2003) *Exposure assessment in Occupational and Environmental Epidemiology*. Oxford University Press. ISBN 0-19-852861-2

Nikolopoulou, M., & Steemers, K. (2003). Thermal comfort and psychological adaptation as a guide for designing urban spaces. *Energy Build, 35*(1), 95 – 101.

Nimlyal, P., Kaandar, M.,& Sediadi, E. (2015). Empirical investigation of indoor environmental quality (IEQ performance in hospital buildings in Nigeria. *Journal technologies (Sciences and Engineering)*, 77:14-50.

Norback, D., & Nordstrom, K. (2008). An experimental study on effects of increased ventilation flow on students' perception of indoor environment in computer rooms. *Indoor Air 18*(4), 293-300.

Nwogu, B. (1991). *Educational research: Basic issues and methodology*. Ibadan: Wisdom Publishers Limited.

O'Sullivan, D., Keane, M., Kelliher, D.,& Hitchcock, R. (2004). Improving building operation by tracking performance metrics throughout the building lifecycle (BLC). *Energy and Buildings Journal 36*, 1075 – 1090.

Odiake, T. (2016). The way forward for Nigerian Universities. *Punch* newspaper, August 19, 2016, 23.

Ogolo, M. (1996). *Student guide to writing research and project proposals.* Port Harcourt: City Creeks Publishers.

Ojogwu, C., & Alutu, A. (2009). Analysis of the Learning Environment of University Students in Nigeria. *Journal of Social Science 19*(1), 69 – 73.

Okebukola, P. (2002). *The State of University Education in Nigeria*. Abuja: National Universities Commission.

Okolie, K. (2011). *Performance Evaluation of Buildings in Educational Institution: a case of Universities in South-East Nigeria*. Ph.D Thesis, Nelson Mendela Metropolitan University, Port Elizabeth, South Africa.

Olanrewaju, A., & Kafayah, S. (2008). The Need to maintain our buildings: Sustainable Development. In: *Proceedings of PSIS Enviro (The 1st National Seminar on Environment, Development and Sustainability)*. Politeknik Sultan Idris Shah, PSIS, Ssbak Bernam, Selangor, Malaysia.

Oldham, G., & Rotchford, N. (1983) Relationships between office characteristics and employee reactions: a study of the physical environment. *Adm. Sci. Q*. 28, 542–556.

Olesen, B. (2015). Indoor environmental input parameters for the design and assessment of energy performance of buildings. *REHVA Journal* (ISSN: 1307-3729), pages: 17 – 23.

Olesen, B.,& Brager, G. (2004). A better way to predict comfort: The new ASHRAE standard 55-2004. *ASHRAE Journal*, 20 – 26.

Ornstein, S. (1999). A post-occupancy evaluation of workplaces in Sao Paolo, Brazil. *Environment and Behavior, 31*(4), 435-462

Oseland, N. (1999). *Environmental Factors Affecting Office Workers' Performance: A Review of Evidence*. CIBSE Technical MemorandumTM24. Paris: CIBSE.

Ozturk, A.,& Balanlı, A. (1995). Building biology: Concepts and scope. *Symposium of Healthy Cities and Civil Engineering*, pp. 135-140.

Passarelli, G., (2009). Sick building syndrome: An overview to raise awareness. *Journal of Building Appraisal 5*(1), 55 – 66.

Patrick, D. (1994). *Toxic air pollution handbook.* New York, NY: Van Nostrand Reinhold

Penn, A., Desyllas, J.,& Vaughan, L. (1999). The Space of Innovation: Interaction and Communication in the Work Environment. Environment and Planning B: *Planning and Design 26*(2), 193 – 218.

Peponis, J., Sonit, B., Ritu B., Joyce B., Christine C., Mahbub, R., Susan, W., Zhang, Y., & Craig, Z. (2007). Designing space to support knowledge work. *Environment and Behavior, 39*(6), 815 - 840.

Pinjala, S., Pintelon, L. & Vereecke, A. (2006). An empirical investigation into relationship between business and maintenance strategies. *International Journal of Production economics, 104*, 214-229.

Pintelon, L., Gelders, L. & Van Puyvelde, F. (2000). *Maintenance Management*, Acco Leuven/Amersfoort.

Preiser, W., & Vischer, J. (2005). *Assessing Building Performance*, Elsevier, Oxford, United Kingdom.

Property Council of Australia (2009). *Managing indoor environmental quality*. Property Council of Australia, Sydney, NSW.

Pukite, I., & Geipele, S. (2017). Determining Customer Satisfaction in the Real Estate Management Sector in Riga. *Baltic Journal of Real Estate Economics and Construction Management, 5(1)*, 226-237.

Ray, M., & Lahiri, T. (2010). Health Effects of Urban Air Pollution in India, *Air Pollution: Health and Environmental Impacts*. Ed. Bhola R. Gurjar, Luisa T. Molina, and C. S. P. Ojha. Boca Raton: CRC Press, 165–202.

Riley, M., Kokkarinen, N.,&Pitt, M. (2010). Assessing post occupancy evaluation in higher education facilities. *Journal of Facilities Management 8*(3), 202 – 213.

Robson, C. (2011). *Real world research: A resource for users of social research methods in applied settings.* John Wiley & Sons.

Roelofsen, P. (2002). The impact of office environments on employee performance: The design of the workplace as a strategy for productivity enhancement. *Journal of Facilities Management, 1(*3), 247-264.

Rogers, C. (2002). *Space Management in Higher Education: Report of the Findings of the Newcastle University Space Management Project* (pp. 1–88). Newcastle: University of Newcastle.

Russell, J., & Doi, J. (1957). *Manual for Studies of Space Utilization in Colleges and Universities*. American Association of Collegiate Registrars and Admissions Officers

Sailer, K.,& Penn, A. (2007). The Performance of Space – Exploring Social and Spatial Phenomena of Interaction Patterns in an Organisation. *Paper presented at the International Architecture + Phenomenology Conference,* 13-17 May 2007, in Haifa, Israel.

Sailer, K.,& Penn, A. (2009). Spatiality and transpatiality in workplace environments: In: Koch, D., Marcus, L. & Steen, J. (eds.), *7th International Space Syntax Symposium* (Stockholm, Sweden: Royal Institute of Technology KTH), 095:01 - 95:11.

Salleh, M., Mahmoud, D., Karim, W.,& Idris, A. (2011). Cationic and anionic dye adsorption by agricultural solid wastes: a comprehensive review. *Desalination 280*(1–3), 1–13.

Salthammer, T. (2011). Evaluation of Formaldehyde Guideline Values for Indoor Air. Joint Conference of International Society of Exposure Science & International Society for Environmental Epidemiology, Jan.

Samet, J., Marbury, M., & Spengler, J. (1987). Health effects and sources of indoor air pollution. Part I. *Am Rev Respir Dis, 36*(6), 1486-1508.

Saunders, M., Lewis, P.,& Thornhill, A. (2009). Research methods for business students. England: Pearson Education Limited

Seeley, I. (1976). *Building Maintenance* – 1st Ed. London: Macmillan Publishers Ltd.

Sekaran, U. (2003). *Research method for business: A skill building approach,* 4th edition. New York: John Wiley & Sons

Seppänen, O., Fisk, W., &Faulkner, D. (2003). Costs benefit analysis of the night-time ventilative cooling. In: *Proceedings of the Healthy Buildings 2003 Conference.* Singapore, 3:394-399.

Seppänen, O. & Fisk, W. (2006). Some quantitative relations between indoor environmental quality and work performance or health. *International Journal of HVAC&R Research, 12*(4), 957 – 973.

Shakantu, W.M. (2004). An investigation into building material and waste logistics: A case of Cape Town. Unpublished Ph.D. thesis. Britain Glasgow Caledonian University.

Shen, Q., Lo, K., & Wang, Q. (1998). Priority setting in maintenance management: A modified multi-attribute approach using analytic hierarchy process. *Construction Management & Economics, 16*(6), 693 – 702.

Sherwin, D. (2000). A review of Overall Models for Maintenance Management. *Journal of Quality Maintenance Engineering*, 6(3), 138-164.

Shikdar, A. (2002). Identification of ergonomic issues that affect workers in oilrigs in desert environment. *International Journal of Occupational Safety and Ergonomic, 10*(8), 169 - 177.

Smedje, G.,& Norback, D. (2000). New ventilation systems at select schools in Sweden-Effects on asthma and exposure. *Archives of Environmental Health 55*(1), 18 – 25.

Snee, R. (2015). A Practical Approach to Data Mining: I Have All These Data; Now What Should I Do?, *Quality Engineering, 27(4),* 477-487 , Taylor & Francis

Space Management Group. (2006). *Space Utilisation: Practice, Performance and Guidelines*. London: SMG

Spengler, J.,& Chen, Q. (2000). Indoor air quality factors in designing a healthy building. *Annual Review of Energy and the Environment 25*, 567 – 600.

Spengler, J., Samet, J., & McCarthy, J. (2000). *Indoor air quality handbook.* New York, NY: McGraw-Hill.

Sundell, J. (2004). On the history of indoor air quality and health. *Indoor Air 14*(7), 51 – 58.

Sundstrom, E., Burt, R.,& Kamp, D. (1980). Privacy at work: Architectural correlates of job satisfaction and job performance. *Academy of Management Journal, 23*, 101 – 117.

Sundstrom, E., Town, J., Rice, R., Osborn, D.,& Brill, M. (1994) Office noise, satisfaction and performance. *Environment and Behavior 26*(2), 195 – 222.

Sutrisna, M. (2009). Research methodology in doctoral research; understanding the meaning of conducting qualitative research. Working paper presented in ARCOM doctoral workshop. Liverpool: John Moores University. May 12.

Tabachnick, B., & Fidell, L. (2013). *Using Multivariate Statistics*. 6th Ed Boston: Pearson.

Takki, T.,& Virta, M. (2007). A systematic method for improving indoor environment quality through occupant satisfaction surveys. *Proceedings of the 9th REHVA World Congress Clima 2007.*

Takki, T., Villberg, K., Hongisto, V., Kosonen, R., & Korp, A. (2011). Sick building syndrome from an architectural perspective. In: S. A. Abdul-Wahab (Ed.), *Sick building syndrome in public buildings and workplaces* (pp. 353 – 370). Berlin: Springer.

Then, D. (1994). Facilities Management – The Relationship between Business and Property. *Proceedings of Joint EuroFM/IFMA Conference – Facility Management European Opportunities*, 253–262

Thompson, O. (2002). Much the same, but different' the use of space as an academic resource. *Perspectives*, *6*(4), 105 – 109.

Tiller, K. (2001). Lighting recommendations. In: Splenjer, J., Samet, J. M., McCarthy, J. F. (Eds) *Indoor Air Quality Handbook*, New York: McGraw-Hill.

Toftum, J. (2002). Human response to combined indoor environment exposures. *Energy and buildings*, 34:601-606.

Toftum, J. (2004). Air movement – Good or bad? *Indoor Air 14*(7), 40 – 45.

Tünay, O.,& Alp, K. (1996). *Hava kirlenmesi kontrolü.* Istanbul: Mega Ajans.

Uhde, E.,& Salthammer, T. (2007). Impact of reaction products from building materials and furnishings on indoor air quality—a review of recent advances in indoor chemistry. *Atmespheric Environment 41*(15), 3111 – 3128.

Unwin, S., Fecht, B., & Bergsman, T. (2008). Business metrics of laboratory space utilization. *Facilities*, *26*, 366 – 373.

Veitch, J., & Gifford, R. (1996). Assessing beliefs about lighting effects on health, performance, mood and social behaviour. *Environment and Behavior 28*, 446-470.

Veitch, J. & Newsham, G. (1998). Lighting quality and energy-efficiency effects on task performance, mood, health, satisfaction and comfort. *Journal of the Illuminating Engineering Society 27*(1), 107 – 129.

Veitch, J., & Newsham, G. (2000). Exercised control, lighting choices, and energy use: An office simulation experiment. *Journal of Environmental Psychology*, *20*(3), 219–237.

Veitch, J., Charles, K., Newsham, G., Marquardt, C.,& Geerts, J. (2004). *Workstation characteristics and environmental satisfaction in open-plan offices: COPE field findings* (NRCC-47629). Ottawa, Canada: National Research Council.

Veitch, J., Newsham, G., Mancini, S., & Arsenault, D. (2010). *Lighting and Office Renovation Effects on Employee and Organizational Well-Being.* Ottawa, Canada: National Research Council.

Vince, I. (1987). *Sick building syndrome.* IBTC Technical Services, London.

Visser, J. (1998). Modelling maintenance performance: a practical approach. *IMA Conference*, Edinburgh, 1 – 13.

Vischer, J. (2005). *Space meets status: Designing workplace performance*. Oxford, UK: Taylor and Francis/Routledge.

Vischer, J. (2006). The Concept of Workplace Performance and its Value to Managers. *California Management Review* 49(2), 1-18.

Vischer, J. (2008). Towards Environmental Psychology of Workspace: How People are affected by Environments for Work. *Architectural Science Review 51*(2), 92-108.

Vural, S. (2004). Yapi Ici Hava Niteligi Risk Sureci Modeli Belirlenmesi. Doktora Tezi. YTU FBE, Istanbul.

Vural, S. (2011). Indoor air quality. In: S. A. Abdul-Wahab (Ed.), *Sick building syndrome in public buildings and workplaces* (pp. 59 - 74). Berlin: Springer.

Vural, S., & Balanli, A. (2011). Sick Building Syndrome from an Architectural Perspective. In: S. A. Abdul-Wahab (Ed.), *Sick building syndrome in public buildings and workplaces* 371 – 392. Berlin: Springer.

Waeyenbergh, G., & Pintelon, L. (2002). A framework for maintenance concept development. *International Journal of Production Economics 77(*3), 299 - 313.

Walinder, R., Norback, D., Wieslander, G., Smedje, G., Erwall, C.,& Venge, P. (1998). Nasal patency and biomarkers in nasal lavage – the significance of air exchange rate and type of ventilation in schools. *Int Arch Occup Environ Health* 71, 479 – 86.

Wargocki, P., Wyon, D., Baik, Y., Claussen, G., & Fangerr, P. (1999). Perceived air quality, sick building syndrome (SBS) and productivity in an office with two different pollution loads. *Indoor Air, 9*(3), 165 – 179

Wireman, T. (1998). *Developing performance indicators in maintenance*, New York: Industrial Press.(Balanli & Ozturk, A Systematic Approach to solve Building Biology related problems, 1997; Balanli & Ozturk, A conceptual model to examine buildings in terms of building biology, 2004; Barrett, Zhang, & Moffat)

Wong, H., & Jan, W. (2003). Total building performance evaluation of academic institution in Singapore. *Building and Environment, 38*, 161-176.

Wong, L., Mui, K.,& Hui, P. S. (2008). A Multivariate Logistic Model for Acceptance of Indoor Environmental Quality (IEQ) in Offices. *Building and Environment43*(1), 1-6.

Wood, B. (2003). *Building care*. Oxford, United Kingdom: Blackwell Publishing.

World Health Organisation (WHO) (1983). Indoor air pollutants: Exposure and health effects. EURO reports and studies No. 78 Copenhagen: WHO regional office for Europe.

World Health Organisation (WHO) (2009). WHO guidelines for indoor air quality: Dampness and mould. In: Heseltine, E. & Rosen, J. (Eds). Germany: WHO: Europe division.

World Health Organization (WHO), (2008). World Health Statistics.

Yin, R. (2003). *Case study research: design and methods (3rd Ed.)*. Los Angeles: Sage Publications.

Yin, R. (2009). *Case study research: design and methods (4th Ed.)*. Los Angeles: Sage Publications.

Zagreus, L., Huizenga, C., Arens, E.,& Lehrer, D. (2004). Listening to the Occupants: Web – based Indoor Environment Quality Survey. *Indoor Air14(8)*, 65-74

Zalejska-Johnson, A., & Wilhelmsson, M. (2013). Impact of perceived IEQ on overall satisfaction in Swedish dwellings. *Building and Environment, 63*, 134 - 144.

Zubairu, S. N. (1999). Maintenance of government office building in Nigeria – a post occupancy evaluation approach. Unpublished PhD. thesis, Department of Building,University of Lagos, Lagos state, Nigerias

APPENDIX II

Record Sheet 1 Subjective and Objective Assessment on IEQ in Office Workspace in SET

Office: **Assessment Period (days):**

User: **Dept.:** **Workspace I - A1**

IEQ Parameters		**Assessment, Preferences and Measurements**												**Remarks**
	Time	**10am**			**12pm**			**2pm**			**4pm**			
	Assess	S	I	NS	S	I	NS	S	I	NS	S	I	NS	
	Pref.	H	E	L	H	E	L	H	E	L	H	E	L	
Temperature (°C)	Assess.													
	Pref.													
	Readings													
Humidity (%)	Assess.													
	Pref.													
	Readings													
Air Movement (m/s)	Assess.													
	Pref.													
	Readings													
Acoustics (dBA)	Assess.													
	Pref.													
	Readings													
Lighting (Lux)	Assess.													
	Pref.													
	Readings													
Workspace II – A2														
Temperature (°C)	Assess.													
	Pref.													
	Readings													
Humidity (%)	Assess.													
	Pref.													
	Readings													
Air Movement (m/s)	Assess.													
	Pref.													
	Readings													
Acoustics (dBA)	Assess.													
	Pref.													
	Readings													
Lighting	Assess.													

(Lux)	Pref.													
	Readings													

Recorder’s Name: ___________________________ DATE: ____________________ SIGN: _______________

APPENDIX III

mean temp.	Code	MEAN HUMIDITY	CODE	MEAN ACOUSTIC	CODE	mean air flow	Code	mean lighting	code
31.1	0	67.1	0	46.55	1	0	0	154.1	0
30.05	0	76.35	1	70.5	1	0	0	303	0
27.5	1	78.35	1	47.5	1	0	1	439	0
27.85	1	76.9	1	69.4	1	0	1	160.8	0
29.3	1	69.85	1	44.65	1	0	1	961	0
29.15	1	80.3	0	74	0	0	0	575	1
26.5	1	86.25	0	70.05	0	0	0	99.8	0
27.7	1	82.95	0	59.15	0	0	0	103.9	0
28.2	0	78.7	1	65.7	0	0	1	147.8	1
29.15	0	77.65	0	62.45	0	0	1	302	0
29.8	0	73.5	1	75.35	0	0	1	94.9	0
25.3	0	85.35	1	52.75	0	0	1	109.1	0
26.6	1	84.15	1	48.05	0	0	1	292	1
27.7	1	82.55	1	67.85	0	8	0	51.7	0
28.5	0	80.85	0	43.55	1	4	1	111	0
29.2	0	76.2	0	46.35	0	0	0	180.1	1
29.8	0	75.05	0	84.3	0	0	0	1.8	0
27	1	73.95	1	56.6	0	0	0	86	0
26.35	0	92.1	0	57.65	0	0	0	100	0
31.45	0	65.4	0	52.55	0	0	0	624	1
29.6	0	72.25	0	54.4	0	8	0	601	1
30.55	0	64.9	0	46	0	0	0	849	0
31.7	0	64.35	0	59.15	0	0	0	386	0
28.6	0	76.6	0	62.75	0	0	0	135.5	0
29.6	0	72.55	0	73.6	0	0	0	194.3	0
31	0	69.2	0	40.4	0	0	0	427	0
24.85	0	76.45	0	52.4	0	0	0	219	0
24.85	0	72.4	0	52.45	0	0	0	263	0
25.7	0	81.2	0	56.55	0	0	0	184.3	0
26.4	0	79	0	55.45	0	0	0	256.4	0
26.55	0	79	0	56.95	0	0	0	714	0
29.4	1	79	0	51.85	1	0	0	903.4	0
29.3	0	78	0	60.75	1	0	0	435	0
28.95	1	77	1	67.1	1	0	0	632	0
32.2	0	64	0	49.6	0	7	0	529	0
25.65	1	88	0	56.9	0	4	0	490	0
28.25	0	77.25	0	47.45	0	9	0	466	0
26.05	1	87.15	1	58.55	0	4	0	494	0

31.05	0	64.85	0	50.8	0	9	0	470	0
27.2	0	78.4	1	63.55	0	0	0	383	0
27.15	1	82.3	1	49.9	0	0	0	302	0
24.55	1	94.8	1	65.8	0	0	0	397	0
28.15	1	76.75	1	56.65	0	0	0	286	0
26.65	0	80.7	0	48.25	0	0	0	192	0
27.15	1	81.6	1	76.3	0	4	0	334	0
27.35	1	82.7	0	45.15	0	0	0	194	1
28.05	1	78.55	0	67.1	0	0.4	0	852	0
28	1	83.16	1	68.7	0	0.4	0	451	0
28.45	0	79.45	1	69.2	0	0.4	0	215	0
28.45	0	78.85	0	78.05	0	0.6	0	110	1
28.85	1	89.3	1	62.9	0	0.6	0	631	0
27.15	0	82.7	0	77.15	0	0	0	630	0
28.75	1	78.65	0	80.4	1	0.7	0	208	1
28.95	1	87.85	0	63.95	1	0	0	316	0
27.5	0	81.35	0	50.35	0	0	0	394	0
30.55	0	83.2	0	49.55	0	0	0	375	0
27.2	0	80.3	0	86.25	0	0	0	545	0
28.45	1	69.95	0	67.65	0	0	0	650	1
27.65	0	76.75	0	43.8	0	0	0	685	0
29.75	0	67.5	0	64.4	0	0	0	215	0
28.2	0	62.35	0	46.55	0	0.4	0	259	0
28.85	0	68.7	0	48.9	0	0	0	540	0
30.6	0	61.2	0	74.3	0	0	0	928	0
27.65	0	65.7	0	66.25	0	0	1	253	1
31.5	0	56	0	45.6	0	0	0	111	0
26.55	0	79	0	71.4	0	0	0	332.5	0
27.95	0	60.25	1	50.05	1	0.5	1	501	0
24.95	0	74.7	0	73.4	0	0	1	172.9	0
26.45	1	73.6	1	8404	1	0.4	0	92.2	1
25.7	0	56.45	0	47.35	0	0	1	236	1
26.15	0	61.05	0	55.5	1	0	0	106.2	0
25.9	0	67.4	0	85.3	0	0	0	61	1
26.2	0	56.9	0	75.2	0	1.7	1	31.3	1
25.15	0	63.45	0	53.85	0	1.5	1	99.8	0
24.4	0	81.8	0	70.9	1	0.5	1	109	0
27.2	0	60.35	0	56.9	0	0.7	1	122.4	0
31.25	0	67	0	57.65	1	3.1	1	190	0
24.45	0	62.75	0	56.9	1	4.2	1	94.9	0
22.5	0	79.45	0	47.45	1	4	0	116.5	0
29.7	0	88	0	74.9	1	0	0	368	1
24.2	1	77.25	0	65.8	1	4	1	123.4	1
27.6	0	94.8	0	56.65	1	4	1	854	1

28.45	1	76.75	1	48.25	0	3.3	1	574	0
29	0	80.7	1	69.2	1	3.5	1	112.7	1
28.15	0	81.6	0	78.05	1	4.1	0	844	0
25.65	0	78.85	0	62.9	1	0	1	549	1
28.25	0	89.3	0	77.1	0	0	1	789	1
22.5	1	82.7	0	88.9	1	0	1	151.3	1
28.15	1	79.45	1	70.15	0	0	0	492	1
26.65	1	74.9	1	56.45	0	0	0	192.7	1
27.15	1	71.9	1	71.95	1	0	1	904	1
28.85	0	83.2	1	48.25	1	0	1	335	1
27.15	1	77.25	1	66.6	1	0	1	480	1
27.75	1	80.65	1	69.25	0	0	1	158.2	1
28.75	1	79.6	1	43.65	0	0	1	915	1
29.35	1	76.4	1	54.9	1	0	1	339	1
30.55	1	74.9	1	57.6	1	0	1	131.6	1
27.2	1	77.95	1	66.4	1	0	1	136.6	1
28.25	1	75.85	1	57.05	1	0	1	164.8	1
28.8	1	73.6	1	67.4	1	0	1	123.8	1
27.65	1	72.4	1	51.4	0	0	1	235	0
28.45	1	79.6	1	63.95	1	0	1	163.7	0
28.5	0	77.8	0	57.6	1	0	0	156.1	0
28.45	1	70	1	75.15	1	0	1	132.1	0
28.7	1	66.7	1	61.95	1	0	1	201	0
29.75	1	76.35	1	68.5	1	0	1	148	0
29.2	0	76.55	1	65.7	1	0.4	1	113	0
28.55	1	80.3	1	64.45	1	0	0	100.2	0
29.25	1	73.05	1	56.35	1	0	0	125.1	0
29.5	1	70	1	46.3	1	0	1	142.9	0
30.55	1	71.65	1	72.1	1	0	1	96.1	1
30.3	1	75.15	1	66.05	1	0	1	262	0
30.35	1	49.25	1	61.05	1	0	0	197	1
28.8	1	32.55	1	62.65	1	0	0	23.9	1
29.85	1	19.5	1	66.65	1	0	0	21.7	1
31.05	1	38.3	1	68.7	1	0	1	172.9	1
31.05	1	32	1	78.25	1	0	1	321	1
29.25	1	48.6	1	69.35	1	0	1	200	1
28.95	1	48.6	1	66.75	1	0	1	181.1	1
29	1	36.65	1	67.1	1	0	1	184.3	1
31.45	1	33.5	1	73.3	0	0.8	0	115.6	1
28.95	1	50.65	1	68.35	0	0.4	0	209	1
28.65	1	49.3	1	66.5	0	0	1	203	1
30.85	1	50.6	0	61.05	0	0	1	198	1
32.6	1	50.3	1	29.8	0	0	1	102.9	1
30.6	1	48.35	1	65.5	0	0	0	131	1

29.85	1	45.05	1	60.15	0	0	1	184.5	0
29.1	1	41.55	1	58.05	0	0.8	0	159.4	0
31.65	1	44.4	0	61.65	0	0	0	140	0
32.1	0	45.25	0	57.25	0	0.4	0	198.3	0
29.6	0	49.45	0	59.8	1	0	0	221	0
29.3	1	50.6	0	56.15	1	0	0	188	0
32.15	0	49.85	1	70.35	1	0	0	158	0
29.45	0	52.7	1	67.55	1	0	0	150.3	0
29.25	0	43.45	1	74	1	0	0	139	1
26.9	0	40.05	1	74.1	1	0	0	118.4	1
27.1	0	33.35	1	71.3	1	0	0	151.5	1
27.5	1	43.1	1	67.8	1	0	0	135	1
27.9	1	41.9	1	77.25	1	0	0	233	1
30.6	1	40.55	1	70.2	0	0	0	200	1
28.7	1	40.2	1	67.85	1	0	0	333	1
28.85	1	39.65	0	59.7	0	0	0	182.2	1
27.65	1	33.35	1	58.2	0	0	0	166	1
28.05	1	36.85	0	75.05	0	0.7	0	306	0
29	1	40.7	0	68.75	0	0.4	0	167	1
27.55	1	42.2	0	60.45	0	0.9	0	396	1
29.75	1	37.1	0	77	0	0.4	0	354	1
56.8	1	39.55	1	62.05	1	0.9	0	136.5	0
28.4	0	39.8	0	68.75	0	0	0	140.3	0
30.45	0	40.05	0	64.9	0	0	0	126	1
30.5	0	55.25	0	58.25	0	0	0	376	0
28.8	0	37.8	0	52.2	1	0	0	223	1
28.5	1	36.2	1	72.15	1	0	0	184	0
27.55	1	49.25	0	72.85	0	0.4	0	169.7	0
27.6	0	48.45	1	52.25	0	0	0	144.3	0
30.35	0	29.45	1	73.4	0	0	0	145.1	0
29	0	27.95	0	71.1	0	0.4	0	272	0
28.6	1	36.75	1	63.85	0	0.4		126.1	1
31.8	0	43.2	1	78.05	0	0.4	0	192.7	1
32.7	1	37.5	0	57.25	1	0.4	0	235	0
27.4	1	35.1	0	46.4	0	0.6	0	151.7	0
29.45	1	45.75	1	62.7	0	0.6	1	54.4	0
27.95	0	39.15	1	78.6	0	0	0	40.7	0
31.6	0	47.2	0	57.6	0	0.7	1	46.3	0
32.35	1	32.55	1	67.45	0	0	0	37.6	0
33.2	0	45.9	0	54.05	0	0	0	380	1
31.3	0	38.05	0	56.1	0	0	0	286	0
31.5	1	37.45	0	52.05	0	0	0	381	1
34.55	1	40.9	0	50.8	0	0	0	285	0
31.5	0	45.05	1	59.2	1	0	0	111	0

33.35	0	43.2	0	71.55	0	0	0	99.4	0
32.35	0	46.5	0	71.65	0	0.4	0	72.4	0
31.8	0	41.7	1	58.9	0	0.8	0	69	0
29.4	0	42	1	68.5	0	0	1	441	0
29.25	0	48.2	0	58.05	0	0	0	450	0
32.3	1	45.8	0	74.75	0	0	0	684	0
32.75	1	37.95	1	62.3	0	0.4	1	382	1
30.6	0	46.9	0	70.7	0	0.4	1	294	0
29.85	1	45.25	0	72.65	0	0	1	44.4	0
34.35	1	44.55	1	70.5	0	0	1	57.5	0
31.95	0	48.75	1	40.65	0	0	1	89.7	0
32.8	0	49.25	0	48.7	0	0	1	354	0
34.45	1	51.4	0	52.75	0	0	0	390	0
31.9	1	50.15	1	62.55	0	0	1	331	0
32.5	1	53.6	0	56.6	0	0	0	653	0
34.4	1	51.5	0	58.7	0	0	0	594	0
31.15	0	55.3	0	55.8	0	0	0	363	0
31.2	1	47.65	0	55.7	0	0	1	165.2	0
31.35	1	50.05	0	42.1	1	0	0	115.3	0
33.7	1	46.95	1	67.45	1	0	0	98.2	0
32.05	0	60.6	0	62.5	1	0	0	92.5	0
31.95	0	62.25	1	64.9	0	0	0	33.9	0
33.1	0	61.05	1	70.4	0	0	0	917	0
34.45	0	58	1	64.5	0	0	0	719	0
32.1	0	60.05	1	61.8	0	0	0	561	0
35.15	1	55	0	70.45	0	0	0	398	0
28.25	0	54	0	62.45	0	0	1	508	0
27.7	1	47	1	55.25	0	0	0	217	0
31.35	1	56	0	83.5	1	0	0	192	0
31.1	1	54	0	50.6	1	0	1	401	0
30.65	0	47	0	67.3	0	0	0	56.5	0
33	0	45	0	58.45	1	0	0	75.5	0
37	0	73.55	0	52.3	1	0	1	91.9	0
33.5	1	69.25	0	64.6	0	0	0	34.2	0
32.9	0	72.25	0	60.4	1	0	0	53.9	0
32.1	0	67.4	0	51.1	0	0	0	75.7	0
33.6	0	74.85	0	71.25	0	0	0	96.5	1
32.5	0	66	1	71.55	0	0	0	116.1	1
28.1	0	63	0	60.8	1	0	1	174.7	1
29.9	0	73	0	56.65	0	0	1	207	1
27	1	71	0	79.4	0	0	0	67.1	1
28	1	66	0	56.8	0	0	0	53.7	0
30.5	1	62.05	0	78.6	0	0	0	73.4	0
27	1	72	0	74.25	0	0	0	79.5	0

30.4	1	61	0	54.4	0	0	1	53.6	0
31.7	0	71	0	47.05	0	0	1	74.1	0
29.35	0	72	0	60.75	0	0	0	133.3	1
27.8	0	66	0	52	0	0	0	152.9	0
30.3	0	64	0	63.25	0	0	0	115.7	0
31.55	0	65	0	54.7	0	0	1	125.7	0
28	1	76	1	61.05	1	0	0	92.4	0
30.2	1	67	0	46.45	0	0	0	66.7	1
31.15	0	66	0	48.2	0	0	1	56	0
29	0	76	1	54.05	0	0	0	77.1	1
28.1	0	65	0	46.75	0	0	0	103	0
29.65	0	67	0	56.95	0	0	1	80	0
30.1	0	74	1	50.45	0	0	0	191.3	0
30.6	0	71.5	0	56.95	0	0	1	139.2	0
26.3	1	73.05	1	46.75	1	0	0	115.6	1
28.85	0	70.05	0	48	0	0	0	129.1	0
30.6	1	74	1	63.5	0	0	0	60.6	0
26.8	0	72	1	51.8	0	0	0	155	1
30	0	70.05	0	64.15	0	0	0	48.5	0
24.35	0	71.5	0	63	0	0	0	39.2	0
29	1	74	0	52.4	0	0	1	65.3	0
28.2	0	72	0	62.8	0	0	0	30.1	0
30.35	1	74	0	63.4	0	0	1	73.8	0
24.75	0	72	0	64.9	0	0	0	192.8	0
29	1	73	0	50.45	0	0	1	69.3	0
28.3	1	70	0	50.95	0	0	1	190.3	0
30.3	0	82.5	0	44.75	0	0	1	42.9	0
25.1	0	68.5	1	46.9	0	0	0	159.6	0
29	0	67.5	0	39.9	0	0	0	29.6	0
28.4	0	54	0	71.55	0	0	0	159.6	0
29	0	56.65	1	69.2	0	0	0	188.3	0
28.5	0	58.3	0	42.45	0	0	1	272.2	0
25.7	0	49.2	0	62.2	0	0.8	1	90	0
30.2	0	49.4	1	67.55	0	0.7	0	26.2	0
23.55	0	59.75	0	66.7	1	0.4	0	110	0
27.6	1	42	1	59.75	0	0	0	135.4	0
29.8	0	49	0	69.4	0	0.4	0	120	0
31.65	0	39.5	1	67.1	0	0.4	0	183.1	0
29.15	1	42	0	58.4	0	0.7	0	68.5	0
29.7	0	48	0	60.95	0	0.5	0	179	0
30.1	0	46	0	68.8	0	0	0	564	0
29	1	47.5	0	60.8	0	0.4	0	145	0
28.4	0	49	1	63.35	0	0.4	0	329	0
30.1	1	47.5	0	53.45	0	0.6	0	229	0

30.45	0	41	0	67.95	0	0	0	68.7	0
39.45	1	54	0	71.5	0	0.5	0	12	1
29.8	0	52.5	0	62.7	0	0.8	0	40	1
29.05	0	54	0	74.9	1	0.4	0	50	1
29.75	0	47	0	56.55	0	0	0	50	1
29.4	0	44.5	0	56.45	0	0.5	0	84	1
28.2	1	51	0	50.1	0	0.8	0	78	1
30.35	0	53.5	0	58.85	0	0.4	0	44	1
30.1	0	46	0	62.65	0	0.4	1	80	1
30.85	0	51	0	63.55	0	0	0	81	1
31.2	0	53	0	61.3	0	0	0	82	1
33	0	49	0	63.75	0	0.4	0	71	1
33.5	0	49	0	61.85	0	0.4	0	64	1
33.5	0	57.5	0	63.65	0	0	0	84	1
31.45	1	54.5	0	68.75	0	0	0	82	1
29	0	54.5	0	69.3	0	0	0	60	1
27.4	0	56	0	58.55	0	0	0	74	1
28.95	0	58.5	0	63.7	0	0.4	0	68	1
31.3	0	54	0	64.15	0	0	0	70	1
28.75	0	56	0	65.1	0	0.4	0	118	1
28	0	55.6	0	56	0	0	0	41	1
28.85	0	56.5	0	44.55	0	0	0	37	0
28.8	0	64	0	63.15	0	0	0	33	1
30.75	0	69	0	52.6	0	0.5	0	47	0
30.75	0	56	0	66.5	1	0	0	50	0
29.35	0	79.5	0	67.3	0	0	0	90	0
29.4	0	71.05	0	71.85	0	1.1	0	104	0
31.5	0	42	1	74	0	0	0	84	0
31.2	0	45.5	0	27.3	0	0.5	1	62	0
30.95	0	49	0	65.3	0	0	0	80	0
29.45	0	41	0	73	0	0	0	63	0
29.5	0	45	0	67.7	0	0	0	70	0
31.15	0	40.5	0	54.85	0	0	0	69	0
25.5	0	41.5	0	68.15	1	0.4	0	149	0
27.95	0	43.5	1	65.9	0	0	0	45	0
30.6	0	42	0	64.3	0	0	1	96	0
29.9	0	51.5	0	71.1	1	0	0	55	0
29.05	0	43	0	66.75	0	0	0	71	0
30.5	0	53	0	70.75	0	0	0	64	0
29.9	0	48	0	68.7	0	0.5	1	60	0
29.5	0	47.5	0	68.4	0	0.5	1	48	0
30.45	0	47	0	74.8	0	0	0	171	0
29.85	0	47.5	0	66.75	0	0	0	133	0
28.65	1	56	0	72.9	0	0	1	94	0

30.7	1	56	0	65.6	0	0	1	80	0
32.1	0	52.5	0	67.05	0	0	1	51	0
29.8	0	51.5	0	67.2	0	0	0	52	0
31.2	1	49.5	0	72.85	0	0	0	67	0
30.6	0	54	0	67.35	0	0	1	66	0
31	0	48	0	65.9	0	0	1	165	0
30.35	0	46	0	65.2	0	0.5	1	125	0
31.55	0	41	0	70.3	0	0	1	85	1
31.7	0	56	0	69	0	0	1	88	1
31.4	0	58.5	0	70.3	0	0	1	65	1
31.7	0	45	0	56.7	0	0	1		
28.9	0	53.5	0	70.65	1	0	1		
31.1	0	45	0	69.7	1	0	1		
31.4	0	51	0	70.95	1	0	1		
29.6	0	46.5	1	62.2	0	0	1		
31.55	0	53	1	65.35	1	0	1		
31.6	0	48	1	68.4	1	0	1		
31.35	0	45	0	57.95	1	0	1		
29.7	0	44	0	65.5	0	0	1		
31.5	0	58	0	61.9	0	0	1		
29.6	0	51.5	0	66.2	0	0	1		
31.3	0	38.5	0	68.3	0	0	1		
39.6	1	41	0	67.1	0	0	1		
30.9	1	57	0	69.9	0	0	1		
30.95	1	47.5	0	60.3	0	0	1		
33.7	0	37.5	0	63.7	0	0	1		
33.5	0	40.5	0	61.6	0	0	1		
32.7	0	56.5	0	66.75	0	0	1		
32.5	0	52	0	73.25	0	0	1		
33.25	1	50	0	68.75	0	0	1		
32.5	1	52.05	1	66.45	0	0	1		
32.2	1	50	1	60.45	0	0	1		
32	0	44	1	64.35	0	0	1		
32.95	1	44	1	63.28	0	0	1		
30.8	0	51.05	0	68.2	0	0	1		
30.75	1	48	0	64.25	0	0	1		
30.9	1	44	0	65.8	0	0	1		
33.4	0	42	0	56.3	0	0	1		
31.7	1	53.25	1	62.1	0	0	1		
33.4	1	54.05	0			0	1		
34.25	1	52.05	0			0	1		
33.2	1	53.05	0			0	1		
31.8	1	51.05	1			0	1		
33	1	52.05	1			0	1		

33.8	1
34.075	1
33.95	1
33.6	1
34.1	1
34.4	1
34.03	1

APPENDIX IV

Statistics

		A4	A5	A6	A9	A13
N	Valid	169	169	169	169	169
	Missing	0	0	0	0	0
Mean		1.08	3.85	3.73	1.05	2.40
Median		1.00	4.00	4.00	1.00	2.00
Mode		1	4	4	1	3
Percentiles	25	1.00	3.00	3.00	1.00	2.00
	75	1.00	5.00	5.00	1.00	3.00

Statistics

		A14	A15	A16	A17	A18
N	Valid	169	169	169	169	169
	Missing	0	0	0	0	0
Mean		2.47	7.52	2.48	2.30	1.45
Median		2.00	8.00	2.00	2.00	1.00
Mode		2	8	1	1	1
Percentiles	25	2.00	8.00	1.00	1.00	1.00
	75	3.00	8.00	4.00	3.00	2.00

Statistics

		A19	A20	A21	A22	A23
N	Valid	169	169	169	169	169
	Missing	0	0	0	0	0
Mean		2.27	1.76	2.46	1.34	2.16
Median		2.00	2.00	2.00	1.00	2.00

Mode		3	1	1	1	2
Percentiles	25	1.00	1.00	1.00	1.00	1.00
	75	3.00	2.00	4.00	1.00	2.00

Statistics

		A24	A25a	A25b	A25c	A25d
N	Valid	169	169	169	169	169
	Missing	0	0	0	0	0
Mean		2.46	3.21	3.01	3.01	2.93
Median		3.00	3.00	3.00	3.00	3.00
Mode		3	4	3	4	3
Percentiles	25	2.00	3.00	3.00	2.00	2.00
	75	3.00	4.00	4.00	4.00	4.00

Statistics

		A26	A27
N	Valid	169	169
	Missing	0	0
Mean		2.75	1.93
Median		3.00	1.00
Mode		1	1
Percentiles	25	1.00	1.00
	75	4.00	2.50

Frequency Table

A4		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	156	92.3	92.3	92.3
	FEMALE	13	7.7	7.7	100.0
	Total	169	100.0	100.0	

A5		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21 - 30YRS	15	8.9	8.9	8.9
	31 - 40YRS	51	30.2	30.2	39.1
	41 - 50YRS	56	33.1	33.1	72.2
	51 - 60YRS	38	22.5	22.5	94.7
	> 60YRS	9	5.3	5.3	100.0
	Total	169	100.0	100.0	

A6		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GA	18	10.7	10.7	10.7
	AL	23	13.6	13.6	24.3
	L2	33	19.5	19.5	43.8
	L1	43	25.4	25.4	69.2
	SL	31	18.3	18.3	87.6
	APROF	8	4.7	4.7	92.3
	PROF	12	7.1	7.1	99.4
	VL	1	.6	.6	100.0
	Total	169	100.0	100.0	

A9

A9		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PERMANENT	162	95.9	95.9	95.9
	CONTRACT	6	3.6	3.6	99.4
	ANY OTHER	1	.6	.6	100.0
	Total	169	100.0	100.0	

A13

A13		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	B.Sc	15	8.9	8.9	8.9
	M.Sc	73	43.2	43.2	52.1
	PhD	79	46.7	46.7	98.8
	ANY OTHER	2	1.2	1.2	100.0
	Total	169	100.0	100.0	

A14		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GRADUATE	25	14.8	14.8	14.8
	ASSOCIATE	64	37.9	37.9	52.7
	CORPORATE	59	34.9	34.9	87.6
	FELLOW	17	10.1	10.1	97.6
	ANY OTHER	4	2.4	2.4	100.0
	Total	169	100.0	100.0	

A15

A15		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SIGHTING	7	4.1	4.1	4.1
	WALKING	1	.6	.6	4.7
	WRITING	1	.6	.6	5.3
	SMELLING	10	5.9	5.9	11.2
	ANY OTHER	150	88.8	88.8	100.0
	Total	169	100.0	100.0	

A16

A16		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 5YRS	60	35.5	35.5	35.5
	6 - 10YRS	43	25.4	25.4	60.9
	11 - 15YRS	23	13.6	13.6	74.6
	16 - 20YRS	13	7.7	7.7	82.2
	> 20YRS	28	16.6	16.6	98.8
	6	2	1.2	1.2	100.0
	Total	169	100.0	100.0	

A17

A17		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 5YRS	65	38.5	38.5	38.5
	6 - 10YRS	45	26.6	26.6	65.1
	11 - 15YRS	24	14.2	14.2	79.3
	16 - 20YRS	13	7.7	7.7	87.0
	> 20YRS	22	13.0	13.0	100.0
	Total	169	100.0	100.0	

A18

A18		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 5YRS	126	74.6	74.6	74.6
	6 - 10YRS	24	14.2	14.2	88.8
	11 - 15YRS	9	5.3	5.3	94.1
	16 - 20YRS	6	3.6	3.6	97.6
	> 20YRS	4	2.4	2.4	100.0
	Total	169	100.0	100.0	

A19		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BUNGALOW	45	26.6	26.6	26.6
	ONE-STOREY	50	29.6	56.2	56.2
	TWO-STORIES	60	35.5	91.7	91.7
	MORE THAN TWO STORIES	12	7.1	98.8	98.8
	ANY OTHER	2	1.2	100.0	100.0
	Total	169	100.0		

A20

A20		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GROUND FLOOR	83	49.1	49.1	49.1
	1st FLOOR	46	27.2	27.2	76.3
	2nd FLOOR	38	22.5	22.5	98.8
	OTHER FLOOR	2	1.2	1.2	100.0
	Total	169	100.0	100.0	

A21

A21		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NORTH	50	29.6	29.6	29.6
	SOUTH	40	23.7	23.7	53.3
	WEST	31	18.3	18.3	71.6
	EAST	48	28.4	28.4	100.0
	Total	169	100.0	100.0	

A22

A22		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 4.6m (15ft)	136	80.5	80.5	80.5
	> 4.6m (15ft)	10	5.9	5.9	86.4
	Not Applicable	23	13.6	13.6	100.0
	Total	169	100.0	100.0	

A23

A23		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enclosed Office	56	33.1	33.1	33.1
	Enclosed Office Shared With Other Staff	77	45.6	78.7	78.7
	Cubicles With 4.6m (15ft) and Above High Partitions	10	5.9	84.6	84.6
	Cubicles With Low Partition	5	3.0	87.6	87.6
	Open Office	21	12.4	100.0	100.0
	Total	169	100.0		

A23

A24

A24		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PASSIVE	27	16.0	16.0	16.0
	ACTIVE	43	25.4	25.4	41.4
	MIXED-MODE	94	55.6	55.6	97.0
	4	5	3.0	3.0	100.0
	Total	169	100.0	100.0	

A25a

A25a		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	3.6	3.6	3.6
	2	24	14.2	14.2	17.8
	3	67	39.6	39.6	57.4
	4	72	42.6	42.6	100.0
	Total	169	100.0	100.0	

A25b		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	11	6.5	6.5	6.5
	2	29	17.2	17.2	23.7
	3	76	45.0	45.0	68.6
	4	53	31.4	31.4	100.0
	Total	169	100.0	100.0	

A25c		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	10	5.9	5.9	5.9
	2	43	25.4	25.4	31.4
	3	52	30.8	30.8	62.1
	4	63	37.3	37.3	99.4
	5	1	.6	.6	100.0
	Total	169	100.0	100.0	

A25d		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	14	8.3	8.3	8.3
	2	30	17.8	17.8	26.0
	3	80	47.3	47.3	73.4
	4	44	26.0	26.0	99.4
	5	1	.6	.6	100.0
	Total	169	100.0	100.0	

A26

A26		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Distractions	66	39.1	39.1	39.1
	Remoteness from Home	11	6.5	45.6	45.6
	Poor Indoor Environmental Quality	22	13.0	58.6	58.6
	Unstable Power Supply	44	26.0	84.6	84.6
	Poor Internet Service	22	13.0	97.6	97.6
	Any Other Reason(s)	4	2.4	100.0	100.0
	Total	169	100.0	100.0	

A27		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	HOME	115	68.0	68.0	68.0
	UNIVERSITY LIBRARY	12	7.1	7.1	75.1
	FACULTY LIBRARY	5	3.0	3.0	78.1
	LABORATORY	13	7.7	7.7	85.8
	PRIVATE OFFICE	23	13.6	13.6	99.4
	ANY OTHER PLACE	1	.6	.6	100.0
	Total	169	100.0	100.0	

APPENDIX V

Group Statistics

	factor1	N	Mean	Std. Deviation	Std. Error Mean
tempearture	Satisfactory	205	29.6110	2.31004	.16134
	Non satisfactory	148	30.0710	3.44650	.28330

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
tempearture	Equal variances assumed	5.169	.024	-1.501	351	.134	-.46000	.30654	-1.06288	.14287
	Equal variances not assumed			-1.411	239.651	.160	-.46000	.32602	-1.10224	.18223

Group Statistics

	factor2	N	Mean	Std. Deviation	Std. Error Mean
humidity	satisfactory	227	59.4546	14.20419	.94277
	Non satisfactory	119	59.4362	17.53995	1.60788

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
humidity	Equal variances assumed	22.170	.000	.011	344	.992	.01841	1.74628	-3.41633	3.45315
	Equal variances not assumed			.010	200.697	.992	.01841	1.86389	-3.65692	3.69373

Group Statistics

	factor3	N	Mean	Std. Deviation	Std. Error Mean
acoustic	Satisfactory	252	61.7287	9.63125	.60671
	Non satisfactory	89	157.2927	884.13285	93.71789

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
acoustic	Equal variances assumed	10.695	.001	-1.720	339	.086	-95.56401	55.55388	-204.83774	13.70973
	Equal variances not assumed			-1.020	88.007	.311	-95.56401	93.71986	-281.81231	90.68430

Group Statistics

	factor4	N	Mean	Std. Deviation	Std. Error Mean

air_flow	Satisfactory	214	.4000	1.37065	.09370
	Non Satisfactory	131	.2802	.86544	.07561

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
air_flow	Equal variances assumed	1.169	.280	.897	343	.370	.11985	.13361	-.14294	.38264
	Equal variances not assumed			.995	342.655	.320	.11985	.12040	-.11697	.35667

Group Statistics

	factor5	N	Mean	Std. Deviation	Std. Error Mean
lightning	satisfactory	210	225.0486	206.09871	14.22216
	Non satisfactory	102	207.1765	193.17480	19.12716

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
lightning	Equal variances assumed	1.913	.168	.733	310	.464	17.87210	24.37662	-30.09246	65.83666
	Equal variances not assumed			.750	212.208	.454	17.87210	23.83523	-29.11204	64.85624

Group Statistics

	Factor	N	Mean	Std. Deviation	Std. Error Mean
General	.00	1108	74.4295	117.90176	3.54202
	1.00	589	79.2719	359.58414	14.81641

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
General	Equal variances assumed	1.802	.180	-.409	1695	.683	-4.84243	11.84247	-28.06983	18.38496
	Equal variances not assumed			-.318	655.991	.751	-4.84243	15.23390	-34.75552	25.07066

Correlations

		Minna	Ilorin
Minna	Pearson Correlation	1	-.587*
	Sig. (2-tailed)		.035
	N	13	13
Ilorin	Pearson Correlation	-.587*	1

	Sig. (2-tailed)	.035	
	N	13	13

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

		Minna	Makurdi
Minna	Pearson Correlation	1	-.205
	Sig. (2-tailed)		.502
	N	13	13
Makurdi	Pearson Correlation	-.205	1
	Sig. (2-tailed)	.502	
	N	13	13

Correlations

		Ilorin	Makurdi
Ilorin	Pearson Correlation	1	.024
	Sig. (2-tailed)		.939
	N	13	13
Makurdi	Pearson Correlation	.024	1
	Sig. (2-tailed)	.939	
	N	13	13

Correlations

		General	Minna
General	Pearson Correlation	1	-.396
	Sig. (2-tailed)		.181
	N	13	13
Minna	Pearson Correlation	-.396	1
	Sig. (2-tailed)	.181	
	N	13	13

Correlations

		General	Ilorin
General	Pearson Correlation	1	.919**
	Sig. (2-tailed)		.000
	N	13	13
Ilorin	Pearson Correlation	.919**	1
	Sig. (2-tailed)	.000	
	N	13	13

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		General	Makurdi
General	Pearson Correlation	1	.306
	Sig. (2-tailed)		.310
	N	13	13
Makurdi	Pearson Correlation	.306	1
	Sig. (2-tailed)	.310	
	N	13	.13

APPENDIX V

	S.L	ACQ	VQ	AirQ	TQ	F.F	C.M	wsu_a	wsu_b	wsu_c	wsu_d	wsu_e	wsu_f	wsu_g
S.L	1	0.569069	0.566081	0.5739	5.86E-01	0.677138	0.48597	0.119786	-0.0759	0.036947	-8.87E-02	0.186082	0.014501	0.17637
ACQ	0.569069	1	0.489523	0.53418	3.59E-01	0.548391	0.427046	0.00761	-0.08947	-0.01143	-8.17E-02	0.089388	-0.04811	0.09457
VQ	0.566081	0.489523	1	0.618026	5.05E-01	0.491213	0.426331	0.143749	-0.01997	0.055025	-2.81E-02	0.118045	0.10664	0.16375
AirQ	0.5739	0.53418	0.618026	1	6.47E-01	0.568439	0.583132	0.200015	-0.03235	0.026065	1.04E-01	0.145398	0.117824	0.09809
TQ	0.585835	0.359054	0.504892	0.646744	1.00E+00	0.576307	0.481836	0.106506	0.099301	0.030983	4.53E-05	0.073549	0.09976	0.12403
F.F	0.677138	0.548391	0.491213	0.568439	5.76E-01	1	0.639497	0.070094	0.012621	-0.04674	-3.21E-02	0.028165	0.064862	0.08736
C.M	0.48597	0.427046	0.426331	0.583132	4.82E-01	0.639497	1	0.096348	-0.04211	-0.03037	3.52E-02	0.064289	0.064723	0.05457
wsu_a	0.119786	0.00761	0.143749	0.200015	1.07E-01	0.070094	0.096348	1	-0.03455	0.399125	3.12E-01	0.403769	0.176081	-0.0161
wsu_b	-0.0759	-0.08947	-0.01997	-0.03235	9.93E-02	0.012621	-0.04211	-0.03455	1	0.006876	1.07E-01	-0.09754	0.069403	-0.0493
wsu_c	0.036947	-0.01143	0.055025	0.026065	3.10E-02	-0.04674	-0.03037	0.399125	0.006876	1	1.92E-02	0.281825	0.121144	0.34884
wsu_d	-0.08873	-0.08173	-0.02814	0.104451	4.53E-05	-0.03205	0.035227	0.312119	0.107225	0.019154	1.00E+00	-0.07997	-0.05022	-0.1451
wsu_e	0.186082	0.089388	0.118045	0.145398	7.35E-02	0.028165	0.064289	0.403769	-0.09754	0.281825	-8.00E-02	1	0.127285	0.13284
wsu_f	0.014501	-0.04811	0.10664	0.117824	9.98E-02	0.064862	0.064723	0.176081	0.069403	0.121144	-5.02E-02	0.127285	1	-0.0112
wsu_g	0.176372	0.094572	0.163754	0.098095	1.24E-01	0.087369	0.054571	-0.01619	-0.04935	0.348849	-1.45E-01	0.132846	-0.01123	
wsu_h	0.057376	0.065419	0.109363	0.111843	1.68E-01	0.15863	0.106174	0.139284	0.176358	0.087775	1.76E-01	0.061953	0.115286	-0.0528
wsu_i	0.113548	0.104015	0.217609	0.213737	1.72E-01	0.137537	0.03819	0.346782	0.039942	0.160799	8.65E-02	0.080435	0.104772	-0.0546
wsu_j	0.037074	0.030179	0.058879	0.079822	1.21E-01	0.082184	0.062354	0.132216	0.120292	0.251587	-3.20E-02	0.120136	-0.00621	0.23467
wsu_k	-0.08115	-0.08929	-0.03162	-0.15729	-9.96E-02	0.01076	-0.05912	-0.2712	0.029647	-0.03685	-5.65E-02	-0.15679	-0.07466	0.26016
wsu_l	-0.04792	0.067651	0.021349	-0.01414	-5.09E-02	0.018956	-0.06842	-0.10569	0.140605	-0.06428	9.79E-03	0.003775	0.034605	0.12231
wsu_m	0.103531	0.098061	0.13092	0.131573	6.64E-02	0.186506	0.133464	-0.12864	0.21364	-0.28513	-1.65E-03	-0.1002	-0.11117	-0.1004

Correlations

			sl	acq	vq	arq	tq	ff	cm	wsu_a	wsu_b	wsu_c	wsu_d	wsu_e
Spearman's rho	sl	Correlation Coefficient	1	0.535947	0.569491179	0.526368	0.565522	0.698343	0.49498	0.076318	-0.09996444	0.041821	-0.1338	0.14278
		Sig. (2-tailed)	.	5.96E-14	6.4955E-16	1.98E-13	1.14E-15	4.89E-26	7.87E-12	0.324033	0.195964557	0.58928	0.08286	0.06402
		N	169	169	169	169	169	169	169	169	169	169	169	16
	acq	Correlation Coefficient	0.535947	1	0.483635685	0.535934	0.387227	0.584066	0.46362	-0.01354	-0.12467439	-0.00315	-0.10974	0.07563
		Sig. (2-tailed)	5.96E-14	.	2.72293E-11	5.97E-14	1.98E-07	7.73E-17	2.18E-10	0.861267	0.106300766	0.967627	0.155497	0.32839
		N	169	169	169	169	169	169	169	169	169	169	169	16
	vq	Correlation Coefficient	0.569491	0.483636	1	0.617118	0.499255	0.513107	0.477286	0.081192	-0.05557747	0.025561	-0.07542	0.0624
		Sig. (2-tailed)	6.5E-16	2.72E-11	.	4.09E-19	4.87E-12	9.83E-13	5.35E-11	0.293998	0.472942395	0.741491	0.329804	0.42018
		N	169	169	169	169	169	169	169	169	169	169	169	16
	arq	Correlation Coefficient	0.526368	0.535934	0.617117979	1	0.661454	0.512603	0.550783	0.181606	-0.05795799	0.078484	0.065984	0.10669
		Sig. (2-tailed)	1.98E-13	5.97E-14	4.08637E-19	.	1.26E-22	1.04E-12	8.6E-15	0.018126	0.454163768	0.310445	0.39402	0.16737
		N	169	169	169	169	169	169	169	169	169	169	169	16
	tq	Correlation Coefficient	0.565522	0.387227	0.499254614	0.661454	1	0.554573	0.499472	0.071673	0.066786057	-0.00811	-0.03948	0.07901
		Sig. (2-tailed)	1.14E-15	1.98E-07	4.87298E-12	1.26E-22	.	5.16E-15	4.75E-12	0.354435	0.388281098	0.916641	0.610299	0.30715
		N	169	169	169	169	169	169	169	169	169	169	169	16
	ff	Correlation Coefficient	0.698343	0.584066	0.513107349	0.512603	0.554573	1	0.644091	0.044543	-0.04181162	-0.05102	-0.06596	0.00903
		Sig. (2-tailed)	4.89E-26	7.73E-17	9.8311E-13	1.04E-12	5.16E-15	.	3.5E-21	0.565264	0.589367323	0.510031	0.39417	0.90719
		N	169	169	169	169	169	169	169	169	169	169	169	16
	cm	Correlation Coefficient	0.49498	0.46362	0.477285945	0.550783	0.499472	0.644091	1	0.073034	-0.04054686	-0.04964	-0.01108	0.04626
		Sig. (2-tailed)	7.87E-12	2.18E-10	5.34794E-11	8.6E-15	4.75E-12	3.5E-21	.	0.345344	0.600687228	0.521569	0.886348	0.55028
		N	169	169	169	169	169	169	169	169	169	169	169	16
	wsu_a	Correlation Coefficient	0.076318	-0.01354	0.081191727	0.181606	0.071673	0.044543	0.073034	1	0.012808383	0.300995	0.345738	0.35442
		Sig. (2-tailed)	0.324033	0.861267	0.293997527	0.018126	0.354435	0.565264	0.345344	.	0.868723622	6.99E-05	4.14E-06	2.27E-0
		N	169	169	169	169	169	169	169	169	169	169	169	16
	wsu_b	Correlation Coefficient	-0.09996	-0.12467	-0.05557747	-0.05796	0.066786	-0.04181	-0.04055	0.012808	1	0.020701	0.166458	-0.0690
		Sig. (2-tailed)	0.195965	0.106301	0.472942395	0.454164	0.388281	0.589367	0.600687	0.868724	.	0.789357	0.03054	0.37229
		N	169	169	169	169	169	169	169	169	169	169	169	16
	wsu_c	Correlation Coefficient	0.041821	-0.00315	0.025560879	0.078484	-0.00811	-0.05102	-0.04964	0.300995	0.020701135	1	-0.03115	0.23901
		Sig. (2-tailed)	0.58928	0.967627	0.741491272	0.310445	0.916641	0.510031	0.521569	6.99E-05	0.789356688	.	0.68768	0.0017
		N	169	169	169	169	169	169	169	169	169	169	169	16
	wsu_d	Correlation Coefficient	-0.1338	-0.10974	-0.07541516	0.065984	-0.03948	-0.06596	-0.01108	0.345738	0.166458165	-0.03115	1	-0.1198
		Sig. (2-tailed)	0.08286	0.155497	0.329803692	0.39402	0.610299	0.39417	0.886348	4.14E-06	0.030540443	0.68768	.	0.12051
		N	169	169	169	169	169	169	169	169	169	169	169	16
	wsu_e	Correlation Coefficient	0.142789	0.075634	0.062410308	0.106696	0.079019	0.009035	0.046267	0.354422	-0.0690605	0.239013	-0.11989	

	Sig. (2-tailed)	0.064029	0.328397	0.420185936	0.167371	0.307152	0.907193	0.550287	2.27E-06	0.372291552	0.00175	0.120511	.
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_f	Correlation Coefficient	0.020871	-0.0398	0.090183113	0.091767	0.129495	0.046814	0.037624	0.142576	0.043251758	0.111598	-0.07502	0.10233
	Sig. (2-tailed)	0.787667	0.607434	0.243591379	0.235375	0.093345	0.545583	0.627212	0.064429	0.576597761	0.148592	0.332326	0.18552
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_g	Correlation Coefficient	0.150412	0.063797	0.138776529	0.122651	0.067712	0.050702	0.044878	-0.11794	-0.00647603	0.366674	-0.18245	0.09376
	Sig. (2-tailed)	0.050942	0.409912	0.071951863	0.112144	0.381725	0.512689	0.562339	0.126732	0.933402709	9.43E-07	0.017588	0.2252
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_h	Correlation Coefficient	0.039401	0.030936	0.020727125	0.073504	0.133807	0.137452	0.094032	0.157818	0.170963682	0.072991	0.153918	0.04676
	Sig. (2-tailed)	0.611025	0.689687	0.789098409	0.342241	0.082849	0.074736	0.223968	0.040436	0.026254856	0.34563	0.045717	0.54600
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_i	Correlation Coefficient	0.124633	0.080984	0.189176983	0.253442	0.190929	0.141402	0.082437	0.355137	0.073137982	0.163401	0.109309	0.05917
	Sig. (2-tailed)	0.106417	0.295236	0.013765181	0.000885	0.012898	0.066682	0.286632	2.16E-06	0.344657067	0.033776	0.157153	0.44471
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_j	Correlation Coefficient	0.022747	0.025213	0.024885081	0.071527	0.113719	0.09962	0.056594	0.020518	0.152866863	0.249337	-0.08814	0.04054
	Sig. (2-tailed)	0.769101	0.744886	0.748093073	0.355416	0.140978	0.197517	0.464875	0.791176	0.04723379	0.001079	0.254484	0.60067
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_k	Correlation Coefficient	-0.10206	-0.03928	-0.04311819	-0.14491	-0.10098	0.011257	-0.07101	-0.28346	0.058465422	-0.09777	-0.01882	-0.158
	Sig. (2-tailed)	0.186699	0.612115	0.577776643	0.060146	0.191443	0.88451	0.358891	0.000188	0.450215523	0.206005	0.80815	0.03944
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_l	Correlation Coefficient	-0.03307	0.084971	0.062186996	0.022592	-0.01647	0.069348	0.003058	-0.04622	0.166366259	-0.04818	0.055819	0.06153
	Sig. (2-tailed)	0.669487	0.272022	0.421854073	0.770629	0.831686	0.370299	0.968523	0.550709	0.03063372	0.533877	0.471017	0.42672
	N	169	169	169	169	169	169	169	169	169	169	169	16
wsu_m	Correlation Coefficient	0.091888	0.065554	0.067320005	0.053267	0.08064	0.172971	0.156709	-0.0973	0.198522178	-0.26725	0.074261	-0.1285
	Sig. (2-tailed)	0.234756	0.39711	0.384490643	0.491568	0.297303	0.024518	0.041883	0.208232	0.009669203	0.000444	0.337282	0.09576
	N	169	169	169	169	169	169	169	169	169	169	169	16

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

APPENDIX VI

Case Processing Summary

		N	Marginal Percentage
dependent	50.00	1	1.7%
	58.00	1	1.7%
	61.00	1	1.7%
	62.00	1	1.7%
	63.00	2	3.4%
	64.00	5	8.6%
	65.00	3	5.2%
	66.00	2	3.4%
	67.00	2	3.4%
	68.00	2	3.4%
	69.00	2	3.4%
	70.00	2	3.4%
	71.00	3	5.2%
	72.00	1	1.7%
	73.00	2	3.4%
	74.00	1	1.7%
	75.00	1	1.7%
	76.00	1	1.7%
	77.00	3	5.2%
	78.00	2	3.4%
	80.00	7	12.1%
	81.00	1	1.7%
	83.00	1	1.7%
	85.00	1	1.7%
	89.00	1	1.7%
	90.00	3	5.2%
	92.00	1	1.7%
	94.00	1	1.7%
	96.00	2	3.4%
	112.00	2	3.4%
Valid		58	100.0%
Missing		111	
Total		169	

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	373.582			
Final	356.040	17.542	5	.004

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.

Pearson	1809.552	1648	.003
Deviance	356.040	1648	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.261
Nagelkerke	.261
McFadden	.047

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Threshold	[dependent = 50.00]	7.080	3.034	5.446	1	.020	1.134	13.026
	[dependent = 58.00]	7.847	2.954	7.058	1	.008	2.058	13.636
	[dependent = 61.00]	8.306	2.931	8.028	1	.005	2.560	14.052
	[dependent = 62.00]	8.634	2.924	8.722	1	.003	2.904	14.364
	[dependent = 63.00]	9.104	2.921	9.714	1	.002	3.379	14.828
	[dependent = 64.00]	9.850	2.933	11.280	1	.001	4.102	15.599
	[dependent = 65.00]	10.175	2.942	11.958	1	.001	4.408	15.942
	[dependent = 66.00]	10.364	2.949	12.350	1	.000	4.584	16.143
	[dependent = 67.00]	10.541	2.956	12.718	1	.000	4.748	16.334
	[dependent = 68.00]	10.708	2.963	13.065	1	.000	4.902	16.515
	[dependent = 69.00]	10.873	2.970	13.405	1	.000	5.053	16.694
	[dependent = 70.00]	11.043	2.978	13.755	1	.000	5.207	16.879
	[dependent = 71.00]	11.303	2.990	14.287	1	.000	5.442	17.164
	[dependent = 72.00]	11.390	2.995	14.464	1	.000	5.520	17.260
	[dependent = 73.00]	11.560	3.004	14.809	1	.000	5.672	17.448
	[dependent = 74.00]	11.644	3.009	14.978	1	.000	5.747	17.541
	[dependent = 75.00]	11.729	3.013	15.151	1	.000	5.823	17.636
	[dependent = 76.00]	11.817	3.018	15.326	1	.000	5.901	17.733
	[dependent = 77.00]	12.085	3.035	15.861	1	.000	6.138	18.033
	[dependent = 78.00]	12.276	3.047	16.236	1	.000	6.305	18.247
	[dependent = 80.00]	13.062	3.102	17.730	1	.000	6.982	19.142
	[dependent = 81.00]	13.190	3.111	17.972	1	.000	7.092	19.288
	[dependent = 83.00]	13.319	3.121	18.215	1	.000	7.202	19.435
	[dependent = 85.00]	13.458	3.131	18.477	1	.000	7.322	19.594
	[dependent = 89.00]	13.612	3.142	18.768	1	.000	7.454	19.771
	[dependent = 90.00]	14.184	3.184	19.848	1	.000	7.944	20.424
	[dependent = 92.00]	14.437	3.202	20.331	1	.000	8.161	20.712
	[dependent = 94.00]	14.733	3.223	20.898	1	.000	8.416	21.050
	[dependent = 96.00]	15.537	3.288	22.334	1	.000	9.094	21.981
Location	Work_space_utilization	.000	.000	.244	1	.621	.000	.001
	IEQ_parameter	.016	.011	2.315	1	.128	-.005	.037
	User_xteristics	**.146**	**.059**	**6.181**	**1**	**.013**	**.031**	**.260**
	Workspace_xteristics	.047	.067	.491	1	.483	-.084	.177
	Maintenance_practice	**.030**	**.012**	**6.756**	**1**	**.009**	**.007**	**.053**

Link function: Logit.

From the above results only the bolded that is the User characteristics and Maintenance characteristics are contributing to Users satisfaction. Because the p-values ob

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	56.657	32.066	9	.000

Link function: Logit.

Goodness-of-Fit

	Chi-Square	Df	Sig.
Pearson	621.185	216	.000
Deviance	56.657	216	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.865
Nagelkerke	.869
McFadden	.361

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[temp = 24.60]	203.704	62.116	10.755	1	.001	81.960	325.448
	[temp = 26.01]	205.341	62.308	10.861	1	.001	83.219	327.463
	[temp = 26.73]	206.440	62.409	10.942	1	.001	84.120	328.760
	[temp = 26.83]	207.990	62.704	11.003	1	.001	85.093	330.887
	[temp = 27.68]	210.125	63.536	10.937	1	.001	85.596	334.654
	[temp = 28.30]	211.958	64.132	10.923	1	.001	86.262	337.654
	[temp = 28.34]	212.964	64.381	10.942	1	.001	86.780	339.149
	[temp = 28.35]	213.886	64.586	10.967	1	.001	87.300	340.472
	[temp = 30.12]	215.403	64.890	11.019	1	.001	88.221	342.586
	[temp = 30.23]	216.667	65.153	11.059	1	.001	88.969	344.366
	[temp = 30.35]	217.398	65.248	11.102	1	.001	89.515	345.281
	[temp = 30.41]	218.119	65.300	11.157	1	.001	90.133	346.106
	[temp = 30.45]	218.936	65.334	11.229	1	.001	90.883	346.988
	[temp = 30.53]	220.027	65.373	11.328	1	.001	91.898	348.155
	[temp = 30.80]	221.205	65.423	11.432	1	.001	92.978	349.432
Location	Work_space_utilization	.003	.001	5.120	1	.024	.000	.005
	temp_1	1.875	.841	4.966	1	.026	.226	3.525
	humidity_1	.441	.152	8.392	1	.004	.143	.739
	air_flow_1	7.667	3.510	4.772	1	.029	.788	14.547
	acoustics_1	1.044	.330	10.029	1	.002	.398	1.690
	lighting_1	.003	.004	.594	1	.441	-.004	.010
	Workspace_xteristics	.681	.205	11.052	1	.001	.280	1.083
	User_characteristis	.459	.159	8.369	1	.004	.148	.770
	Maintanence_practise	.097	.031	9.750	1	.002	.036	.157

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	71.533	17.189	9	.046

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	255.700	216	.033
Deviance	71.533	216	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.658
Nagelkerke	.661
McFadden	.194

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[humidity = .00]	-93.592	36.754	6.484	1	.011	-165.628	-21.556
	[humidity = 28.70]	-92.628	36.729	6.360	1	.012	-164.616	-20.640
	[humidity = 44.00]	-91.878	36.697	6.268	1	.012	-163.803	-19.953
	[humidity = 45.86]	-91.117	36.645	6.183	1	.013	-162.939	-19.294
	[humidity = 46.00]	-90.467	36.585	6.115	1	.013	-162.173	-18.761
	[humidity = 47.06]	-90.006	36.537	6.068	1	.014	-161.617	-18.395
	[humidity = 47.77]	-89.644	36.496	6.033	1	.014	-161.175	-18.113
	[humidity = 50.05]	-89.293	36.454	6.000	1	.014	-160.742	-17.844
	[humidity = 52.83]	-88.867	36.402	5.960	1	.015	-160.214	-17.520
	[humidity = 56.03]	-88.381	36.341	5.914	1	.015	-159.609	-17.153
	[humidity = 62.55]	-87.949	36.287	5.875	1	.015	-159.070	-16.829
	[humidity = 64.05]	-87.481	36.226	5.832	1	.016	-158.482	-16.480
	[humidity = 66.65]	-86.848	36.140	5.775	1	.016	-157.681	-16.015
	[humidity = 68.82]	-85.641	35.951	5.675	1	.017	-156.104	-15.178
	[humidity = 72.44]	-82.841	34.993	5.604	1	.018	-151.425	-14.257
Location	Work_space_utilization	.001	.001	.641	1	.423	-.001	.003
	temp_1	-1.529	.662	5.345	1	.021	-2.826	-.233
	humidity_1	-.404	.137	8.654	1	.003	-.673	-.135
	air_flow_1	1.984	2.692	.543	1	.461	-3.292	7.260
	acoustics_1	-.203	.168	1.466	1	.226	-.532	.126
	lighting_1	.007	.004	3.806	1	.051	-3.273E-5	.014
	Workspace_xteristics	-.257	.136	3.559	1	.059	-.524	.010
	User_characteristis	-.269	.153	3.079	1	.079	-.569	.031
	Maintanence_practise	.010	.025	.160	1	.689	-.039	.059

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	73.887	14.836	9	.096

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	209.273	216	.616
Deviance	73.887	216	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.604
Nagelkerke	.607
McFadden	.167

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[accoustic = .00]	33.661	28.199	1.425	1	.233	-21.607	88.929
	[accoustic = 48.84]	34.475	28.201	1.494	1	.222	-20.797	89.747
	[accoustic = 52.72]	35.066	28.211	1.545	1	.214	-20.226	90.358
	[accoustic = 53.87]	35.587	28.226	1.590	1	.207	-19.735	90.909
	[accoustic = 57.29]	36.077	28.246	1.631	1	.202	-19.284	91.437
	[accoustic = 60.43]	36.554	28.272	1.672	1	.196	-18.857	91.966
	[accoustic = 61.28]	37.069	28.309	1.715	1	.190	-18.416	92.554
	[accoustic = 61.76]	37.521	28.351	1.752	1	.186	-18.046	93.088
	[accoustic = 63.55]	37.867	28.387	1.779	1	.182	-17.770	93.504
	[accoustic = 63.89]	38.233	28.425	1.809	1	.179	-17.479	93.944
	[accoustic = 64.66]	38.637	28.461	1.843	1	.175	-17.147	94.420
	[accoustic = 65.23]	39.116	28.492	1.885	1	.170	-16.727	94.958
	[accoustic = 65.76]	39.970	28.511	1.965	1	.161	-15.911	95.851
	[accoustic = 67.21]	41.171	28.540	2.081	1	.149	-14.767	97.108
	[accoustic = 67.40]	43.068	28.928	2.217	1	.137	-13.630	99.766
Location	Work_space_utilization	-.002	.001	2.608	1	.106	-.004	.000
	temp_1	1.281	.630	4.140	1	.042	.047	2.515
	humidity_1	.239	.108	4.873	1	.027	.027	.452
	air_flow_1	-4.009	2.590	2.396	1	.122	-9.086	1.067
	acoustics_1	.000	.159	.000	1	.999	-.311	.311
	lighting_1	-.004	.003	2.096	1	.148	-.010	.002
	Workspace_xteristics	-.398	.157	6.416	1	.011	-.706	-.090
	User_characteristis	.304	.134	5.131	1	.023	.041	.567

	Maintanence_practise	-.019	.022	.786	1	.375	-.062	.024

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	61.969	26.754	9	.002

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	213.912	216	.527
Deviance	61.969	216	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.812
Nagelkerke	.815
McFadden	.302

Link function: Logit.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[Lightning = .00]	6.278	26.936	.054	1	.816	-46.515	59.071
	[Lightning = 24.00]	8.671	27.030	.103	1	.748	-44.306	61.648
	[Lightning = 53.86]	10.119	26.954	.141	1	.707	-42.709	62.948
	[Lightning = 57.75]	11.057	26.932	.169	1	.681	-41.728	63.842
	[Lightning = 58.88]	11.868	26.919	.194	1	.659	-40.891	64.628
	[Lightning = 65.00]	12.600	26.919	.219	1	.640	-40.160	65.360
	[Lightning = 69.50]	13.152	26.929	.239	1	.625	-39.627	65.931
	[Lightning = 88.00]	13.842	26.948	.264	1	.607	-38.976	66.660
	[Lightning = 115.64]	14.535	26.976	.290	1	.590	-38.336	67.406
	[Lightning = 124.73]	15.189	27.011	.316	1	.574	-37.752	68.130
	[Lightning = 160.61]	16.208	27.083	.358	1	.550	-36.873	69.290
	[Lightning = 161.74]	17.250	27.126	.404	1	.525	-35.917	70.417
	[Lightning = 299.90]	18.018	27.139	.441	1	.507	-35.174	71.210
	[Lightning = 350.76]	18.695	27.158	.474	1	.491	-34.534	71.923
	[Lightning = 450.72]	19.830	27.225	.531	1	.466	-33.530	73.189
Location	Work_space_utilization	.003	.001	5.593	1	.018	.000	.005
	temp_1	-.003	.543	.000	1	.995	-1.067	1.060
	humidity_1	.086	.099	.760	1	.383	-.108	.281
	air_flow_1	2.371	2.577	.846	1	.358	-2.681	7.423
	acoustics_1	-.115	.164	.495	1	.482	-.437	.206
	lighting_1	-.015	.005	8.621	1	.003	-.025	-.005
	Workspace_xteristics	.317	.153	4.300	1	.038	.017	.616

	User_characteristis	-.104	.121	.749	1	.387	-.341	.132
	Maintanence_practise	.016	.023	.479	1	.489	-.029	.060

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	35.969			
Final	.000	35.969	9	.000

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	1.393	66	1.000
Deviance	2.447	66	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.894
Nagelkerke	1.000
McFadden	1.000

Link function: Logit.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[Air_flow = .00]	-477.286	1127.803	.179	1	.672	-2687.739	1733.167
	[Air_flow = .07]	-473.777	1127.486	.177	1	.674	-2683.609	1736.056
	[Air_flow = .10]	-470.091	1127.306	.174	1	.677	-2679.571	1739.390
	[Air_flow = .30]	-465.741	1127.189	.171	1	.679	-2674.992	1743.509
	[Air_flow = 1.01]	-460.222	1126.877	.167	1	.683	-2668.861	1748.417
Location	Work_space_utilization	.014	.031	.207	1	.649	-.047	.075
	temp_1	-4.608	11.241	.168	1	.682	-26.640	17.423
	humidity_1	-3.366	6.768	.247	1	.619	-16.630	9.899
	air_flow_1	-89.987	169.290	.283	1	.595	-421.790	241.816
	acoustics_1	-4.909	12.339	.158	1	.691	-29.092	19.275
	lighting_1	.014	.414	.001	1	.974	-.799	.826
	Workspace_xteristics	1.292	6.510	.039	1	.843	-11.468	14.052
	User_characteristis	-.574	4.081	.020	1	.888	-8.572	7.425
	Maintanence_practise	.377	.501	.566	1	.452	-.606	1.360

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	74.185	14.538	5	.013

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	190.347	220	.927
Deviance	74.185	220	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.597
Nagelkerke	.599
McFadden	.164

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[temp = 24.60]	32.498	11.204	8.414	1	.004	10.540	54.457
	[temp = 26.01]	33.859	11.437	8.764	1	.003	11.442	56.276
	[temp = 26.73]	34.625	11.569	8.958	1	.003	11.950	57.299
	[temp = 26.83]	35.244	11.672	9.118	1	.003	12.368	58.120
	[temp = 27.68]	35.684	11.741	9.238	1	.002	12.673	58.696
	[temp = 28.30]	36.067	11.799	9.344	1	.002	12.941	59.192
	[temp = 28.34]	36.405	11.850	9.438	1	.002	13.179	59.631
	[temp = 28.35]	36.760	11.904	9.535	1	.002	13.427	60.092
	[temp = 30.12]	37.214	11.975	9.657	1	.002	13.743	60.684
	[temp = 30.23]	37.799	12.066	9.814	1	.002	14.150	61.447
	[temp = 30.35]	38.407	12.156	9.983	1	.002	14.582	62.233
	[temp = 30.41]	39.025	12.240	10.166	1	.001	15.035	63.015
	[temp = 30.45]	39.646	12.317	10.361	1	.001	15.505	63.787
	[temp = 30.53]	40.332	12.393	10.592	1	.001	16.042	64.621
	[temp = 30.80]	41.263	12.479	10.934	1	.001	16.805	65.722
Location	IEQ	.000	.002	.014	1	.906	-.005	.004
	Work_space_utilization	.001	.001	2.055	1	.152	.000	.003
	Workspace_xteristics	.315	.129	5.929	1	.015	.062	.569
	User_characteristis	.315	.122	6.642	1	.010	.075	.554
	Maintanence_practise	.066	.023	8.146	1	.004	.021	.111

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	84.415	4.308	5	.506

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	228.240	220	.337
Deviance	84.415	220	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.236
Nagelkerke	.237
McFadden	.049

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[humidity = .00]	-6.260	8.566	.534	1	.465	-23.050	10.529
	[humidity = 28.70]	-5.436	8.530	.406	1	.524	-22.155	11.282
	[humidity = 44.00]	-4.927	8.514	.335	1	.563	-21.613	11.760
	[humidity = 45.86]	-4.507	8.501	.281	1	.596	-21.170	12.155
	[humidity = 46.00]	-4.135	8.491	.237	1	.626	-20.776	12.507
	[humidity = 47.06]	-3.832	8.482	.204	1	.651	-20.457	12.793
	[humidity = 47.77]	-3.553	8.475	.176	1	.675	-20.163	13.058
	[humidity = 50.05]	-3.277	8.468	.150	1	.699	-19.874	13.321
	[humidity = 52.83]	-2.997	8.462	.125	1	.723	-19.582	13.588
	[humidity = 56.03]	-2.672	8.455	.100	1	.752	-19.244	13.901
	[humidity = 62.55]	-2.339	8.450	.077	1	.782	-18.901	14.222
	[humidity = 64.05]	-1.982	8.446	.055	1	.814	-18.536	14.571
	[humidity = 66.65]	-1.560	8.444	.034	1	.853	-18.110	14.990
	[humidity = 68.82]	-1.053	8.447	.016	1	.901	-17.608	15.503
	[humidity = 72.44]	-.236	8.469	.001	1	.978	-16.834	16.362
Location	IEQ	.000	.002	.027	1	.869	-.004	.005
	Work_space_utilization	.001	.001	.867	1	.352	-.001	.002
	Workspace_xteristics	-.189	.115	2.679	1	.102	-.415	.037
	User_characteristis	-.047	.098	.227	1	.634	-.239	.146
	Maintanence_practise	.001	.018	.007	1	.934	-.033	.036

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	83.111	5.612	5	.346

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	231.063	220	.291

Deviance	83.111	220	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.296
Nagelkerke	.297
McFadden	.063

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Threshold	[accoustic = .00]	-5.246	8.536	.378	1	.539	-21.975	11.484
	[accoustic = 48.84]	-4.436	8.508	.272	1	.602	-21.112	12.240
	[accoustic = 52.72]	-3.959	8.499	.217	1	.641	-20.616	12.699
	[accoustic = 53.87]	-3.617	8.493	.181	1	.670	-20.264	13.029
	[accoustic = 57.29]	-3.307	8.489	.152	1	.697	-19.945	13.330
	[accoustic = 60.43]	-2.968	8.483	.122	1	.726	-19.596	13.659
	[accoustic = 61.28]	-2.615	8.478	.095	1	.758	-19.231	14.001
	[accoustic = 61.76]	-2.299	8.472	.074	1	.786	-18.904	14.307
	[accoustic = 63.55]	-2.015	8.468	.057	1	.812	-18.611	14.582
	[accoustic = 63.89]	-1.700	8.463	.040	1	.841	-18.288	14.887
	[accoustic = 64.66]	-1.343	8.459	.025	1	.874	-17.921	15.236
	[accoustic = 65.23]	-.919	8.455	.012	1	.913	-17.490	15.652
	[accoustic = 65.76]	-.393	8.452	.002	1	.963	-16.959	16.172
	[accoustic = 67.21]	.206	8.452	.001	1	.981	-16.360	16.773
	[accoustic = 67.40]	1.095	8.471	.017	1	.897	-15.508	17.698
Location	IEQ	-.001	.002	.279	1	.597	-.006	.003
	Work_space_utilization	-.001	.001	.921	1	.337	-.002	.001
	Workspace_xteristics	-.166	.114	2.121	1	.145	-.388	.057
	User_characteristis	.139	.102	1.847	1	.174	-.062	.340
	Maintanence_practise	.007	.018	.142	1	.706	-.028	.041

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	88.723			
Final	66.448	22.275	5	.000

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	204.103	220	.772
Deviance	66.448	220	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.751
Nagelkerke	.754
McFadden	.251

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Lightning = .00]	7.176	9.075	.625	1	.429	-10.610	24.963
	[Lightning = 24.00]	8.973	8.966	1.001	1	.317	-8.601	26.547
	[Lightning = 53.86]	9.989	8.993	1.234	1	.267	-7.636	27.614
	[Lightning = 57.75]	10.665	9.012	1.400	1	.237	-7.000	28.329
	[Lightning = 58.88]	11.375	9.035	1.585	1	.208	-6.333	29.084
	[Lightning = 65.00]	12.038	9.067	1.763	1	.184	-5.733	29.808
	[Lightning = 69.50]	12.534	9.100	1.897	1	.168	-5.302	30.369
	[Lightning = 88.00]	13.062	9.143	2.041	1	.153	-4.857	30.982
	[Lightning = 115.64]	13.584	9.190	2.185	1	.139	-4.427	31.595
	[Lightning = 124.73]	14.070	9.236	2.321	1	.128	-4.031	32.172
	[Lightning = 160.61]	14.749	9.305	2.512	1	.113	-3.489	32.988
	[Lightning = 161.74]	15.637	9.408	2.762	1	.097	-2.803	34.076
	[Lightning = 299.90]	16.537	9.515	3.020	1	.082	-2.113	35.187
	[Lightning = 350.76]	17.311	9.604	3.249	1	.071	-1.512	36.134
	[Lightning = 450.72]	18.495	9.746	3.601	1	.058	-.607	37.597
Location	IEQ	-.009	.003	7.610	1	.006	-.015	-.003
	Work_space_utilization	.003	.001	7.149	1	.007	.001	.005
	Workspace_xteristics	.345	.142	5.916	1	.015	.067	.623
	User_characteristis	-.200	.109	3.347	1	.067	-.414	.014
	Maintanence_practise	.012	.018	.480	1	.488	-.023	.048

Link function: Logit.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	35.969			
Final	27.438	8.531	5	.129

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	86.785	70	.085
Deviance	27.438	70	1.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.413

Nagelkerke	.462
McFadden	.237

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Air_flow = .00]	-3.542	15.824	.050	1	.823	-34.556	27.472
	[Air_flow = .07]	-3.083	15.833	.038	1	.846	-34.114	27.949
	[Air_flow = .10]	-2.573	15.847	.026	1	.871	-33.632	28.486
	[Air_flow = .30]	-1.766	15.863	.012	1	.911	-32.856	29.324
	[Air_flow = 1.01]	-.419	15.862	.001	1	.979	-31.508	30.670
Location	IEQ	-.019	.020	.949	1	.330	-.057	.019
	Work_space_utilization	-.001	.002	.690	1	.406	-.005	.002
	Workspace_xteristics	-.010	.216	.002	1	.962	-.433	.412
	User_characteristis	-.129	.185	.483	1	.487	-.492	.234
	Maintanence_practise	.030	.030	1.033	1	.309	-.028	.089

Link function: Logit.