UNIVERSITY OF NAIROBI

Department of Real Estate and Construction Management

An Evaluation of Occupant Perception and Satisfaction of Indoor Environment in LEED-Certified Buildings in Nairobi, Kenya.

BY

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE AWARD OF MASTERS DEGREE IN CONSTRUCTION MANAGEMENT IN THE DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT, UNIVERSITY OF NAIROBI.

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DECLARATION

I declare that this is my original work and has not been presented to any other university or institute of higher learning for examination or academic purposes.

Signature_____ _____

LANGAT EZRA KIPROTICH (Author) **DATE**

REG. NO B53/81136/2012

This research project report has been presented for examination with my approval as the University supervisor.

Signature_____ _____

MR. PETER N. NJERU **DATE**

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DEDICATION

I dedicate this research project report to my beloved parents, Mr. & Mrs. Cheruiyot first, for making sure that I got access to the right quality of education and more importantly inculcating in me a spirit of hard work and the culture of responsibility.

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Finally, my gratitude goes to my family members, classmates and others not mentioned, who supported me over the course of my postgraduate studies.

Although not all the above contributed in one way or another to the success of this study, any inherent flaws do in any way reflect their contribution and, as such, I take full responsibility for any errors or shortcomings herein.

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ABSTRACT

The primary purpose of this study was to evaluate the occupant perception and satisfaction in indoor environment of LEED-Certified buildings in Nairobi, Kenya. LEED is an acronym for 'Leadership in Energy and Environmental Design'. Developed by the United States Green Building Council (USGBC), the tool is used to rate the design and construction practices for green buildings.

The principal objective of this study was toexamine the extent of perceived occupants' satisfaction with various elements of IEQ and to determine their relationship with the perceived productivity of the users of LEED-Certified buildings in Nairobi County. The items in IEQ comprised of furniture and workspace layout, thermal comfort and air quality, lighting quality, acoustic quality, cleanliness, and maintenance quality.

An occupants' satisfaction survey was used to collect the data required for the assessment of perceived occupants' well-being as well as their interactions with their indoor environment, in selected LEED-Certified buildings in Nairobi. Interviews ,with key informants, were alsoconducted to supplement the data collected through administration of the questionnaire.

The study's population comprised of occupants (users) of LEED-Certified buildings and key informants (members of design and construction teams and facility managers).The primary data came from questionnaires issued to occupants of the case buildings and interviews with key informants. Secondary data was from books, journals, websites and facility managers' records.

The primary data was analysed using frequencies, descriptive statistics (mean, mode, median, and others), measures of variability (standard deviation and variance) and the Pearson Product-Moment correlation. The correlation analysis was performed in order to determine the nature of the relationship between the variables.

The study revealed that the users were **very satisfied** with the furniture and workspace layout. This was attributed to the ergonomic considerations in the design and layout configurations of computer-based workstations in case buildings. The study further established that the users were **satisfied** with acoustic quality, thermal

comfort and IAQ, lighting quality, cleanliness and maintenance quality of their workspaces.

The results of correlational analysis established that the thermal comfort, lighting quality, acoustic quality, and cleanliness and maintenance quality had significant correlation while furniture and workspace layout had significant correlation with only acoustic quality and not the other variables.

The study concluded that the assessment of the performance of indoor environment in LEED-Certified buildings was critically important if the management of organisations within those buildings were keen on improving the productivity of their workforce. The role of building occupants was also found to be critical in the appraisal of indoor environment as they were seen to provide valuable feedback essential for their successful management and enhancement of operational practices of LEED-Certified buildings.

The objectives of the study were therefore fulfilled and the study recommended that conventional buildings in Nairobi be subjected to similar investigations while facility managers and designers of green buildings should find ways of improving the compliance with LEED standards and guidelines with a view of minimising the percentage of dissatisfied users.

The social dimension, possibly accounting for much of occupants' productivity, as well as the direct effect of LEED-Certification on property values in Nairobi were recommended as further areas of study.

CHAPTER ONE

INTRODUCTION

1.1.Background Information

The fundamental principles of the Constitution of Kenya 2010 and Kenya Vision 2030 are sustainable development and steady growth. The constitution recognises a clean and healthy environment as a fundamental human right. The Constitution also provides for natural resources and environmental conservation, management, utilisation and sustainable exploitation (GESIP, 2015). Accordingly, the Kenyan government and its stakeholders back up the establishment and enactment of feasible institutional and legal frameworks and investment to enhance green buildings development (Fawaz, 2013).

Most importantly, in the advent of climatic change and global warming, there is increased significance in discussions on sustainable real property development. The interest emanates not only from regulators and developers but also from occupants (Kariuki, Nzioki, and Murigu, 2015).To achieve this goal, March 1998 saw the birth of LEED certification program by the United States Green Building Council (USGBC) (Diamond, 2011).

LEED is a USGBC acronym meaning ‘Leadership in Energy and Environmental Design certification program' and is employed as a tool to assist in the designing and operation of building projects to ensure that they are “green”(Lee and Burnett, 2008). LEED consists of credits, which earn points in seven classes: Site Selection, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Regional Priority, and Innovation in Design (Diamond, 2011).

One hundred points are available across these categories with mandatory pre-requisites such as minimum energy and water use as well as reutilizing and collection, and control of tobacco smoke. Every category has credits for explicit approaches to sustainability. The approaches may include the use of daylighting, low-emitting gadgets, decreased water consumption, easy access to transport, and renewable energy use. From the beginning, LEED standards are tightening as the market change and extend to cover diverse rating systems to cover all building types:

Commercial Interiors, Core and Shell, Existing Buildings, and New Construction (Diamond, 2011). These tenets of LEED continue to be adopted by most countries and building experts globally, and Kenya is no exception.

Kariuki, Nzioki, and Murigu (2015) opine that sustainability property development refers to incorporation of the process of decision making through an organisation to ensure that the decisions made embrace the utmost long-term benefits. It also means waste elimination concept and embracing natural processes and energy circles and flows in buildings bearing in mind the relationship between the natural environment and our actions.

Fassio, Fanchiotti, and Volarro (2014) argue that the crucial objective of all novel processes and technology in green buildings is to have "the intelligent building," which incorporates the operation and maintenance of intelligence systems that make up the buildings. The systems are management software, control systems, information technology, and renewable energy systems, electrical, plumbing and HVAC. Accordingly, the comfort level and the Indoor Environment Quality (IEQ) to be assured to occupants of buildings turn out to be important considerations during the development of a design for an efficient building.

Some of the practices that enhance IEQ encompass the development as well as execution of a management strategy for an indoor air quality(IAQ) for constructing the building's preoccupancy phases including specifying low product and Volatile Organic Compounds (VOC) materials in documents used in construction. It includes designing a building to maximize views, ventilations and interior daylighting (Fawaz, 2013). Accordingly, architects have to ensure that the following internal environment aspects of the building function adequately: building architecture with respect to the building geometry and spaces or rooms, room air quality, room humidity, perceived room temperature, selected colour scheme, materials adopted, furnishing, technical installations, noise emissions, building acoustics and artificial, natural lighting and external-internal air circulation and ventilation.

Quite a good number of comprehensive studies have been conducted in Kenya on the elements of Green Buildings (Sustainable Sites, Water efficiency, Materials and Resources, Energy and Atmosphere) apart from IEQ. In particular, studies on

comparison of energy consumption in favour of green buildings as compared to conventional counterparts have been covered extensively. However, none exists on the IEQ performance of LEED-Certified Buildings in the country. The gap a rationale for conducting this study on IEQ performance evaluation of LEED-Certified buildings in Nairobi County.

1.2.Problem Statement

Maximum productivity is one of the most critical goals of any organisation. Based on past observational research into what drives high levels of performance in organisations, a comfortable indoor environment has been identified as one of the factors. With the increased comfort needs of the employees, concerns have been triggered among organisations on ways of providing work environments and workspace design, which fulfil the needs of their workforce and help boost their productivity. While green buildings are often touted for their reduced impact on the environment, those designed for a high IEQ have been known to produce an added benefit of increased user productivity.

The researcher, therefore, seeks to evaluate the performance of green buildings in Nairobi by examining their IEQ and its contribution to the productivity of its users.

Presently, there are many proponents of green building globally because of adverse effects of global warming. Several companies, institutions, and governments strive to acquire LEED certifications to prove that they have addressed their building's negative environmental effects. According to Fawaz (2013), it is important for green buildings to be self-sufficient on general operations, ventilation, and health and safety issue and energy and water conservation.

Review of past literature reveal that historically, users of LEED-Certified have been underutilised as a source of information, crucial for the assessment of indoor building performance. Coupled with the increased comfort needs of employees, concerns have been triggered among organisations to provide them with work environments and workspace design, which fulfil the needs of their workforce and help boost their productivity.

The major concern that this study seeks to address is the need to attain a complete feedback loop so that developers, facility managers, designers, and policy makers can objectively gauge how well those green building features meet the needs of their users as well as the design.

The regular users of a building provide useful information on how well green buildings work, yet in Kenya; they are the most underutilised source of valuable information on the performance of green building. The concern that this research seeks to address is to undertake an occupant's satisfaction survey of green buildings in Nairobi so that developers, facility managers, designers and policy makers can objectively gauge how well those green building features meet their design intent. This information may also be useful to the management of organisations interested in improving the health, well-being, productivity and effectiveness of their teams.

Additionally, other numerous questions beg to be answered. For instance, whether tenants seek after LEED-Certified buildings compared to their conventional counterparts in Nairobi or whether there is business value in them. Such questions call for comprehensive answers and necessitate the need for the evaluation of the performance of LEED-Certified buildings in Nairobi.

Most organisations will embrace the LEED certificate program if they are provided with incentives for instance financial incentives regarding increased rent or reduce taxation because of their reputation in the society (RICS, 2004). McMullen (2001) opines that most companies strive for sustainability since they reap business value from it. According to Miler et al (2008), green buildings attract higher rents from tenants. Despite all the research conducted on reasons why green buildings are in demand, there is limited research in evaluating the general performance of LEED-Certified buildings to confirm their green status in the course of their occupancy. Most notably, green buildings being a new concept in Kenya, there is very little research evaluating their performance in terms IEQ. Accordingly, the major impetus of the researcher in conducting this study is to provide adequate insight on the matter

A good indoor environment is essential for human health. According to the study conducted by USGBC (2016), IEQ comprise of the indoor conditions of a building such as the quality of air, lighting, ergonomics, thermal conditions, and their effect

on the occupants. Jacobs (2013) estimates that human beings spend on average, more than 80% of their time inside a building. Therefore, apart from protecting the health and comfort of building occupants, green buildings with good indoor environmental quality also enhance productivity, decrease absenteeism, improve the building's value, and reduce liability for building designers and owners.

According to Whole Building Design Guide, in the construction of economical buildings, IEQ marks their successes in that, having healthy and comfortable employees' lead to higher productivity. Unfortunately, majority of the developers, find it easier to focus more on the project economics rather than the value of increased user productivity and health.

Another study by Zhang & Smith (2003) revealed that pollution of air inside a building has increased and is becoming a serious global health concern. The varied aspects of air pollution inside a building covering sources, health effects, their level of concentrations and policy have been studied comprehensively (Samet et al, 1987; Bernstein et al, 2008; Wyon, 2004; Spengler and Sexton, 1983, Turiel et al, 1983; Jones, 1999).

According to EPA (2016), the air pollution inside a building is the highest risk to human health among environmental problems. According to World Health Organisation (WHO), it is estimated that premature deaths annually from non-communicable diseases such as chronic obstructive pulmonary (COPD) disease, stroke, lung cancer, and ischemic heart disease, are accredited to exposure to pollution inside a building.

Several approaches aimed at improving IEQ have been suggested in scientific studies undertaken by (Connolly et al, 2009; Rosbach et al, 2013). They include regulatory tools such as adoption of relevant codes and certification schemes that establish minimum levels of compliance for different building types, and may comprehensively cover the design and construction. However, the implementation of these recommendations might prove to be difficult in the Kenya building industry since LEED Certification program is still new.

Most importantly, this study focusses on Nairobi County since it is the home of many LEED-Certified buildings in Kenya. Although there has been substantial emphasis

on measurement and regulation of energy and material resource efficiency of green buildings in Nairobi, less attention has been paid on how well these buildings meet their design intent (IEQ) for its occupants.

As mentioned hereinabove, the LEED-Certification program is founded on a cumulative credit-points system. Therefore, some LEED-Certified buildings in Nairobi County could have still received certification even if they scored the majority of points in most tenets and performed poorly in others. Although the objective of LEED certification is to reduce consumption of resources and limit hazardous environmental effects, there is considerable difficulty in measuring the resource and environmental benefits (Dao, 2009). Most notably, most researchers in Kenya normally focus in evaluating LEED-Certified buildings performance regarding the reduction of waste and low operational energy ignoring the IEQ, which is a very important tenet of LEED. Fassio, Fanchiotti, and Volarro (2014) agree that there is still a lack of satisfactory evaluation of IEQ on occupant productivity in LEED-Certified buildings.

A study conducted by Heinzerling et al. (2013) reveals three major reasons as to why there is considerable difficulty in IEQ evaluation of LEED-Certified buildings. The first reason is the lack of uniform standards to carry out objective measurements regarding space and time rendering. Second, the assessment classes are proposed, and the IEQ factors weighting scheme are distinct. Finally, adequate consideration is not given to inter-category relationships between IEQ factors. That is why the researcher prioritises IEQ in its evaluation of performance LEED-Certified buildings in Nairobi County to determine the standards used and their effect on occupants' interests.

1.3.Research Purpose

The purpose of the study is to undertake a comprehensive evaluation of the performance of LEED-Certified buildings in Nairobi County, Kenya, by examining the extent of perceived occupants' satisfaction with IEQ elements (Furniture and Workspace Layout (ergonomics), Thermal Comfort and Air Quality, Lighting Quality, Acoustic Quality and Cleanliness and Maintenance Quality) and their relationship with perceived occupant's productivity with regards to workspaces.

1.4.Research Questions

i. What is the extent of occupants' perceived satisfaction with IEQ elements in workspaces of LEED-Certified buildings in Nairobi perceive satisfaction with IEQ elements in workspaces?
ii. What is the relationship between IEQ elements and perceived occupants' productivity in workspaces of LEED-Certified buildings in Nairobi?

1.5.Research objectives

The objectives of this study are:

i. To determine the extent of perceived occupants' satisfaction with IEQ elements in workspaces of LEED-Certified buildings in Nairobi.
ii. To establish the relationship between IEQ elements and perceived occupants' productivity in workspaces of LEED-Certified buildings in Nairobi.

1.6.Study Area and Scope

This study is conducted on LEED-Certified buildings in Nairobi County, Kenya. The study covers and examines the major IEQ parameters while evaluating the IEQ performance of the LEED-Certified buildings in the county. IEQ parameters that the study considers are indoor air quality, interior lighting, acoustic comfort, visual comfort, ergonomics, cleanliness, and maintenance quality.

In evaluating the performance of the IEQ in the LEED-Certified buildings Nairobi, this study should examine the three fundamental issues, key in determining the performance of IEQ of a building. These issues include products (services, automation and controls, equipment's, facilities, materials, structure, fabric and materials), people (users, occupants, owners, and investors), and processes (facilities management, performance evaluation, and maintenance). To realise the objective, the study assesses the performance of the IEQ of LEED-Certified buildings from a technological, social, economic, and environmental standpoint.

The research shows the effects of these parameters on the occupants with respect to liability or profitability for building designers and owners, productivity, absenteeism and building's value. The study also identifies both the limitations and strengths of

the IEQ of LEED-Certified buildings in the county. It provides ways of maintaining and improving the IEQ of the buildings.

1.7. Significance of the study

An evaluation of the IEQ performance in LEED-Certified buildings in Nairobi County would contribute to better sustainable design practices. A thorough understanding of the significance and the relationship among the various IEQ elements, occupant's satisfaction and performance in LEED-Certified buildings, shall enable the developers, facility managers, designers and policy makers to gauge objectively how well those green building features meet their design intent. The information shall be useful to the management of organisations interested in improving employee productivity and effectiveness in workplaces.

The findings of this study shall also help potential tenants to make better investment decisions with regards to the provision of conducive environments that contribute to workers' satisfaction and consequently boost their productivity. This in essence, improves workers' retention, and contributes towards overall organisational success.

Evaluating the performance of IEQ in LEED-Certified buildings in Nairobi County will provide awareness to the construction industry's' stakeholders in achieving buildings with the best economic, social and environmental value. Advocates for green building construction shall also benefit from this study's findings because it will give them the basis for lobbying for green buildings construction to replace the conventional ones. The study may also help investors in initial capital outlay reduction and help in increasing the probability of a higher Return on Investment (ROI).

The findings of the study shall also assist construction industry's professionals and academicians in comprehending the IEQ performance of LEED-Certified buildings in Nairobi County. The findings highlight the need for future evaluation of IEQ performance. Through identification of the strengths and weaknesses in the IEQ of current LEED-Certified buildings, it will enable the designers to incorporate design strategies that will improve the quality of the indoor environment in the future LEED-certified buildings. It will eventually continue the successful market transformation to sustainable building design strategies.

1.8.Definition of significant terms

1.8.1. LEED

LEED is an acronym for "**L**eadership in **E**nergy and **E**nvironmental **D**esign". It was developed in the year 2000 by the United States Green Building Council (USGBC). It is a tool used for rating design and construction practices for green buildings. LEED is used throughout North America as well as in more than thirty (30) countries.

1.8.2. Green Building

Green building refers to both a structure and the using of processes that are resource efficient and environmentally responsible throughout a building's lifecycle: from siting to design, construction, operation, maintenance, renovation, and demolition, (United States Environmental Protection Agency, EPA, 2016).

1.8.3. EPA

EPA is an acronym for Environmental Protection Agency, the United States federal government agency created to protect human health and the environment through drafting and enforcing the regulation in line with the laws passed by the Congress.

1.8.4. Productivity

Although the description of productivity may vary from one organisation to another, it is dependent on the goals of an organisation. In this study, productivity shall be investigated from the occupant's point of view and the meaning and hence interpretation of productivity shall not only be limited to the quantity and quality of work performed but in broader terms, the perception in terms of development of meaningful relationships in work place as well as contentment with work performed.

1.8.5. USGBC

USGBC is an acronym meaning 'United States Green Building Council' a non-profit, nongovernmental membership- based organisation that introduced LEED and continues supporting the LEED rating system (Boeing et.al. 2014).

1.8.6. Indoor Environmental Quality

Indoor Environmental Quality encompasses the conditions inside a building such as air quality, lighting, thermal conditions, ergonomics and their effect on occupants (USGBC, 2016).

1.9. Organisation of the study

The study is organised in five (5) chapters listed as follows:

i. In Chapter 1, the researcher describes the research background, formulate the problem statement by identifying the research gap, research questions, goals, and objectives, and provide justification for the study.

ii. In the second chapter, the researcher undertakes a comprehensive review of relevant literature with a view of identifying the latest developments in the area of IEQ. The literature review shall provide an overview of green building standards and certification systems while narrowing down the focus to LEED-Certification. It shall also provide a review of green building adoption in Kenya as well as the existing legislative framework. Past studies on IEQ evaluation and their major findings shall be revisited. Finally, a conceptual framework shall be developed together with hypothesis and operationalisation table of variables.

iii. The third chapter describes the methodology of the research highlighting the research design, establish the population of the study, and explain the sampling techniques employed. It outlines the data collection methods, instruments and analysis used.

iv. The fourth chapter presents the findings of the analysed data and give the relevant interpretation.

v. The fifth chapter explain the findings; provide linkage to the literature review while relating them to the study objectives.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter highlights the history, the legislative anchorage, and the benefits of green buildings in Kenya. It also focuses on some of the studies on evaluation of IEQ in the construction industry. An inclusive literature review on fundamental facets on IEQ is undertaken in this chapter. It explains how the IEQ is beneficial to various stakeholders in the construction industry globally.

2.2. Green-Building Standards and Certification Systems

A study conducted by Vierra (2014) points out that buildings have extensive direct and indirect impacts on the environment. The impacts are apparent throughout their construction, habitation, repair, repurposing, and pulling down. Similarly, buildings consume massive quantities of energy, water, and materials. They also produce waste and emissions. These realities have prompted the adoption of green building concept that seeks to cut down the impact of buildings on the natural environment via sustainable design.

Ali and Al Nsairat (2009), citing Ando et al (2005), observe that the concept of green building is the cornerstone of sustainable development and takes responsibility for balancing long-term economic, environmental and social health. Many researchers have identified numerous benefits. The benefits include energy efficiency, water efficiency, durable, non-toxic, and highly recyclable materials (Ali & Al Nsairat, 2009) as well as improved occupant productivity, enhanced market value and reduced operation costs (Fowler & Raunch, 2006). Further benefits include longer lifespan, reduced replacement and operation costs (Langdon, 2007), optimisation of efficiencies in resource management, operational performance and minimization of risks which threaten human health and environment (Sev, 2009).

Because of a worldwide concern for the environment and sustainable development, there has been a rapid expansion in the number of green building assessment methods, tools and certifications (Waidyasekara, Silva & Rameezdeen, 2013).The requirement of environmental assessment methods, which respond to environmental

issues and define sustainable levels have been emphasised by Boonstra and Petterson (2003). Sev (2009) observes that the building assessment tools have been developed in recent years, attracting the construction sector and raising public awareness in sustainability.

According to Fowler and Raunch (2006), hundreds of building evaluation tools focuses on sustainable development areas. They are designed to cater for different projects types. The tools include life cycle assessment, life cycle costing, energy systems design, performance evaluation, productivity analysis, Indoor Environmental Quality assessments, operations and maintenance optimisation, whole building design, and operation tools.

Ali and Al Nsairat (2009) divided the assessment tools into two groups. The first group include elements based systems such as LEED (US), BREEAM (UK, EU, EFTA, EU candidatesand the Persian Gulf), CASBEE (Japan), BEAM (Hong Kong), Green Mark Scheme (Singapore), Green Star SA (South Africa) and Pearl Rating System for Estidama (UAE).The second group includes Life Cycle Assessment (LCA) methodology.

The elements-based green building rating systems have been comprehensively explored and compared (Cole 1999; Crawley et al. 1999; Todd et al. 2001; Bosch et al. 2003; Fenner et al. 2008; Lee et al. 2008). Table 1 below summarises the rating systems.

Table 1: Green Building Rating and Certification Systems. Source: (USGBC, 2016)

Product Certification	Type of program	Type of Standard/ Certification	Managing Organisation	Area of focus
1. Energy Star	Single-Attribute	Government certification using a benchmarking method	U.S. EPA and U.S.	Building energy and water use
2. Leadership in Energy and Environmental Design (LEED)	Single-Attribute	Green building rating and certification system through independent third-party verification	U.S. Green Building Council	Performance in: sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials & Resources, IEQ, Locations and Linkages, Awareness and Education, Innovation in Design, Regional Priority through a set of prerequisites and credits
3. Living Building Challenge	Multi-Attribute	Performance-based standard, and certification program for: Landscape and infrastructure projects, Partial renovations and complete building renewals, New building construction Neighbourhood, campus and community design	International Living Future Institute	Performance areas include: Site, Water, Energy, Materials, Health, Equity, beauty All areas are requirements.
International Programs				
4. Beam (Hong Kong)	Multi-Attribute	Comprehensive standard and supporting process covering all building types, including mixed-use complexes, both new and existing to assess, improve, certify, and label the environmental performance of buildings	Business Environment Council	• Performance and assessment in: Site aspects, Material aspects, Water use, Energy use, IEQ, Innovations and additions
5. BREEAM (UK, EU, EFTA member states, EU candidates, as well as the Persian Gulf)	Multi-Attribute	Certification system is a multi-tiered process with pre-assessment, third-party consultant guidance through an assessment organisation for: New Construction, Communities, In Use Buildings and Eco Homes	BRE Global	Assessment uses recognised measures of performance, which are set against established benchmarks in: Energy and water use, Internal environment (health and wellbeing), Pollution, Transport, Materials, Waste, Ecology and Management processes
6. CASBEE (Japan)	Multi-Attribute	Building assessment tools for Predesign New Construction Existing Building and Renovation	JSBC (Japan Sustainable Building Consortium) and its affiliated	Assessment areas include: Energy efficiency, Resource efficiency, Local environment, and IEQ.

			subcommittees	
7. Green Mark Scheme (Singapore)	Multi-Attribute	Benchmarking scheme that aims to achieve a sustainable built environment by incorporating best practices in environmental design and construction, and the adoption of green building technologies.	Building and Construction Authority (BCA)	Rates buildings according to five key elements: Energy efficiency, Water efficiency, Environmental protection,IEQ, and Other green and innovative features that contribute to better building performance
8. Green Star SA (South Africa)	Multi-Attribute	Green building rating system for: Office, Retail and Multi-unit residential	Green Building Council of South Africa	Categories assessed in: Management, IEQ, Energy, Transport, Water, Materials, Land Use & Ecology, Emissions and Innovation
9. Pearl Rating System for Estidama(UAE)	Multi-Attribute	Green building rating system for: Community Buildings, Villas, Temporary Villas and Buildings	Abu Dhabi Urban Planning Council	Assessment of performance in: Integrated Development Process, Natural Systems, Liveable Communities, Precious Water, Resourceful Energy Stewarding Materials and Innovating Practice

The productcertificationsare also recognised by green buildingrating systems such as the National Green Building Standard, LEED and Green Globes. Due to such recognition, green productcertifications are increasing because of kaleidoscopic conditions and increased demand for greener products. The green products labels are summarised in Table 2 below.

Table 2: Summary of Green Product Certifications. Source: (Vierra, 2014)

Product Certification	Program Type	Type of Standard or Certification	Managing Organization	Area of focus
1.Energy Star	Single-Attribute	Government certification relying on manufacturer provided data or third party testing	U.S. EPA and U.S. DOE	Energy consuming products
2.Water Sense	Single-Attribute	Government label based on third-party testing	U.S. EPA	Showerheads, toilets, faucets, urinals, and valves
3.Forest Stewardship	Single-Attribute	Third-party certification	Forest Stewardship Council (FSC)	Forests and forestry products
4.SCS Global Services	Multi-Attribute	Third-party certification	SCS Global Services	Wide range of products (i.e. carpets, textiles, wood products, insulation, and more)
5.Green Seal	Multi-Attribute	Third-party ISO Type 1 certification	Green Seal	Wide range of sectors (paints, adhesives, lamps, electric chillers, windows, window films, occupancy sensors)
6.Cradle to Cradle	Multi-Attribute	Moving toward third-party certification; based on a proprietary standard	Cradle to Cradle Products Innovation Institute C2CPII	Wide range of sectors (metals, fibres, dyes, plastics)
7.Green guard	Multi-Attribute	Third-party certification	UL Environment	Indoor air quality, children and schools focus

Waidyasekara, Silva, and Rameezdeen(2013) reveal that environmental assessment systems or tools (Boonstra & Petterson, 2003), building environmental assessment tools (Sev, 2009; Wallhagen, 2013), sustainable building assessment systems (Fowler and Raunch, 2006; Gibberd, 2005), green building rating systems (Gowri, 2004), building performance assessment methodologies (Sinou and Kyvelou, 2006) and green building assessment tools (Ali and Al Nsairat, 2009), all refer to terms used by researchers to describe rating systems developed so far to assess the performance of projects under sustainable development.

Many reasons inform the pursuit of green building certification of projects. Vierra (2014) observe that certification from any rating system authenticates the green nature of a project. Certification is an important educational and marketing prospect for owners as well as design and construction teams in the process sustainable building. Moreover, it provides incentives to clients, owners, designers, and tenants to adopt and support sustainable construction practices. Rating systems also clearly outline what green standards need to be followed and what types of green products should be included in construction specifications.

The choice of a certification system pursued in a project depends on that particular project. None of these certification systems fits in all instances. Due to the dynamic nature of projects, a certification system might prohibit one project and fit another. The selection centers on the nature of each project as well as its unique aspects such as the magnitude, project location, financial plan and project goals.

Buildings developed to comply with green standards do not mean that the green building industry short of challenges. Emerging challenges are evident especially those concerning the performance of new green technologies and materials. Odom, Scott, and DuBose (2009) lament that many of these technologies and materials have not been tested long enough in the built environment to verify their performance fully.

Vierra et al (2014) predict that new and more stringent requirements will continue to be introduced to the standards and certifications process.

2.3. Overview of LEED

Many countries and regions have established their green building plans to support sustainable buildings. The findings of a survey conducted by Fawaz (2013) revealed that 95.7% of green buildings in Nairobi conform to LEED Green Building Standards.

LEED was created in 2000 by the USGBC, for rating design and construction practices that would define a green building in the US. LEED is prevalent in North America and over 30 other countries. About 6,300 projects are certified so far. Over 21,000 projects are listed.

LEED has credits that offer points (100 in total) in 7 categories: Site Selection, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Regional Priority, and Innovation in Design.

There are mandatory requirements such as minimum energy and water use reduction, recycling, and tobacco smoke control.

Under every category, there are credits for specific sustainability strategies. Some touch on the utilization of low-emitting appliances, and minimal water consumption. There are credits for energy efficiency, access to public transportation, recycled content, renewable energy, and daylighting.

LEED Online Project teams have to collect documentation that demonstrates compliance with LEED requirements and file the documentation to the LEED Online website. The Green Building Certification Institute (GBCI) then reviews the documentation; a LEED certification is approved when all requisites and adequate credits are netted. LEED certification is on four levels: Certified, Silver, Gold, and Platinum. No onsite visits are required, and certification can occur upon completion of construction.

Table 3: The Threshold Elements for Certification Levels. Source: (USGBC, 2016)

Certification	Owner-occupied Buildings	Tenant-occupied Buildings	Recognition Level
Certified	50 – 59	50 – 59	Good Practices
Silver	60 – 69	60 – 69	Best Practices
Gold	70 – 79	70 – 79	Outstanding Performance
Platinum	80 – 89	80 – 89	National Excellence
Super Platinum	90 - 100	90 - 100	Global Leadership

There are various LEED categories in LEED Green Building Rating System as summarised in the table below.

Table 4: LEED Credit Categories. Source: (USGBC, 2016)

Item	Credit Category	Description	Max. Credit Points
1.	Sustainable sites	credits encourage strategies that minimise the impact on ecosystems and water resources	10 Points
2.	Water efficiency	Credits promote smarter use of water, inside and out, to reduce potable water consumption.	11 Points
3.	Materials and Resources	Credits encourage using sustainable building materials and reducing waste. Indoor environmental quality credits promote better indoor air quality and access to daylight and views.	13 Points
4.	Energy and atmosphere	Credits promote better building energy performance through innovative strategies.	33 Points
5.	Indoor environmental quality	Credits promote better indoor air quality and access to daylight and views.	16 Points
6.	Innovation in Design	Innovation in design or innovation in operations credits address sustainable building expertise as well as design measures not covered under the five LEED credit categories	6 Points
7.	Regional Priority	Regional priority credits address regional environmental priorities for buildings in different geographic regions.	4Points

2.4. Overview of green rating tools within the tropics

Many countries have introduced new rating tools over the past few years. Several researches have made international comparison of these sustainable rating tools. However these comparisons are mainly carried out on tools designed for temperate countries. New rating tools are now available for tropical countries. They include BCA Green Mark in Singapore and the Green Building Index (GBI) in Malaysia, Green Rating for Integrated Habitat Assessment (GRIHA) for India among others.

The Green Building Index (GBI) is Malaysia's industry recognized rating tools for green buildings. GBI is specifically designed for the tropical climate while integrating Malaysia's current social infrastructure and economic development. There are six main criteria for GBI rating tool to asses' residential and commercial properties which are energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, innovation. Two rating assessments, Design assessments and completion and verification assessment should be attained in order to get GBI rating.

In India, there are three primary rating systems; (i) Green Rating for Integrated Habitat Assessment (GRIHA), (ii) Indian Green Building Council (IGBC) and (iii) Bureau of Energy Efficiency (BEE).

GRIHA is a green building design evaluation system where buildings are rated in a three-tier process. The process initiates with the online submission of documents as per the prescribed criteria followed by on site visit and evaluation of the building by a team of professionals and experts from GRIHA Secretariat. GRIHA rating system consists of 34 criteria categorized in four different sections. Some of them are; (1) Site selection and site planning, (2) Conservation and efficient utilization of resources, (3) Building operation and maintenance, and (4) Innovation.

The IGBC facilitates Indian green structures to become one of the green buildings based on benchmarks provided by LEED while BEE has developed the Energy Performance Index (EPI) where the unit of Kilo watt hours per square meter per year is considered for rating the building and especially targets air conditioned and non-air conditioned office buildings.

The Green Mark certification is a multi-attribute Benchmarking scheme developed by the Building and Construction Authority (BCA) of Singapore. It aims to provide a comprehensive framework for assessing the overall environmental performance of new and existing buildings to promote sustainable design, construction and operations practices in buildings.

These green rating tools developed for tropical conditions differs from other green building rating systems in the sense that they lay a stronger emphasis on energy efficiency and generally tailored to tropical climates. Heat gain and cooling of inner spaces with air-conditioning are key design considerations.

2.5. Regionalization of LEED

One common criticism of LEED has always been the notion of taking a "one-size-fits-all" rating system and applying it to the entire building sector. If all sustainability is local, then surely LEED needed to respond to geographically distinct regional priority issues.

LEED 2009 addressed this criticism by introducing a process coined "regionalization" by which USGBC collaborates with its chapter volunteers to identify existing LEED credits that should be prioritized to address specific regional issues. The six credits identified for each region were termed Regional Priority Credits (RPC).

Chapter volunteers worked together to identify various regional zones, and locations and associated priority credits were determined.

According to LEED v4, regionalization process is still far from perfect, but it accomplishes two very important goals: First, it provides a mechanism through which LEED can begin to respond to regional priority issues by leveraging sophisticated local dataset tools; and second, it engages regional experts and volunteers in the ongoing development of LEED. Over time, these goals can be expanded and enable the world's most transformative green building rating system to more nimbly respond to local priority issues.

2.6.IEQ Standards and Guidelines

Kosonen et al. (2011) observes that here are several international and local standards and guidelines which give recommendations and propose design criteria for achieving good indoor environment (ISO 7730 2005, EN 15251 2007, ASHRAE 55 2004, CEN CR 1752 1998, etc.). The recommended values for the mean air velocity, air temperature, relative humidity, vertical temperature gradient and mean radiant temperature both for winter and summer conditions are listed in these documents. The minimum outdoor air flow rates to be supplied into the space by the ventilation system in order to assure good air quality for the occupants in the room are also defined (EN 15251 2007).

The Outdoor Air flow Rate of 7-10 litres per second per person is desirable in office buildings while the thermal sensation of the body as a whole (general thermal comfort) can be predicted by calculating the predicted mean vote (PMV) index introduced in ISO 7730 2005. The predicted percentage dissatisfied (PPD) index, obtained from the PMV index, provides information on thermal discomfort (thermal dissatisfaction) by predicting the percentage of people likely to feel too hot or too cool in the given thermal environment. The criteria for the excellent level of PPD-index is 6 % (EN 15251 2007). Criteria for the good and basic levels are set to 10 % and 15 %, respectively.

A model for local discomfort that predicts the percentage of dissatisfied due to draught was introduced by Fanger et al. (1988). Draught Rating (DR) index was derived as a function of mean air velocity, air temperature and turbulence intensity. A draught rating (DR) lower than 15 % is recommended in the standards. CEN CR 1752 (1998) specifies different limits on DR for three categories of thermal environment in rooms. The set categories for the predicted thermal state of the whole body (EN 15251 2007) and local discomforts (CEN 1752 1998) are shown in Table 5: Recommended Thermal Environment Categories. Source (Kosonen et al., 2011) below.

Table 5: Recommended Thermal Environment Categories. Source (Kosonen et al., 2011)

Category	Thermal state of the body as a whole		Local discomfort	Perceived air quality	
	Predicted percentage of dissatisfied PPD [%]	Predicted mean vote PMV	Percentage of dissatisfied due to draught DR [%]	Percentage of dissatisfied PD [%]	Required ventilation rate for occupants* [l/s/pers]
I	< 6	-0.2<PMV<+0.2	< 15	< 15	10
II	< 10	-0.5<PMV<+0.5	< 20	< 20	7
III	< 15	-0.7<PMV<+0.7	< 25	< 30	4

* Total ventilation rate for a room is calculated based on diluting emissions from people and the building emissions (Category II: 0,35-1,4 l/s,m²).

The abovementioned overall thermal sensation levels are confirmed as guidelines in recently approved standard EN 15251, which highlights the importance of maintenance of good thermal conditions, when energy performance of building is designed to fulfil the Energy Performance of Buildings Directive (EPBD).

During the design process, the desired thermal conditions for a space may be selected based on the defined international or national indoor climate classifications (e.g. CEN CR 1752 (1998) and FISIAQ 2001). In the selected indoor climate class the target values are set for both maximum percentage of dissatisfied for the body as a whole (PPD) and for the local discomfort (DR). In addition, the relevant targets for indoor air quality, outdoor air flow rates and acoustics conditions are set during the design process.

Even though numerical physical measures define accurately different factors of the indoor environment, only the perceived quality determines the total performance of the building from user's point of view. The occupant IEQ survey is a tool that helps to assess how well a building is performing from the viewpoint of its occupants (Zagreus et al. 2004). Further, a holistic approach of IEQ development and maintenance is required for an effective process to improve the perception of indoor climate conditions. A systematic method for the assessment and improvement of IEQ has been proposed by Takki and Virta (Takki and Virta 2007).

2.7.Green Building in Kenya

Lamudi (2014), a global property portal focusing exclusively on emerging markets, has stated that Kenya is experiencing a steady growth in the provision of sustainable buildings. A report by Green Africa Foundation (GAF, 2014), a local non-governmental organisation, indicates that in sub-Saharan Africa, Kenya comes second only to South Africa, and it leads East Africa in the adoption of green building standards.

A research survey undertaken by Fawaz (2013) reveals that 95.7% of green buildings in Nairobi conform to LEED green building rating system. According to USGBC (2016), green building projects in Nairobi have either been awarded LEED certification, LEED pre-certification or awaiting certification. During the year 2015, Eaton Place located in United Nations Crescent, Nairobi, World Bank Group-Delta Centre along Menengai Road, Nairobi and Citibank Gigiri Branch and COB, attained LEED certification. In the year 2014, Nairobi Business Park Phase II and Garden City Retail won the LEED Gold pre-certification, making the buildings the first commercial structures in East Africa registered officially as green buildings under international standards of the world's leading green code.

2.8.Reasons for Green Building Adoption in Kenya

Khaemba and Mutsune (2014) opine that the impetus of increased green building practices adoption in Kenya is majorly by the global endeavors to establish resilience to the negative effects of the built environment on environmental, economic, and social systems. Liu (2011) asserts that the built environment heavily impacts on land use, human health connected with it, IEQ, resource consumption, and the natural and social environment.

While defining a green building, Kozlowski (2003) argues that the building employs a carefully integrated design, which reduces site disruptions, conserves water, maximises daylight, has a high degree of IAQ, thermal and occupant comfort, reuses materials and uses materials with recycled content. Therefore, the harmful impacts of the construction practices on the natural environment having been determined, buildings' performances have become a priority for built environment professionals and occupants (Ding, 2008).

The primary concern is that construction industry needs to be mindful of the three fundamental concepts of sustainability namely economic, environmental, and social concepts. For instance, the pursuit of green buildings can be viewed as a causal factor to the important, recent research that has been conducted to determine the economic benefit associated with green building technologies adoption (Wiley, Benefield, and Johnson, 2010). Kats (2003) study revealed that green buildings financial benefits are ten times their primary costs premium. Because of the growing trend towards inclination to green buildings, several green buildings systems, standards, and rating tools have been put in place into the marketplace to give an efficient approach or guidelines to realising sustainability in the built environment (Bebbington, and Gray, 2001).

Several industrialised nations, especially in Europe, currently spend hugely on the replacement cost of their present energy grids and connected production infrastructure. Therefore, developing countries such as Kenya can study and avoid a comparable ordeal in future while building their economies today. Most importantly, replacement costs for inefficient energies can be taxing particularly for developing nations. Moreover, production of sustainable energy plays a significant role in realising Kyoto's Millennium Development goals. From the industrial point of view, accessibility to better sustainable energy is vital at micro and macro level to encourage economic growth and income-generating activities (KAS, 2007).

Kenya’s Vision 2030 projects a long-term development plan to develop an economically prosperous and competitive nation. Part of the action plan is to integrate chief infrastructure projects like the building of the FTZ at Dongo Kundu, Mombasa. There is a high probability that as the expected significant growth come to pass; increased pollution and energy inefficiencies will subsequently follow. It is accurate to state that increased rate of industrialisation in developing nations has led to increased usage of unsustainable forms of energy. Besides, Greg Kats 2003 report, Sustainable Building Task Force of California estimates that the approximate outcome in life cycle savings would amount to 20% of the total construction costs if there are slight increases in upfront costs of approximately 2% to buttress green design. Integration of externalities further amplifies cost implications. Owen (2006) opines that integrating related externalities would probably serve to expedite the

process of transition to green alternatives. Therefore, the adoption of green designs has a high probability of having externality and financial impact with effects to the construction industry patterns of resource allocation.

2.9.Legislative Anchorage of Green Buildings in Kenya

2.9.1. The Kenyan Constitution

As mentioned, sustainable development and steady growth are among the fundamental principles of the Kenyan Constitution thus it plays a pivotal role as a legal anchorage of green buildings establishment in Kenya. Sustainable development is provided for by Article 10(2) (d) of the constitution, which emphasises on promoting and instilling the value of sustainable development. On the other hand, Article 42 of the Constitution recognises a healthy and clean environment as a fundamental human right and provides for conservation, management, utilisation, and sustainable exploitation of the environment and natural resources.

Further, Article 43(1) of the Constitution dictates that the government should ensure access to adequate housing with reasonable sanitation standards to all Kenyan citizens. To realise this constitutional requirement, several Bills have been tabled in the Parliament, which if passed, will lead to effective implementation of this constitutional requirement. These Bills include the Housing Bill (2016), the Built Environment Bill (2012), the National Building Maintenance Policy and the National Building Regulations (2012).

2.9.2. The Built Environmental Bill 2012

The Built Environment Bill (2012) brings direction to the growing construction industry through minimum standards and practices establishment. It also seeks to create the Building Authority of Kenya whose purpose is to bring about the control, management and law enforcement in the building industry by formulating standards for health, energy safety, water maintenance, and certification (Kagai, 2012).

2.9.3. The National Building Regulations 2012

The National Building Regulations 2012 purposes to amend the outdated building code to keep up with the novel technologies, novel designs, and the innovative construction systems. The review and harmonisation of the planning and building

regulations have been undertaken in two phases. The first phase consisted of the period from April 2009 up to October 2009 when the task force presented their outcomes to the Minister. It was followed by a sensitization workshop for the parliamentary committee on Transport, public works, and housing and Kenya Institute of Planners.

The second phase runs from August 2010 is characterised by a deliberate change of tactic focusing on Building Regulations that are to be gazetted by Minister of Local Government. It will replace the current outdated Building Code.

2.9.4. The National Building Maintenance Policy 2012

The National Building Maintenance Policy 2012 aims to safeguard the systematic and effective buildings maintenance all through their life span. It is a roadmap to be followed in addressing effective restoration, preservation, refurbishment, setting standards, training and deployment of manpower, financing, enacting appropriate legislations, capacity building to both owners and users, and an establishment of an institutional framework.

2.9.5. National Environment Policy, 2013

The Policy propositions various processes and activities to respond to all environmental matters and challenges. It lays out a framework for a cohesive approach in development and viable management of natural resources in the country. It appreciates the diverse susceptible ecosystems and suggests many policy interventions not only to conventional environmental management endeavors throughout the country but also endorses robust institutional and governance processes to sustain the attainment of the desired intentions and goals.

2.9.6. Kenya Vision 2030 strategy

Kenya Vision 2030 is a long-term action plan for the national development of the country economically, socially and politically. This strategy seeks to ensure that Kenyans are housed decently and adequately in a sustainable environment. The strategy envisions administrative and legal reforms to attain the urbanisation and housing demand in future. Its implementation is via a series of five-year plans the initial one being the 2008-2012 plans (UNEP, 2013).

2.9.7. Environmental Management and Coordination Act

The Act dictates that the development plan incorporates the preparation of Participatory National Environment Plans that contain sectoral coordination and linkages together with measures of environmental conservation. Further, it requires the assessment of environmental impacts. For projects that are complete, the Act dictates that annual environmental audit be conducted with explicit mitigation measures. The National Environmental Management Authority (NEMA) explains and builds a capacity of the regulated community aimed at improving their compliance and receives feedback on the law implementation. NEMA has also established an intricate mechanism for environmental laws enforcement and initiate environmental offenders' prosecution in lieu with the appropriate arms of government (NEMA, 2012).

2.9.8. The Water Act, 2002

The Water Act (2002) creates and controls the institutions that are authorised to provide water and sewerage services together with those responsible for large-scale infrastructure development for harnessing water resources. The Act outlines a framework for water resources management and allocation strategies.

2.9.9. The Energy (Solar Water Heating) Regulations, 2012

The Energy (Solar Water Heating) Regulations, 2012, emphasised on energy conservation and efficiency, reduction in electricity expenses, use of solar energy, energy management award and enhanced glazing in walling.

2.9.10. United Nations Conference on Sustainable Development (UNCSD), RIO+ 20 Guidelines on Green Economy Policies.

The government works within the private sector to encourage the sector to embrace green initiatives. It is keen to ensure that Kenya achieves a transition to a green economy in line with the United Nations' Conference on Sustainable Development (UNCSD) guidelines held in 2012. The result of the document Rio+20 summits The Future We Want (UNCSD, 2012) emphasised on the transition to a green economy as a way towards sustainable development. Transitioning could lead to poverty eradication, sustained economic growth, social inclusion enhancement, human

welfare improvement and creating employment opportunities for and decent work for all while maintaining the Earth's ecosystem healthy, balanced and functioning (UNEP, 2013).

2.9.11. Sessional Paper No. 3 of 2009 on National Land Policy

The policy objective of this policy is "to guide the country towards the efficient, sustainable, and equitable use of land for prosperity and posterity" (*on National Land Policy - United Nations Economic ...*, n.d.). It highlights the general framework and outlines the main measures required to tackle the key land administration issues, environmental degradation information management, institutional framework, archaic legal framework, conflict resolution, historical injustices restitution, and proliferation of informal settlement. The policy's fundamental principle is land use planning, which is isolated as necessary for the sustainable and efficient management and utilisation of land and its resources (Kimani and Musungu, 2010).

2.10. Review on Green Building IEQ Performance Evaluation

2.10.1. Introduction

A good indoor environment is essential for human health. According to USGBC (2016), IEQ encompasses the conditions inside a building such as air quality, lighting, thermal conditions, ergonomics and their effect on occupants. Jacobs (2013) estimates that on average, people spend more than 80% of their time indoors. Therefore, apart from protecting the health and comfort of building occupants, green buildings with good indoor environmental quality also enhance productivity, decrease absenteeism, improve the building's value, and reduce liability for building designers and owners.

Indoor air pollution has increased and is becoming a global health concern (Zhang & Smith 2003). A large body of literature is now available on diverse aspects of indoor air pollution such as sources, concentrations, health effects, engineering, and policy (Samet et al, 1987; Bernstein et al, 2008; Wyon, 2004; Spengler and Sexton, 1983, Turiel et al, 1983; Jones, 1999). Chokor et al. (2015) highlighted that increased state

of awareness is presented on IEQ and associated with the performance, health, and satisfaction of occupants.

EPA (2016), report that indoor air pollution is ranked the highest risk to human health among all types of environmental problems. According to World Health Organization (WHO), it is estimated that premature deaths annually from non-communicable diseases such as stroke, ischemic heart disease, lung cancer, and chronic obstructive pulmonary (COPD) disease are attributed to exposure to household pollution.

Several approaches aimed at improving IEQ have been suggested in scientific studies undertaken by (Connolly et al, 2009; Rosbach et al, 2013). They include regulatory tools such as adoption of relevant codes and certification schemes that establish minimum levels of compliance for different building types, and may comprehensively cover the design and construction. According to USGBC (2016), the strategies adopted by LEED certification system aimed at improving IEQ include compliance to minimum indoor air quality performance, implementing environmental tobacco smoke control and enhanced indoor air quality strategies, use of low-emitting materials, development of construction indoor air quality management plan, undertaking indoor air quality assessment, providing quality thermal comfort, interior lighting, daylighting, quality views and ensuring effective acoustic performance.

The indoor environment has been acknowledged as a fundamental parameter in sustainable buildings evident by the increased study in the last ten years. In fact, limiting the effects of indoor pollutants should be prioritised, since most individuals in the offices and workplaces spend the majority of their time indoors. USGBC (2006) indicated that the level of indoor pollutants may be five times or occasionally 100 times exceed outdoor pollutants evident by the USGBC action of rating acoustic, thermal comfort, and lighting as fundamental facets of IEQ (USGBC, 2009). Accordingly, the USGBC recommended that high-performance facilities should achieve at least 80% of satisfaction with respect to thermal comfort despite the fact that it is rarely achieved.

2.10.2. Occupants' Satisfaction in Green Buildings

Several comprehensive studies exist on IEQ parameters that significantly affect occupant's satisfaction. Radwan, Issa and Hill (2014) focused on the review of IEQ in green buildings globally. The study verified empirically the accuracy of the claim that green buildings have much to offer regarding IEQ than conventional buildings. Their research aimed at authenticating that improvement and assessment of green buildings is fundamental in lieu with the increased growth of green buildings in the construction industry. In this study, the researchers focused on the following parameters namely literature country of origin, year of publication, type, and a sample of buildings studied, and particular IEQ aspects studied.

The IEQ aspects studied included Acoustics, Lighting, Air Quality, and Thermal Comfort. The findings of their study revealed that the IEQ aspect green buildings that occupants were more satisfied with as compared to the conventional ones is Air Quality, the result showcased in seven out of ten studies reviews in different countries. In assessing air quality, they examined the occupants' feedbacks in both mechanically and naturally ventilated building. The study reveals that although mechanically ventilated buildings operated more efficiently, occupants still preferred naturally ventilated buildings.

Contrastingly, Acoustics emerged as the weakest IEQ aspect in green buildings with six out of the eight studies revealing dissatisfaction from occupants. Occupants' were more satisfied with offices with high cubicles whereas building with low cubicles registered the lowest satisfaction levels by occupation with respect to acoustics. With respect to Thermal Comfort, six out of twelve studies revealed that occupants were satisfied with their green building's thermal comfort providing the need for more research. Finally, five out of eleven studies showed improved lighting in green buildings compared to their conventional ones. Most notably, the study showed that the Thermal Comfort and Air quality in green buildings are almost on average with that of conventional buildings with lighting and Acoustics registering poor performance.

Frontczak and Wargocki (2011) concluded that the most important factor among other IEQ parameters was the thermal comfort. Lee and Guerin (2009) indicated that

occupants' performance and satisfaction are majorly influenced by the office-furnish quality whereas IAQ affected the performance of occupants. Kim and De Dear (2011) showcased the nonlinear relationship between occupant satisfaction and IEQ factors and classified the factors into Proportional and Basic Factors with respect to their impact on occupant satisfaction.

2.10.3. Occupants' Productivity in Green Buildings

Budaiova and Vilcekova (2015) assessed the effect of IEQ on productivity at office work. The study further discussed occupants' satisfaction with their modern building environment where the IEQs are controlled in line with the existing guidelines and standards. The findings of the study revealed that not only the comfort of occupants is influenced by the indoor microclimate influence but also their health. Therefore, it is important for architects and engineers to ensure that the comfort parameters are preserved at optimal values. Most importantly, the study showed that the total objective productivity of occupants is stimulated with proper IEQ with office tasks higher than 92% in green buildings when compared to conventional buildings.

Webster et al (2008) opine that a building's overall quality is fundamental to the wellbeing of workers and boost their morale at work. Newsham et al (2009) examined the link between IEQ and job satisfaction extensively about satisfaction with respect to lighting and views and the nature of the link between job and environmental satisfaction. The study illustrated that better IEQ plays a fundamental function in improving job satisfaction and other organisational productivity aspects. Mahbob et al (2011) reiterated this position in their study by opining that poor IAQ has a direct correlation to productive loss.

Lee (2011) concluded that indoor air quality (IAQ) improvement would lead to increased worker satisfaction with the overall building quality. Thermal comfort and IAQ are directly linked with health issues and worker productivity in the workplace. Since employees' cost of doing business is significantly higher than energy cost, designers of workplaces are required to provide workers with an environment that is comfortable and productive as possible via improved thermal comfort and IAQ. Furthermore, Miller et al. (2009) carried out a survey on 2,000 workers and presented that IEQ improvement could lead to increased productivity by 4.8% and reduce the sick

leave days by three days per year. In addition to presenting that user access appropriate acoustics, comfortable temperatures, views, and natural daylight can directly have an impact on productivity, health, and sense of fashion. Fisk (2000) concluded that green indoor environment could reduce the symptoms of sick building syndrome by 9 to 20% and asthma and allergies by 8 to 25%, resulting in savings in productivity and lost time.

A study by Singh et al. (2011) revealed that IEQ improvement resulted in decreasing in work hours due to stress, depressions, respiratory allergies, and asthma and productivity improvements. There were quite significant improvements in perceived productivity, which could lead to an extra 38.98 work per year for each occupant.

2.10.4. IEQ in Residential Buildings

In examining the impact of IEQ and innovation to residential houses in Malaysia, Raid, Kassim, and Hussin (2015) showed that the major reason of IEQ element application is preventing occupants from the Sick Building Syndrome (SBS) experience. Aliffadillah (2008) reiterated that occupants, buildings, and facilities would suffer negative impacts if there were an imbalance of IEQ. Accordingly, IEQ should not only be limited to odour, lighting sound, humidity, thermal conditions and air pollution but is should also incorporate natural ventilation, design and the use of energy.

2.10.5. IEQ, Management and Development Planning

It is worth noting that IEQ is rarely prioritised in most management and development planning since IEQ facets account for 12% of LEED-Certified building residential building evaluation elements. Nevertheless, proper balancing of IEQ is crucial since it correlates to thermal comfort, which constitutes humidity, and temperature that subsequently influences indoor quality. Occupant's satisfaction and health being a priority to most Malaysian residents 13% of the respondents provided suggestions on ways of improving indoor quality via green technology (Sulaiman, Yusof, and Kamarudin, 2013).

Accordingly, if better quality performance in air quality, thermal, acoustics, and visual comfort were to be achieved IEQ would lead to an ideal environment for productivity and human health. As a result, IEQ and innovation would indirect influence residential property's rent rate and market price. To construction experts, it

is essential to identify the impetus for the investment of such buildings and the approaches to overcome such barriers.

2.10.6. IEQ in Educational Buildings

There have also been several studies conducted investigating the factors that affect the performance and occupation of educational occupants. Heschong (1999) study showcased the impact of daylighting in classrooms by the improved performance of students on math and reading tests by 20% and 26% respectively. In addition, Heschong (2003) showed that proper views could improve student learning whereas poor IAQ, poor ventilation, direct sun penetration could make it worse. A study conducted by Hathaway et.al (1992) that there was reduced student absenteeism by 3.5 days per year in classrooms with natural lighting compared to classrooms with little daylighting. Issa et al (2011) illustrated that staff, student and teacher absenteeism in green Canadian schools was enhanced by 2- 7.5 %, while the performance of students improved by 8-19% in comparison to conventional schools. As a result, more studies continued to emerge to identify the main parameters that affect occupants' satisfaction in educational institutions.

Khalil et al (2011) evaluated the performance of indoor environment towards sustainability of higher education buildings in Malaysia. In their study, they opined that indoor environment disruption might result to reduced occupants' activities and the learning process. The researchers stressed the importance of achieving IEQ that would highly satisfy the occupants. In answering the question, they identified post-occupancy evaluation (POE) as an essential tool in identifying the indoor environment problems since it helps indicate the occupants comfort level and satisfaction. The study also revealed that proper indoor conditions have positive significance towards the students learning. Therefore, POE is an ideal tool to be embraced by building stakeholders in the IEQ design of future buildings to assist in making them more comfortable, healthy and sustainability.

Lee (2014) focused on IEQ and its effects on building occupants in Taylor University, Malaysia. Parameters influencing occupant's indoor preferences and environmental conditions together with health effects because of poor IEQ are assessed. The study also evaluated the performance and wellbeing of the occupants

in the University while incorporating the root elements of IEQ such as IAQ, thermal comfort, acoustic quality, and lighting quality. The findings of the study show that the occupants considered the most important IEQ element in the buildings regarding ranking from first to last to be Thermal Comfort, IAQ, Lighting Quality, and Acoustic Quality respectively.

2.10.7. Effect of Maintenance Quality on IEQ

Fuu and Tabassi (2014) explained the importance of the relationship between the quality of building maintenance management services for IEQ and occupants satisfaction. They opined that for the IEQ of a building to be guaranteed, there should be proper maintenance. Their studies show that the higher the maintenance management system of building the higher the occupant's satisfaction and vice versa and air quality as an IEQ factor requires extra maintenance management in public buildings.

2.5 Benefits of Green Buildings

Ali and Al Nsairat (2009) citing Ando et al (2005) observe that the concept of green building is a hallmark of sustainable development and takes responsibility for balancing long-term economic, environmental, and social health. Many researchers have identified numerous benefits. The benefits include energy efficiency, water efficiency, durable, non-toxic and highly recyclable materials as well as improved occupant productivity, enhanced market value and reduced operation costs (Fowler & Raunch, 2006). Further benefits include longer lifespan, reduced replacement and operation costs (Langdon, 2007), optimisation of efficiencies in resource management, operational performance and minimization of risks which threaten human health and environment (Sev, 2009).

2.11. Conceptual Framework

The conceptual framework defines the mental stretch of the study in formulating the linkage between the independent variables and the dependent variable. The independent variables are further dissected into their measurable indicators. The effect of the independent variables on the dependent variable is interfered with by

extraneous variables- moderating and intervening variables, that come in between and affect the envisaged magnitude of the effect.

The study sought to evaluate the performance of LEED-Certified buildings in Nairobi County, Kenya by examining the relationship between IEQ elements and perceived occupant's productivity concerning workspaces in buildings under occupancy.

The independent variables comprised IEQ components which encompass indoor air quality (IAQ), which concentrates on airborne pollutants and other health, safety, and comfort matters such as aesthetics, ergonomics, acoustics, lighting, and cleanliness and maintenance levels. According to Mugenda (1999), an independent variable (predictor variable) refers to a variable that a researcher deploys to establish and measure its effect on another variable.

On the other hand, dependent variable sometimes referred to as criterion variable attempts to indicate the outcome arising from the manipulation of an independent variable. The dependent variables therefore comprised of the overall spatial quality measured regarding occupant's satisfaction, occupant's performance, and building value.

The design, operation and maintenance practices, as well as activities within a building were intervening variables that helped further explain the relationship between the independent and dependent Variables.

The moderating variables also known as mediating or intermediary variable refer to a research variable that determines the direction and/or strength of the relationship between dependent and independent variables. In this study, the main moderating variables were the demographic characteristics of building occupants, the level of motivation of occupants, number of working hours and occupant's health status among others.

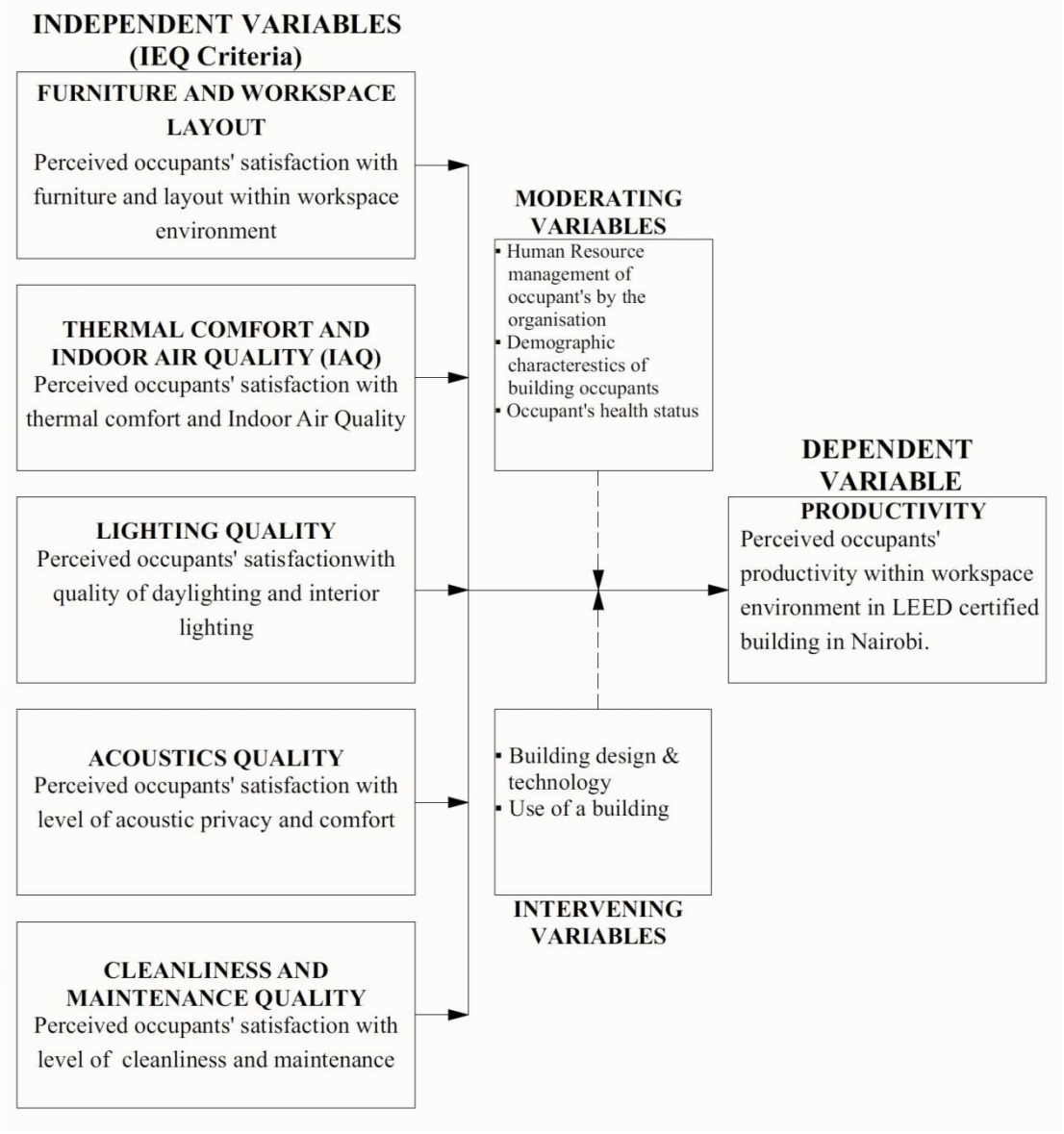

Figure 1: Conceptual Framework (Source: Author, 2016)

2.12. Hypothesis

A hypothesis is a proposed explanation for a phenomenon. For a hypothesis to be a scientific hypothesis, the scientific method requires that one can test it. Scientists base hypotheses on preceding observations that cannot fittingly be explained with the accessible scientific theories. In this study, the null hypothesis (H_0) and the alternative hypothesis (H_A) were stated as follows:

2.12.1. Null Hypothesis (H0)

H_0: The IEQ elements have **no** statistically significant effect on perceived occupants' productivity in LEED-Certified buildings in Nairobi, Kenya.

2.12.2. Alternative Hypothesis (HA)

H_A: The IEQ elements have statistically significant effect on perceived occupants' productivity in LEED-Certified buildings in Nairobi, Kenya.

2.13. Operationalization of Variables

Operationalization in research design refers to the process of strictly defining variables into measurable factors. The process defines vague concepts and allows them to be measured, empirically as shown in the table below:

Table 6: Operationalization Table of Variables; Source :(Author, 2016)

Research Objectives	Data Needs/ Variables	Data Sources	Data Collection Method	Data Analysis Method	Data Output
1. To determine the level of perceived occupants' satisfaction with IEQ elements in workspaces of LEED-Certified buildings in Nairobi.	Level of perceived occupant's satisfaction with the following IEQ elements: •Workspace Furniture (ergonomics) and layout •Thermal Comfort and Indoor Air Quality •Lighting Quality •Acoustic Quality •Cleanliness and Maintenance Quality	•Building Occupants • Facility Manager's Records • LEED Website •Consultants' drawings and specifications	Questionnaire/ Key Informant	•Descriptive Statistics •Cross Tabulation	Level of satisfaction
2. To establish the relationship between IEQ elements and perceived occupants' productivity in workspaces of LEED-Certified buildings in Nairobi.	Effect of perceived occupant's satisfaction with the following IEQ elements on perceived productivity: •Workspace Furniture (ergonomics) and layout •Thermal Comfort and Indoor Air Quality •Lighting Quality •Acoustic Quality •Cleanliness and Maintenance Quality	•Building Occupants •Facility Manager's Records • LEED Website •Consultants' drawings and specifications	Questionnaire / Key Informant	•Descriptive Statistics •Inferential Statistics	Level of productivity

CHAPTER THREE

RESEARCH METHODOLOGY

3.1.Introduction

This chapter highlights the methodology utilized for the acquisition and synthesis of the data studied. Since the objective of the research is to measure occupant satisfaction, occupant level of performance and value implications /profitability to the owners/ investors during the occupation phase of LEED-Certified buildings in Nairobi County, the methodology used in collecting data and computing the levels of satisfaction is comprehensive. It consists of five steps (1) selecting LEED-Certified buildings in Nairobi County (2)selecting the target population to examine the IEQ performance of the buildings (3) selecting a Post-Occupancy Evaluation (POE) survey by sampling to evaluate the, the owners/investors profitability, occupant's level of satisfaction and performance and the LEED-Certified buildings productivity with minimum program requirement(4) collecting the requisite amount of data on occupants satisfaction and performance and the selected buildings profitability and conformity to MPR (5)analysing the levels of occupant satisfaction, occupant performance and the value implications/profitability of the LEED-Certified buildings in Nairobi County and discussing potential parameters that might be having an impact on the occupant's satisfaction and productivity with IEQ performance in LEED-Certified buildings in Nairobi County.

3.2.Research Design

The study adopted descriptive survey research design. Gay (1983) describes survey research as a self-report study, which requires the collection of quantifiable information from the sample.

The research design involved identification of a problem, definition of clear objectives as well as preparation of research instruments (questionnaire and interviews) to be used in the research survey. The responses were then analysed using appropriate statistical procedures.

According to Mugenda (2003), survey research seeks to obtain information that describes existing phenomena by questioning people about their observations, approaches, behaviour, or principles thereby qualifying it as a descriptive research. Apart from just describing, surveys can be used to explain or explore the existing status of two or more variables from time to time.

The descriptive survey research was therefore considered design research approach appropriate for carrying out an evaluation of the performance of LEED-Certified Buildings in Nairobi, Kenya.

3.3.Building selection

Since the purpose of this study is to evaluate the IEQ performance of LEED-Certified buildings in Nairobi County, in selecting the LEED buildings for the study, the building had to be in Nairobi County, LEED-Certified and occupied before the beginning of the process of data collection. Four buildings were chosen for the study. The table below shows the summary of those buildings, their names, their certification category, their location in Nairobi County, their LEED Scorecard and year of certification

Table 7: Building Selection. Source: (Author, 2016).

PROJECT	CERTIFICATION CATEGORY	PROJECT LOCATION	LEED SCORE CARD	YEAR OF CERTIFICATION
Citibank Gigiri Branch	LEED ID+C: Commercial Interiors v3 - LEED 2009	United Nations Crescent Nairobi, Kenya	64/110-CERTIFIED	2015
Eaton Place	LEED BD+C: Core and Shell v3 - LEED 2009	United Nations Crescent Nairobi, Kenya	47/110-CERTIFIED	2015
Garden City Retail	LEED BD+C: Core and Shell v3 - LEED 2009	Thika Road Nairobi	16/110-GOLD PRE-CERTIFIED	2014
World Bank Group-Delta Centre	LEED ID+C:Commercial Interiors v3 - LEED 2009	Delta Centre Menengai Road	67/110-GOLD CERTIFIED	2013

3.4. Target Population

The target population of this study was occupants (users), Members of design and construction teams, Facility managers, and members of the relevant professional body (Architectural Association of Kenya (AAK) Environmental Design Chapter).

In total 116 respondents were involved with 20 respondents comprising the above-named persons from each building. Specifically, in determining the level of occupant productivity and occupant performance in the buildings, the workers and users of the buildings took the survey.

Most notably, most of the above projects were done together with the local profession. However, where foreign expertise was employed in doing the projects, and their contacts proved cumbersome to find, their local liaisons were contacted.

3.5.Sample Size and Sampling Procedure

The study adopted Fisher et al (1972) formula in determining the sample size and stratified random sampling in selecting the respondents in the sample size. The sample size in descriptive studies was determined by using Fisher et al formulae. The following formula was used.

$$N= \frac{Z^2 pq}{d^2}$$

Where;

n = the desired sample size (if the target population is greater than 10,000)

Z = the standard normal deviation at 95% confidence level (=1.96)

P = the expected population correlation coefficient (population effect size)

Since immediate estimate could not be established due to time and resources constraints, 50% (large effect size) was used to determine sample size

q= 1-p
d= level of precision (set at +/- 5% or 0.05)

Thus;

$$n= \frac{(1.96)2\,(0.50)\,(0.50)}{(0.05)^2}$$

=384

Since the target population was less than 10,000, the sample size was adjusted using the following formula;

$$n= \frac{n}{(1+n)/N}$$

Where: nf= desired sample size when population is less than 10,000.

n= the desired sample size when the population is more than 10,000

N= the estimate population size of all 164

Hence: nf= 384
1+ (384/164)
= 384/3
=116

Therefore, 116 number of respondents were considered the appropriate study sample size, representing 116/164=0.7 of the target population.

The stratified sampling technique was employed in this study. As explained herein above the respondents were classified into four groups, namely occupants (users), design and construction team, Property Owners (Facility managers), and the Environmental Design professionals.

The list of LEED-Certified buildings in Nairobi together with their certification category and date of certification were identified on the USGBC website. From the list, detailed information such as their exact location within Nairobi and more importantly, the contact details of their facility managers was obtained from the individual building's websites. Information on the tenants (users), design and construction teams were obtained from facility manager's records.

There were cases where foreign consultants were involved in the projects. In the case where it could not be possible to be contacted for any feedback, their local liaisons were identified and asked to respond to the questionnaires.

Finally, the information on environmental design consultants was gathered from records kept by the facility managers. The sample targeted six environmental design consultants and five officials each from National Environmental and Management Authority (NEMA) and City County of Nairobi (CCN) who were all subjected to interviews. In total 116 respondents in this group were needed for feedback.

Table 8: Sampling Frame. Source: (Author, 2016).

Sampling Unit	Target Respondents	Actual Respondents
i. Occupants	90	57
ii. Facility Manager	4	2
iii. Design and Construction Team	12	5
iv. Regulatory Officials	10	3
Totals	**116**	67

3.6.Pilot- Testing

According to Mugenda (2008), pilot testing is about doing a preliminary test of the data collection instruments and techniques to pinpoint and remove problems, allowing programs to make corrective revisions to instruments and data collection

procedures to ensure that the data that will be collected is reliable and valid. The uniformity and legitimacy of research tools define the quality of data collected and hence that of the whole research (Babbie, 1998).

To ensure reliability and validity of research instrument, a test-retest method was used. In particular, the questionnaire was administered twice within a week to the same group of people who did not make the sample population.

Key informants in the four categories of respondents were also used in the pilot test to establish the reliability and validity of the instrument. The questionnaires wereadministered to the key informants, and their responses were analysed to establish its validity and reliability. Any statements within the instrument found likely to lead to unreliable or invalid responses were altered to obtain more reliable and valid information. During the pilot study, amendments and necessary modifications were undertaken in the data collection tools to enhance the level of validity of the instruments.

3.7. Research Instrument

Kosonen et al (2011) observe that historically, building occupants have been underutilized as a source of information on building performance. In this study, therefore, an occupant satisfaction survey was conducted to analyse the perception of the actual indoor environment quality in four LEED-Certified Buildings in Nairobi. The questions evaluated satisfaction with the following IEQ areas: office layout and furnishing, thermal comfort, indoor air quality, lighting, audibility, safety and security, and building sanitation and upkeep. Elementary demographics on respondents and their workplace were obtained. The survey questions determined, collected information, if the workspace is within the internal or perimeter zone, close to a window, and its positioning and the office layout.

A self-administered questionnaire has been utilized as a diagnosis tool to identify specific problems and their sources. Accompanying the questionnaire was an introduction letter issued by the University of Nairobi as well as a letter of transmittal signed personally to give it a personal touch thus improve the response rate.

The approach of the self-administered questionnaire gives two main benefits: 1) it can inexpensively be administered to many respondents and 2) it can be administered quickly and is well suited for simple and short questionnaires.

Upon starting the survey, respondents tick questions asking them to gauge their satisfaction with diverse characteristics of their working environment. Satisfaction is rated on a five -point scale with a neutral midpoint.

	Extremely Satisfied	**Very Satisfied**	**Moderately Satisfied**	**Slightly Satisfied**	**Not at all Satisfied**
i. How satisfied are you with the amount of space available for individual work and storage?					
ii. How satisfied are you with ease of interaction with co-workers?					
iii. How satisfied are you with the level of visual privacy?					

Figure 2: A sample of the occupant IEQ survey page. Source: (Author, 2016).

As a rule, a 50 % response rate is necessary to lessen non-response bias to an acceptable rate (Hill et al. 1999).

3.8.Data Collection Method and Instruments

In collecting the data, semi-structured questionnaires consisting of both open and close-ended questions were employed in primary data collection in line with the objectives of the study. Questionnaires were distributed to the respondents of the study through personal administration and by selecting seven research assistants who helped with the administration of questionnaires. Before questioning began, consent was sought from the respondents, and the above-named respondents were involved in the study. The interviews with the green building consultants were conducted personally.

The study was reliant on primary data. Specifically, an 8-item questionnaire which was prepared and distributed by research assistants by identifying the respondents in the various groups. The questionnaires consisted of different types of questions, which include both single choice and multiplechoice responses to attain independent and

exclusive responses. The questionnaire also used the Likert scale questions in determining varying degrees of extent and attitudes of sentiments on a particular stand or statement. The data collected was scaled, categorical, or numerical depending on the questions presented. The purpose of the question was to establish the IEQ performance in green building Vis a Vis the occupants' performance and occupants productivity. The study's aim and objectives were made known to the respondents through a cover letter. The research assistants acted as interview guides in a bid to seek clarity on questionnaire responses.

3.9.Data Analysis

Data analysis techniques employed in this study were both quantitative and qualitative. Quantitative techniques were used in analysing the close-ended questions in questionnaires whereas qualitative techniques were used to analyse the questionnaires open-ended questions.

After completion of the data collection process, the questionnaires were counter checked to confirm their completeness before coding. Once coded the computation was done using Statistical Package for Social Sciences (SPSS) version 17.

Descriptive statistics was used to describe and make sense of the data. The descriptive statistics included the frequencies, percentages and means and standard deviations.

Qualitative data was then analysed through content analysis and presented, systematically, in prose form to generate a report according to the objective of the study. Inferential statistics such as regression and Pearson-moment correlation analysis were used to analyse the relationship between perceived occupants' satisfaction with IEQ elements (Furniture and Workspace Layout (ergonomics), Thermal Comfort and Air Quality, Lighting Quality, Acoustic Quality and Cleanliness and Maintenance Quality) and the perceived occupant's productivity with regards to workspaces. The relationship between the variables was represented by the linear equation below:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5$$

Where Y= perceived occupants' productivity

X_1= Perceived occupants' satisfaction with furniture and workspace layout,

X_2= Perceived occupants' satisfaction with acoustic quality,

X_3= Perceived occupants' satisfaction with thermal comfort and air quality,

X_4= Perceived occupants' satisfaction with Lighting quality,

X_5= Perceived occupants' satisfaction with cleanliness and maintenance quality,

α =Constant, β=Coefficient.

A multivariate regression model was also developed to quantify the strength of association between the variables.

The research findings were then presented using tables and graphs and pie-charts.

3.10. Validity of the Study and Research Instruments

The validity of the study establishes the authenticity of the research findings and whether the study has indeed measured what it was structured to measure. Extensive literature searches were done to help to establish the validity of this research. To collect reliable data, the researcher designed the questionnaires based on the template provided by LEED describing the guidelines applicable in conducting occupants' satisfaction survey.

The pilot study as mentioned below helped enhance the level of validity of the instruments.

3.11. Reliability of the Research Findings

Reliability affirms the consistency of the research findings over a period and the accuracy of the total populace covered by the study. The data collection in this study incorporated accepted and well-tested procedures capable of yielding systematic data if used in similar studies. Reliability of the study was authenticated via the test-retest method thus simultaneous consistency is assured. Similar scores show consistency in the study whereas variations show the apparent difference. If the apparent difference in the scores were to arise, data collection tools would be modified to bring consistency. In the pilot study, the questionnaire was administered twice to the same

group of people who were not part of the sample population. If the results were consistent, the scores should be similar. If they were not consistent, the instruments would have been modified.

3.12. Chapter Summary

The chapter was introduced by outlining the purpose of the study and methods used in building selection. It outlined that LEED-Certified buildings in the operation phase in Nairobi County qualified them for the study. It then identified respondents target population) involved in the study to include designing and construction, occupants (users), owners of the building (management and maintenance team) and the regulatory body professionals from the above or involved with selected buildings. It also identified workers, users, architects, owners (facility or maintenance managers), engineers, Construction managers, and personnel from the Nairobi City County, NEMA, and AAK. For efficient data, collection respondents were specific groups. The chapter then concluded by highlighting the data collection and analysis methods.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.1. Introduction

This chapter presents an analysis of data collected through self-administered questionnaire.

4.2. Response Rate

From the sampling frame of 116 respondents, 90 respondents were issued with self-administered questionnaires while semi-structured interviews were conducted on the rest. Out of the 90 questionnaires issued, only 57 were completed and submitted for analysis. The figure represented 63.33% response rate. According to Babbie (2002), a response rate of 50% and above is adequate for data analysis. The response rate, therefore, was good enough for data analysis.

The highest response rate (43.86%) was registered at Garden City Retail while the lowest response rate was registered at Citi Bank Gigiri (12.28%) respectively. The response rate for the remaining buildings was recorded as summarized in Table 9 below.

Table 9: Response rates for selected LEED-Certified buildings in Nairobi. Source: (Author, 2016).

LEED-CERTIFIED BUILDING	PROJECT LOCATION	FREQUENCY	PERCENTAGE
Citibank Gigiri Branch	United Nations Crescent Nairobi, Kenya	**7**	**12.28%**
Eaton Place	United Nations Crescent Nairobi, Kenya	**8**	**14.04%**
Garden City Retail	Thika Road, Nairobi	**25**	**43.86%**
World Bank Group-Delta Centre	Delta Centre Menengai Road	**17**	**29.82%**
TOTALS		**57**	**100%**

The response rates are graphically illustrated in Figure 3 below.

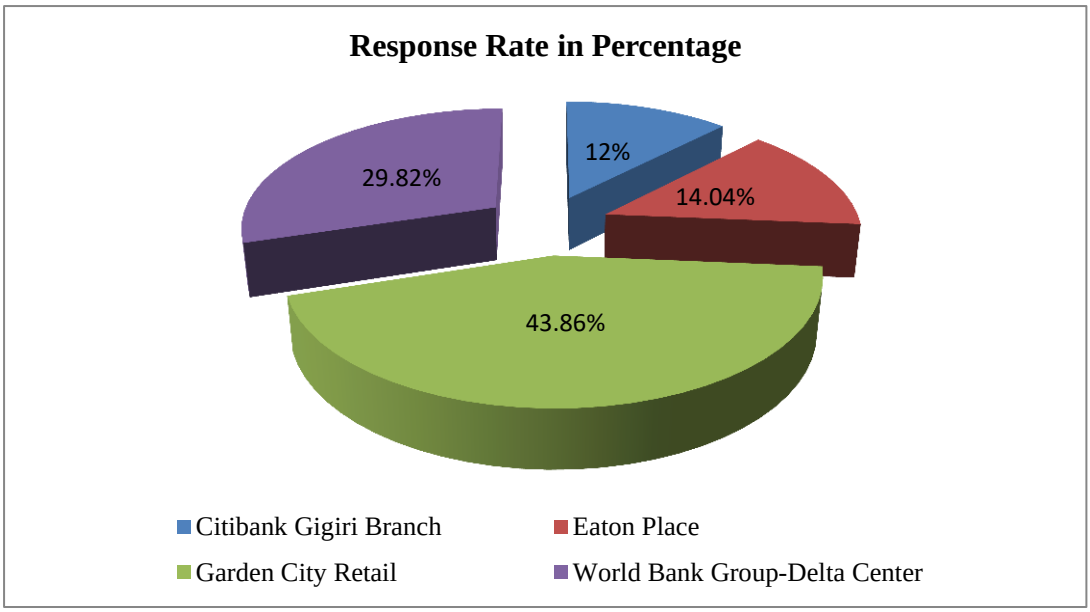

Figure 3: Response rates for selected LEED certified buildings in Nairobi. Source: (Author, 2016).

The study sought to establish the extent of the enclosure of workspaces in LEED-Certified buildings in Nairobi. This information was useful in explaining the results of the extent of satisfaction with the elements of IEQ. The results on distribution of occupants in different categories of workspaces are presented in the table below.

Table 10: Distribution of occupants in different categories of workspaces. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Enclosed Office Private	16	28.1	28.1	28.1
Enclosed Office Shared	12	21.1	21.1	49.1
Cubicle With High Partitions	8	14.0	14.0	63.2
Cubicle With Low Partitions	8	14.0	14.0	77.2
Workspace In Open Office With No Partitions	13	22.8	22.8	100.0
TOTAL	**57**	**100.0**	**100.0**	

The survey reveals that majority of respondents (28.1 percent) occupy private enclosed workspaces. Only 22.8 percent of the respondents occupy open offices with

no partitions at all while about 21 percent occupy share-enclosed workspace. The occupants of office cubicles with high partitions as well as those in cubicles with low partitions share the least percentage (14 percent) of the total respondents respectively.

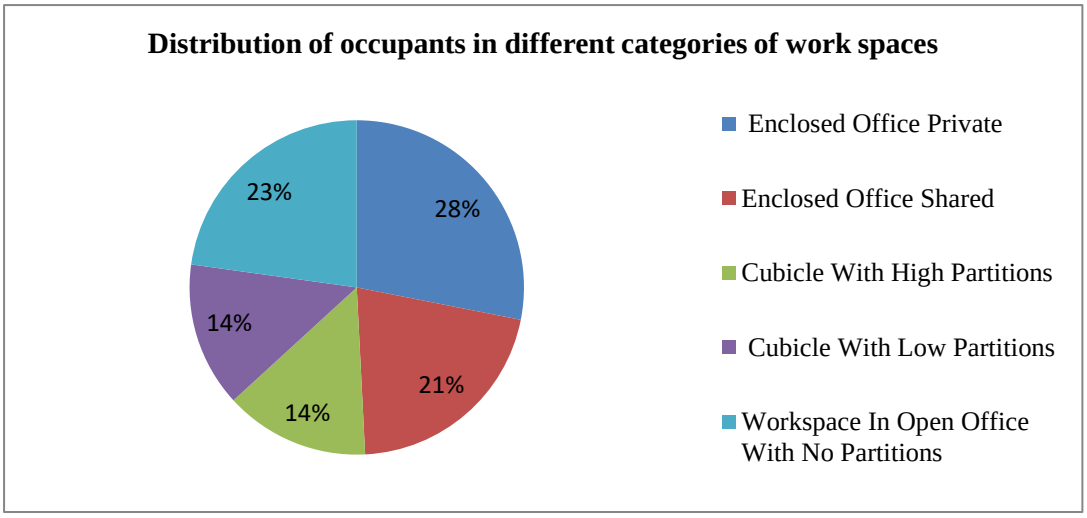

Figure 4: Distribution of occupants in different categories of work spaces. Source: (Author, 2016).

4.4.Furniture and Workspace Layout

The study sought to establish the extent of perceived occupants 'satisfaction with various furniture and layout considerations in LEED-Certified buildings in Nairobi. This information was useful in the assessment of the effect of furniture and workspace layout on occupants' productivity. The results of occupants' satisfaction levels with ease of interaction with co-workers, the level of visual privacy and flexibility, re-arrangement and re-organisation of workspace furniture are presentedin Table 11, Table 12 and Table 13respectively;

Table 11: Occupants' satisfaction with ease of interaction with co-workers. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.8	1.8	1.8
Disagree	1	1.8	1.8	3.5
Neutral	2	3.5	3.5	7.0
Agree	11	19.3	19.3	26.3
Strongly Agree	42	73.7	73.7	100.0
Total	**57**	**100.0**	**100.0**	

The survey as per Table 11 above reveals that more than half of the respondents (73.7 percent) strongly agree that workspace is open enough to interact with their workplace colleagues while 19.3 percent agree to a lesser extent. Only3.5 percent of the respondents are neutral. The rest of the respondents are of the contrary opinion.

Table 12: Occupants' satisfaction with Visual Privacy. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	0	0	0	0
Dissatisfied	0	0	0	0
Not Sure	0	0	0	0
Satisfied	27	47.4	47.4	47.4
Very Satisfied	30	52.6	52.6	100.0
Total	**57**	**100.0**	**100.0**	

The survey also indicates that all the respondents are satisfied with the level of visual privacy within their workplace. The proportion of very satisfied respondents (52.6 percent) to the satisfied respondents (47.4 percent) is fairly balanced.

Table 13: Occupants' satisfaction with furniture flexibility rearrangement and reorganization of the workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	1	1.8	1.8	1.8
Dissatisfied	1	1.8	1.8	3.5
Not Sure	3	5.3	5.3	8.8
Satisfied	14	24.6	24.6	33.3
Very Satisfied	38	66.7	66.7	100.0
Total	**57**	**100.0**	**100.0**	

The results of the survey as shown in Table 13above, indicate that majority of the respondents were satisfied with the flexibility of furniture to re-adjust, rearrange, and reorganize their workspace. The highest proportion of respondents were very satisfied (66.7 percent) followed by satisfied respondents (24.6 percent). Only 5.3 percent of the respondents were neutral. The rest of the respondents were dissatisfied and very dissatisfied each at 1.8 percent respectively.

The percentage distribution of respondents on a five-point satisfaction scale for each variable of furniture and workplace layout is represented by the group column chart shown in Figure 5 below.

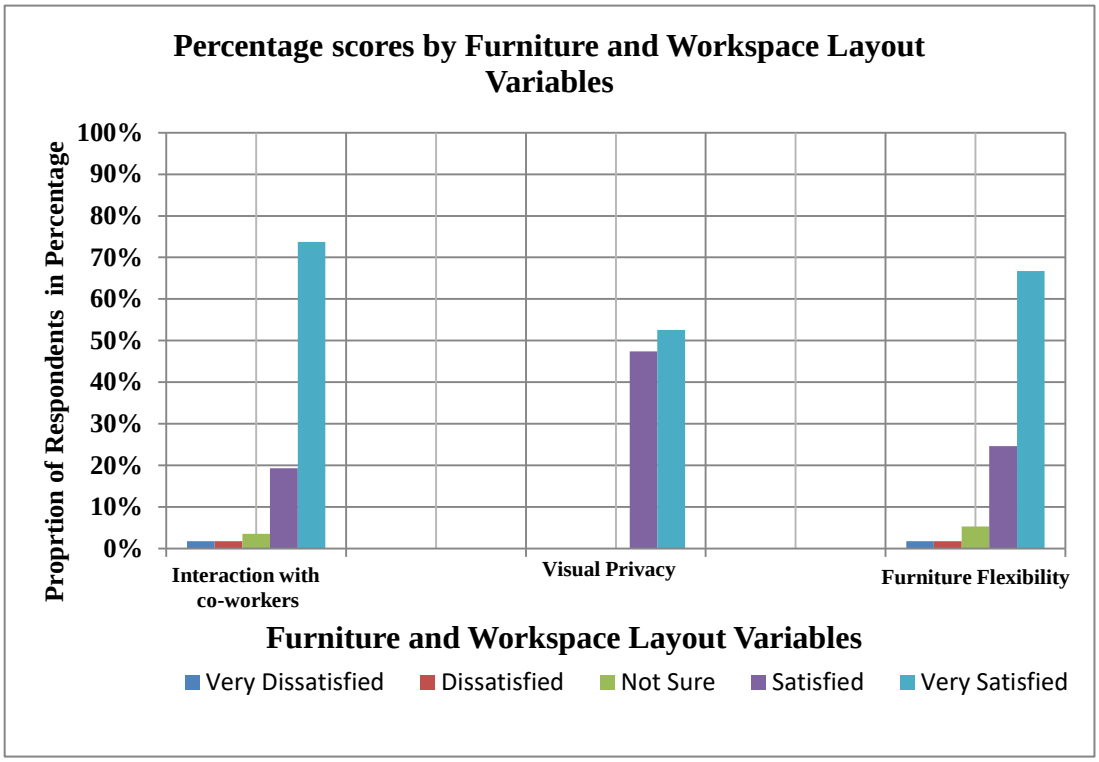

Figure 5: Group column chart showing the variables of furniture and workspace layout and the percentage distribution of respondents on five point satisfaction scale. Source: (Author, 2016).

Using data obtained from Table 11, Table 12 and Table 13 above, the arithmetic means scores attained by the variables of furniture and workspace layout and the overall mean were computed and the results are summarised in Table 14 below;

Table 14: Arithmetic mean and standard deviations of occupants' extent of satisfaction with variables of furniture and workplace layout. Source: (Author, 2016).

Furniture and Workplace Layout Considerations	N	Min	Max	Mean	Std. Deviation
Satisfaction with ease of interaction with co-workers.	57	-2	2	1.61	.796
Satisfaction with Visual Privacy	57	1	2	1.53	.504
Satisfaction with furniture flexibility rearrangement and reorganization of workspace	57	-2	2	1.53	.826
OVERALL MEAN				**1.55**	

These survey results obtained in Table 14 above are represented graphically in Figure below;

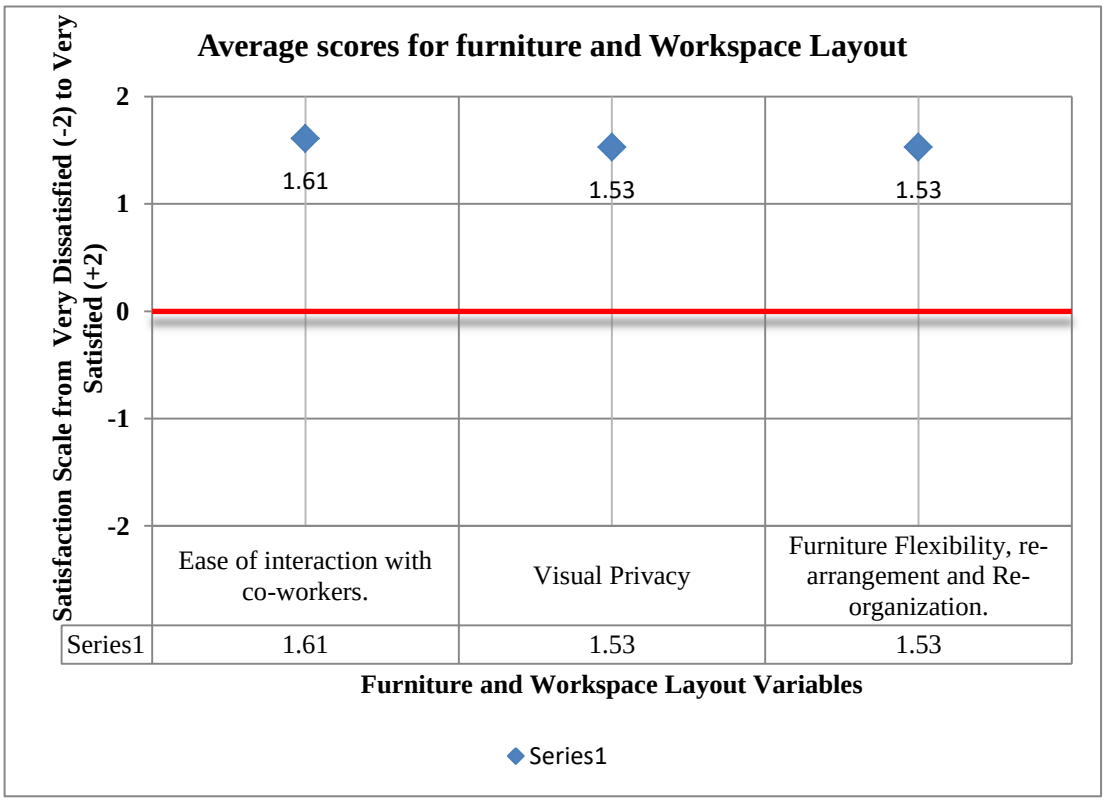

Figure 6: Scatter diagram showing computed means of furniture and workplace layout variables. Source :(Author, 2016).

According to the survey results shown in Table 14 above, the occupants were **very satisfied**(according to satisfaction scale used in this study where **-2**=Very

Dissatisfied, ˉ**1=** Dissatisfied, **0**=Neutral, **1**= Satisfied and **2**=Very Satisfied) with the furniture and workspace layout in LEED-Certified buildings in Nairobi.

The high positive rating (very satisfied) by the respondents in this study, on furniture and workplace layout, is attributed to the ergonomic considerations in the design and layout configurations of computer-based work stations in case buildings.

During data collection, the researcher observed that the workstations in the majority of workspaces especially in World Bank group Delta Centre suited the requirements of each employee, the type of occupation, their visual demands, and individual demographic differences.

More specifically, the office chairs had, adjustable seat height, curved lower back (lumbar) support on backrest, adjustable backrest height which allowed the lumbar support to be adjusted to suit the individual. It also had an adjustable backrest tilt in both forward and backward direction. The office chair also had a seat pan tilt with a rounded front edge so as allow adjustments that ensure users maintain the natural curve of the spine. In addition, the chair had adjustment controls that were easy to operate from the seated position with seat pan depth adjustment.These ergonomic features lessen the need to order chairs with different sized seats to suit shorter or taller users. Other ergonomic features such as caster rollers which lessened the likelihood to tip over andcomfy cushioning and upholstery on the seat and backrest reduced potential injury and ensured the worker's comfort, hence the high rating.

The interviews with the procurement representative also revealed that any new furniture wasalways tried on the users before purchase.

Further assessment by the researcher revealed that the buildings particularly Eaton Place in Gigiri had the optimum configuration of their computer workstations which ensured that workers moved freely from one workstation to the next. The majority of organisations within the case buildings had a mix of space partitions ranging from full height to half height to open plan. This allowed for easy interaction among co-workers while ensuring visual privacy.

The ergonomic design of the workstation also contributed to the high rating by the respondents. The researcher noticed that the workstations were designed to allow adequate height, depth and work surface to suit the user, the type of work they doand

the equipment they use. Other ergonomic features comprised of: a flat smooth surface for the keyboard and mouse so they can be used on the same level, space to position all the equipment so that posture or vision is not compromised when completing tasks, a suitable height (about 700 to 720 mm when measured from the top of the workstation to the floor) as well as adequate clearance under the desk with sufficient space comfortably stretch legs.

4.5.Acoustic Quality

The study sought to establish the extent of satisfaction with workspaces of various acoustic qualities as perceived by occupants of LEED-Certified buildings in Nairobi. This information was useful in the assessment of the effect of acoustic quality on occupants' productivity in LEED-Certified buildings in Nairobi. The results of the field survey showing the extent of occupants' satisfaction with sound (noise) level are presented in Table 15below;

Table 15: Occupants' satisfaction with sound level within a workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	4	7.0	7.0	7.0
Dissatisfied	0	0	0	7.0
Neutral	9	15.8	15.8	22.8
Satisfied	29	50.9	50.9	73.7
Very Satisfied	15	26.3	26.3	100.0
Total	**57**	**100.0**	**100.0**	

The results summarised in Table 15 above indicate that about half of the respondents (50.9 percent) were satisfied with sound (noise) level as perceived in their workspace environment while 26.3 percent of the respondents were very satisfied. Only 9 percent of the respondents were neutral. The rest of the respondents were very dissatisfied (4 percent).

The percentage distribution of respondents' perceived satisfaction with sound (noise) level, on a five-point satisfaction scale used in this study, is graphically represented by the bar chart shown in Figure 5 below.

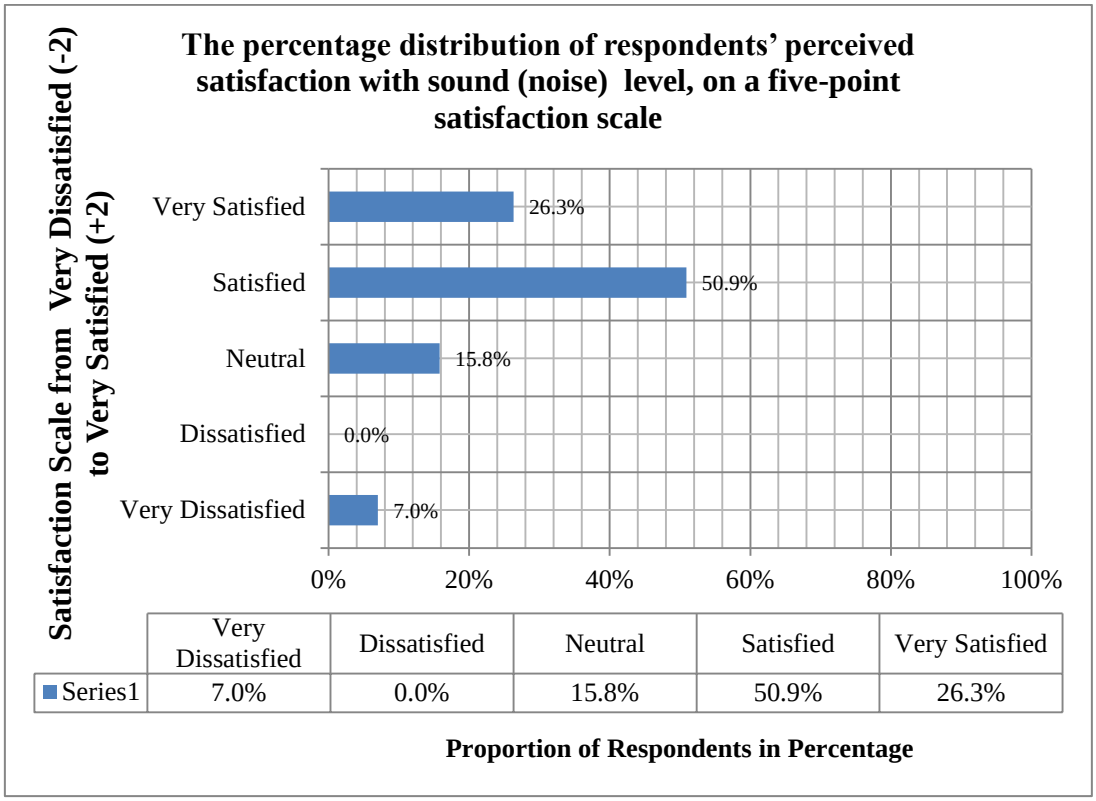

Figure 7: Combined bar chart and table showing the percentage distribution of respondents' perception of their extent of satisfaction with sound (noise) level, on a five-point satisfaction scale. Source: (Author, 2016).

The results of the field survey showing the extent of occupants' satisfaction with sound privacy (the ability to converse without your co-workers earwigging and vice versa) are presented in Table 16 below.

Table 16: Occupants' satisfaction with sound privacy within a workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	3	5.3	5.3	5.3
Dissatisfied	1	1.8	1.8	7.0
Neutral	12	21.1	21.1	28.1
Satisfied	28	49.1	49.1	77.2
Very Satisfied	13	22.8	22.8	100.0
Total	**57**	**100.0**	**100.0**	

According to the results in Table 16above, the majority of the respondents were satisfied with sound privacy in their workspace. About a half were very satisfied

(49.1 percent) while the proportion of very satisfied respondents (22.8 percent) to the neutral respondents (21.1 percent) was almost equal. The rest of the respondents were either very dissatisfied (5.3 percent) or satisfied (1.8 percent).

The distribution in percentage of respondents' perception of the extent of satisfaction with sound privacy (the ability to converse without your co-workers earwigging and vice versa are presented, on a five-point satisfaction scale used in this study, is graphically represented by the bar chart shown in Figure 5 below;

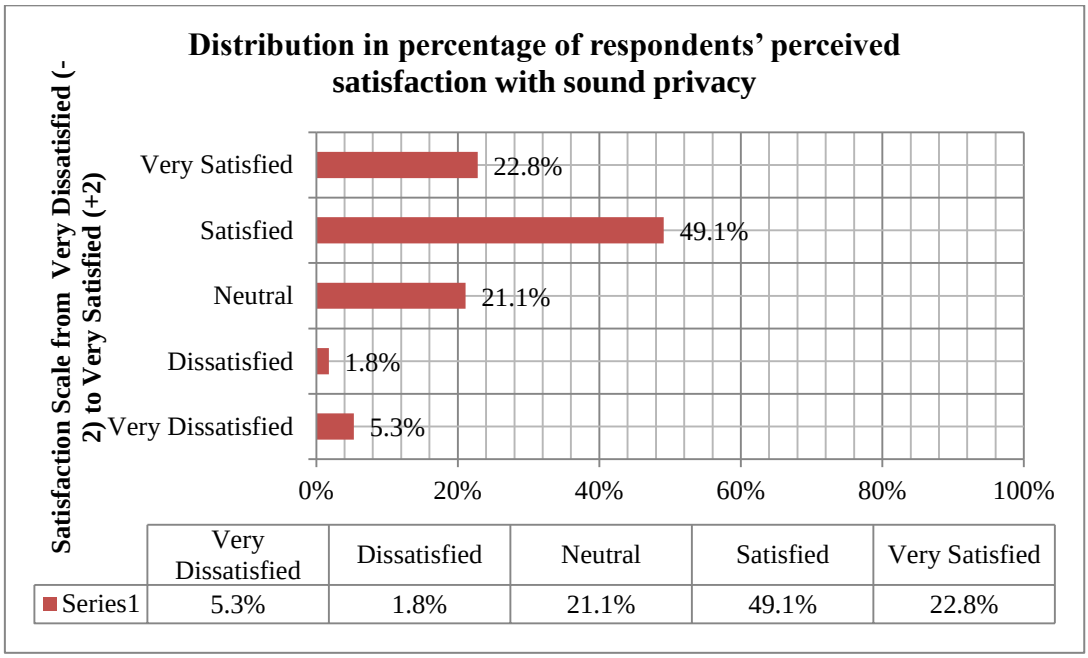

Figure 8: Combined bar chart and table showing the percentage distribution of respondents' perception of their extent of satisfaction with sound privacy, on a five-point satisfaction scale. Source: (Author, 2016).

Using data obtained from Table 15 and Table 16 above, the arithmetic means scores attained by the variables of acoustic quality in LEED-Certified buildings in Nairobi and the overall mean were computed, and the results are presented in the Table below;

Table 17: Arithmetic mean and standard deviations of occupants' satisfaction with sound quality variables. Source: (Author, 2016).

Acoustic Quality Considerations	N	Min	Max	Mean	Std. Deviation
Satisfaction with sound level within workspace environment	57	-1	2	.96	.844
Satisfaction with sound privacy within workspace environment	57	-2	2	.82	.984
OVERALL MEAN				**0.89**	

According to the results of computed arithmetic mean shown in Table 17 above, the occupants were **satisfied** (a mean of 0.5 to 1.4 on the satisfaction scale used in the study indicate, satisfied) with acoustic quality of LEED-Certified buildings. The results of computed arithmetic mean presented in Table 17 above are represented graphically in Figure 9 below;

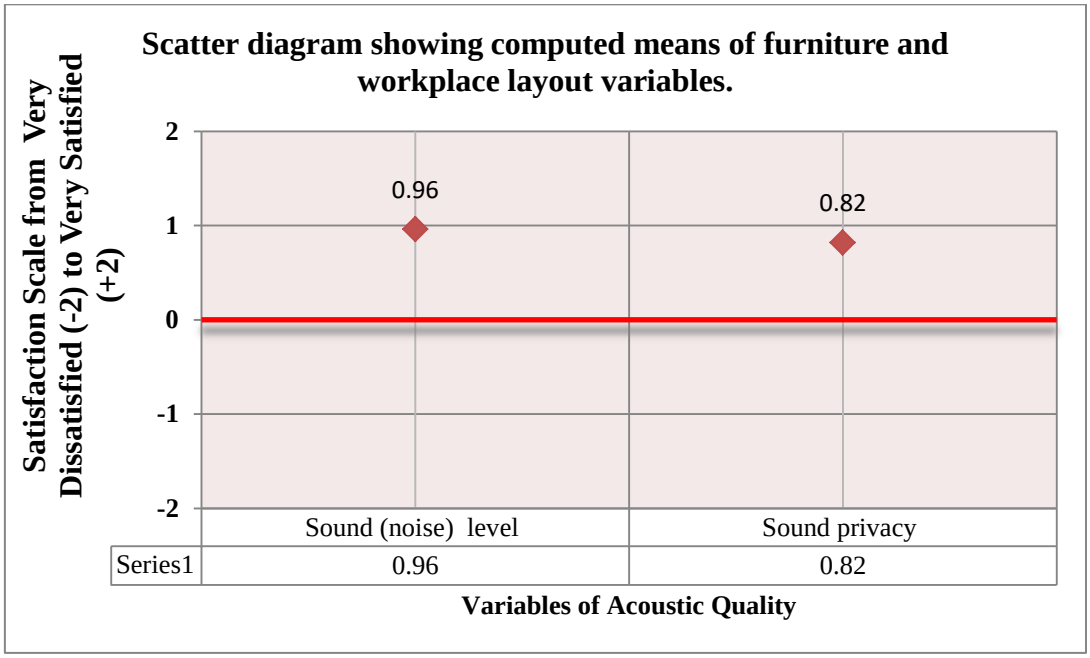

Figure 9: Scatter diagram showing computed means of acoustic quality variables. Source: (Author, 2016).

According to the computed arithmetic mean shown in Table 17above and graphically represented in Figure 6above, the occupants attained a mean score of 0.89 meaning that they were **satisfied** (according to satisfaction scale used in this studywhere **2**=Very Dissatisfied, **1**= Dissatisfied, **0**=Neutral, **1**= Satisfied and **2**=Very Satisfied).

The **satisfied** rating attained by overall acoustic quality in LEED-Certified buildings in Nairobi is attributed to the extent of workspace enclosure in the case buildings. The majority of organisations within the case buildings had a mix of workspace enclosure ranging from full height partitions, to half partitions to open plan workspaces. The results of field survey indicate that only 28.1 percent of the respondents occupy private workspaces free from internal noise interference emanating from the co-workers. The researcher observed that rest of the respondents (77.9 percent) suffered from internal noise interference from co-workers due to the open nature of their workspace (full height partitions, half partitions or open plan workspaces).

Furthermore, upon review of architect's drawings and specifications for Eaton place and confirmed by the visit to the building, the researcher noted that the building had extensive glass and aluminium curtain wall and apparently the glass was not sufficiently sound proof. This confirms the likelihood that the small percentage of dissatisfied respondents (7%) may have attributed their dissatisfaction to the external noise interference originating from vehicular traffic along United Nations Crescent.

4.6.Thermal Comfort and Air Quality

The study sought to establish the extent of perceived occupants' satisfaction withair quality and thermal comfort within the workspaces of LEED-Certified buildings in Nairobi. This information was useful in the assessment of the effect of thermal comfort and air quality on occupants' productivity in LEED-Certified buildings in Nairobi.

The results of field survey of variables of thermal comfort and air quality (ability to control temperature or airflow, overall temperature and air quality within workspace) are presented in Table 18, Table 19 and Table 20respectively;

Table 18: Occupants' satisfaction with ability to control temperature or airflow within the workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	1	1.8	1.8	1.8
Dissatisfied	2	3.5	3.5	5.3
Neutral	1	1.8	1.8	7.0
Satisfied	19	33.3	33.3	40.4
Very Satisfied	34	59.6	59.6	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table above revealed that more than half of the respondents (59.6 percent) were very satisfied with the ability to control temperature or airflow within their workspace while 33.3 percent of were satisfied. Only 1.8percent of the respondents reported that they were neutral. The rest of the respondents were either dissatisfied (3.5 percent) or very dissatisfied (1.8 percent).

Table 19: Occupants' satisfaction overall temperature within their workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	1	1.8	1.8	1.8
Dissatisfied	0	0	0	0
Neutral	6	10.5	10.5	12.3
Satisfied	12	21.1	21.1	33.3
Very Satisfied	38	66.7	66.7	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table 19 above revealed that a high proportion of the respondents (66.9 percent) were very satisfied with the ability to control the overall temperature within the workspace compared to those satisfied (21.1 percent).1.8percent of the respondents were of neutral opinion while the rest of the respondents were very dissatisfied (1.8 percent).

Table 20: Occupants' satisfaction with overall air quality within their workspace. Source (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	2	3.5	3.5	3.5
Dissatisfied	2	3.5	3.5	7.0
Neutral	2	3.5	3.5	10.5
Satisfied	27	47.4	47.4	57.9
Very Satisfied	24	42.1	42.1	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table 20above revealed that majority of the respondents were either satisfied(47.4 percent) or very satisfied (42.1 percent) with overall air quality within their workspaces compared to satisfied respondents (21.1 percent).The rest of the respondents were neutral, dissatisfied and very dissatisfied each sharing an equal percentage of 3.5 percent.

The percentage distribution of respondents on a five-point satisfaction scale for each variable of thermal comfort and air quality is represented by the group column chart shown in Figure 10below;

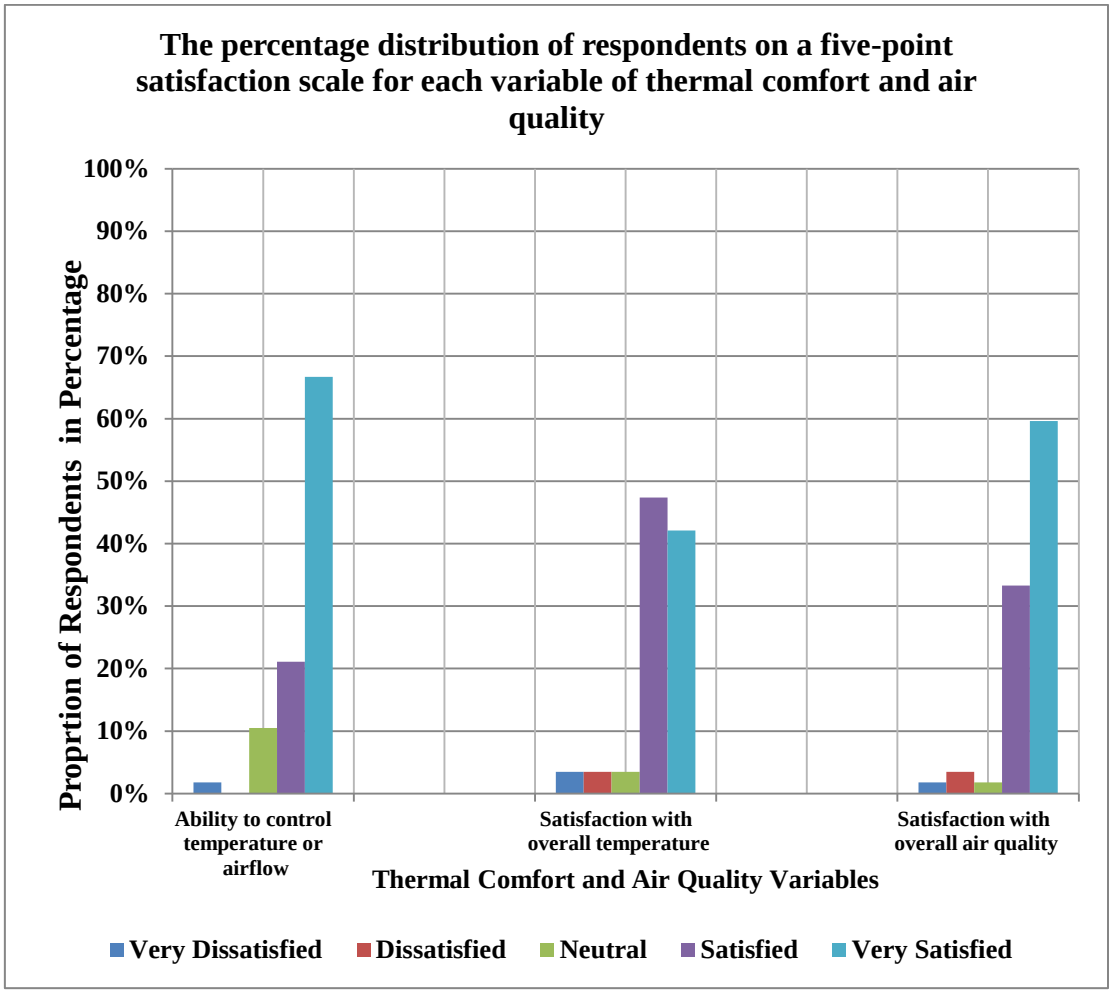

Figure 10: Group column chart showing the percentage distribution of respondents on a five-point satisfaction scale for each variable of thermal comfort and air quality

Using data obtained from Table 18, Table 19 and Table 20 above, the arithmetic means scores attained by the variables of thermal comfort and air quality in LEED-Certified buildings in Nairobi and the overall mean score were computed, and the results are presented in the Table below;

Table 21: Arithmetic mean and standard deviations of occupants' satisfaction with thermal comfort and air quality variables. Source: (Author, 2016).

Thermal Comfort and Air Quality Considerations	N	Min	Max	Mean	Std. Deviation
Satisfaction with temperature control	57	-2	2	1.46	.847
Satisfaction with overall thermal comfort	57	-2	2	1.51	.826
Satisfaction with air quality	57	-2	2	1.21	.940
OVERALL MEAN				**1.39**	

The results of computed arithmetic mean presented in Table 21 above are represented graphically in Figure 11below;

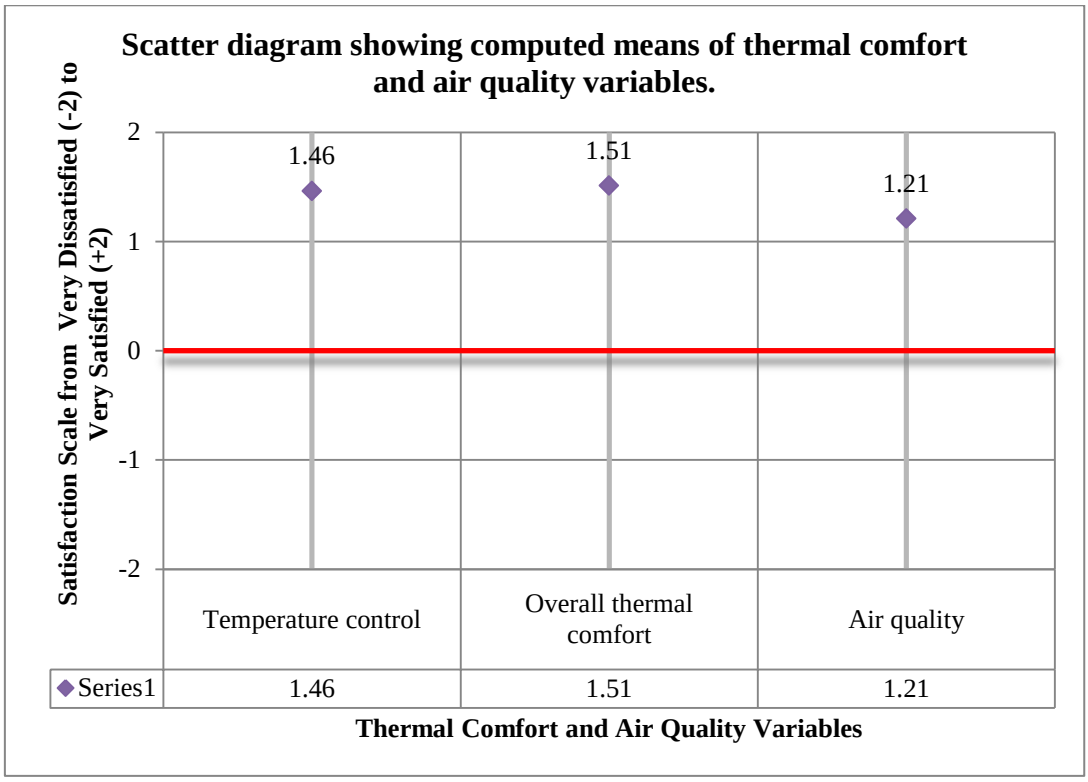

Figure 11: Scatter diagram showing computed means of thermal comfort and air quality variables. Source: (Author, 2016).

According to the results of computed arithmetic mean shown in Table 21 above and graphically represented in Figure 11 above, the occupants attained a mean score of **1.39** meaning that they were**satisfied** (according to satisfaction scale used in this study where ˉ**2**=Very Dissatisfied, ˉ**1=** Dissatisfied, **0**=Neutral, **1**= Satisfied and **2**=Very Satisfied) with the thermal comfort and Indoor Air Quality (IAQ) of LEED-Certified buildings.

The researcher attributes the overall rating of **1.39 (satisfied),** to compliance with minimum LEED standards for thermal comfort and IAQ in both naturally and mechanically ventilated workspaces in the case buildings. The researcher observed the sound building design techniques accorded to the building envelope. The researcher observed that Eaton Place building had the generous roof overhangs of between 0.8 and 1.0 metres as well as the sun-shading elements ensured that the occupants were well protected from intense solar radiation, ensuring that the indoor

temperature conditions were optimum. The optimum indoor thermal conditions were confirmed by the moderate clothing level of the occupants.

4.7.Lighting Quality

The study sought to establish the extent of perceived occupants' satisfaction with the lightingquality within the workspaces of LEED-Certified buildings in Nairobi. This information was useful in the assessment of the effect of lighting quality on occupants' productivity. The results of the field survey conducted to establish the extent of occupants' satisfaction with the variables of indoor light quality (ability to control interior lighting and the amount of natural lighting coming to workspace) are presented in Table 22and Table 23below;

Table 22: Occupants' satisfaction with ability to control interior lighting within the workspace. (Source: Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	1	1.8	1.8	1.8
Dissatisfied	0	0	0	0
Neutral	3	5.3	5.3	7.0
Satisfied	35	61.4	61.4	68.4
Very Satisfied	18	31.6	31.6	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table 22above revealed that a high proportion of the respondents (61.4 percent) were satisfied with the ability to control interior lighting within the workspace as compared to very satisfied respondents (31.6 percent).Only 5.3 percent of the respondents are of neutral opinion while the rest of the respondents were very dissatisfied (1.8 percent).

The percentage distribution of respondents' perceived satisfaction with the ability to control interior lighting, on a five-point satisfaction scale used in this study, is graphically represented by the bar chart shown in Figure 12 below;

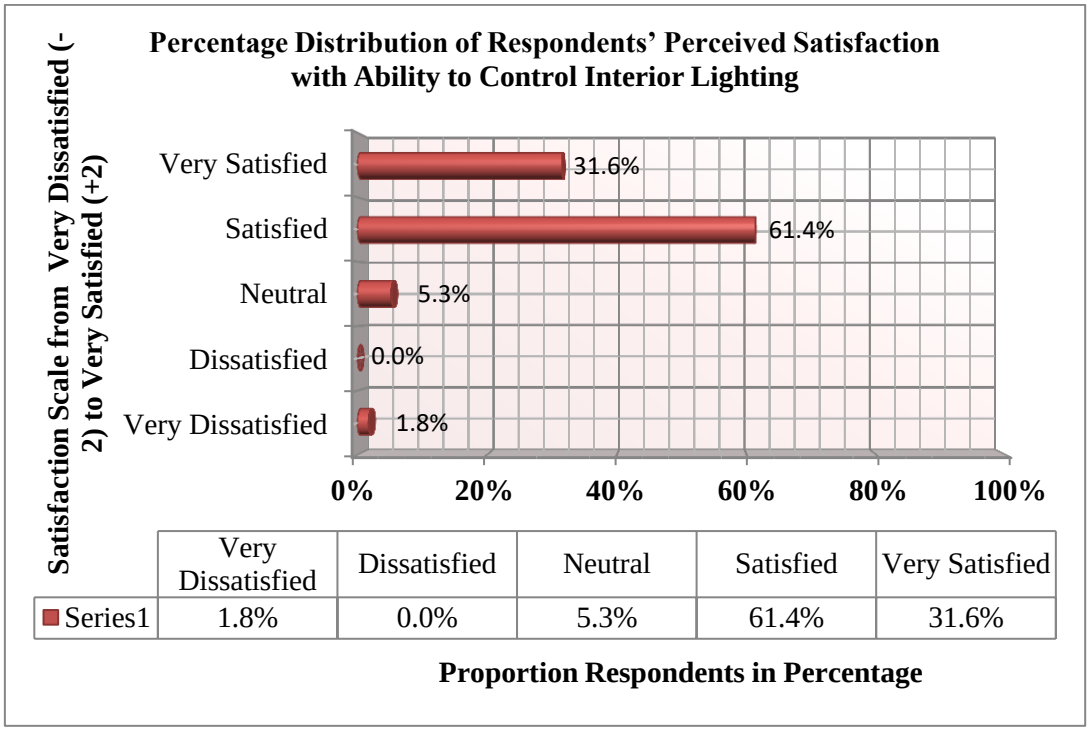

Figure 12: Combined bar chart and table showing the percentage distribution of respondents' perception of their extent of satisfaction with ability to control interior lighting, on a five-point satisfaction scale. Source: (Author, 2016).

The results of the field survey conducted to establish the extent of occupants' satisfaction with the amount of natural lighting within the workspace is presented in Table 23 below;

Table 23: Occupants' satisfaction with ample natural lighting within the workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	5	8.8	8.8	8.8
Dissatisfied	2	3.5	3.5	12.3
Neutral	5	8.8	8.8	21.1
Satisfied	23	40.4	40.4	61.4
Very Satisfied	22	38.6	38.6	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table 23 above indicate that a fairly equal proportion of respondents were either satisfied (40.4 percent) or very satisfied (38.6 percent) with the amount of natural lighting within their workspaces. An equal proportion of respondents were

either neutral or very dissatisfied each at 8.8 percent. The rest of the respondents were dissatisfied (3.5 percent).

The percentage distribution of respondents' perceived satisfaction with the natural lighting within their workspace, on a five-point satisfaction scale used in this study, is graphically represented by the bar chart shown in Figure 13 below.

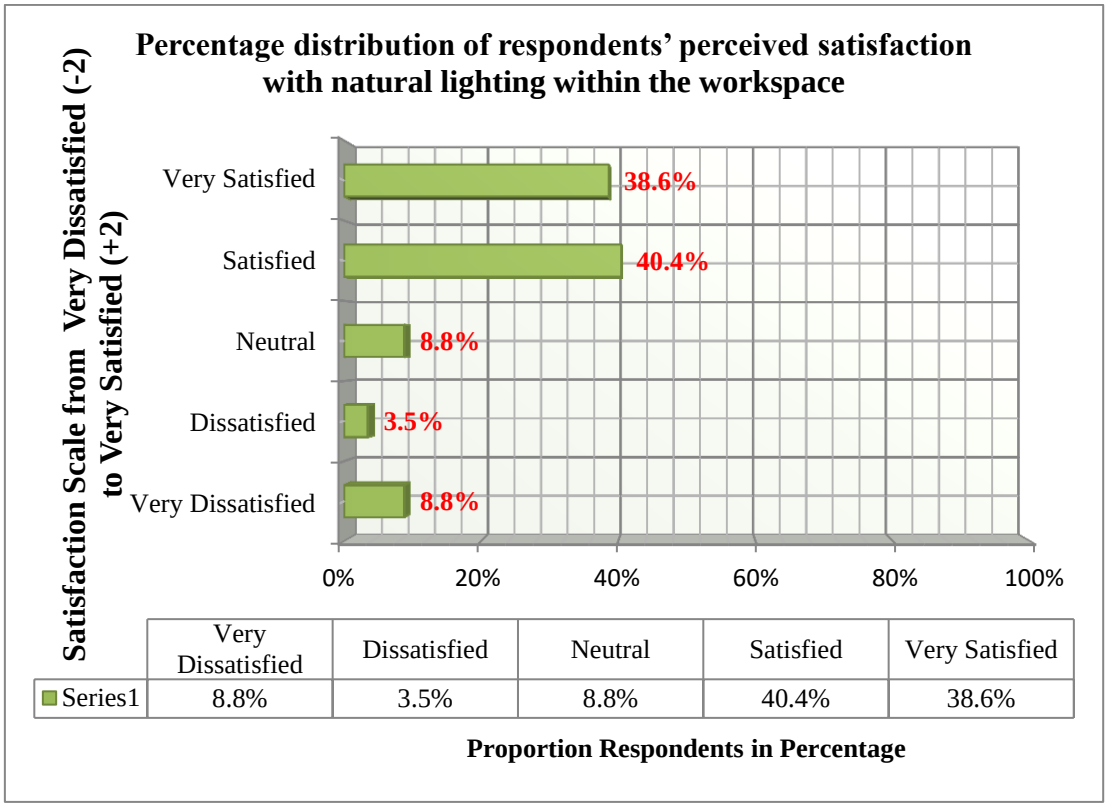

Figure 13: Combined bar chart and table showing the percentage distribution of respondents' perception of their extent of satisfaction with natural lighting within their workspaces, on a five-point satisfaction scale. Source: (Author, 2016).

Using data obtained from Table 22 and Table 23 above, the arithmetic means scores attained by the two variables of lighting quality (ability to control interior lighting and the amount of natural lighting within a workspace) in LEED-Certified buildings in Nairobi and their overall mean score were computed, and the results are presented in Table 24below;

Table 24: Arithmetic mean and standard deviations for satisfaction levels of control of light and the amount of natural lighting entering the workspace. Source: (Author, 2016).

Lighting Quality Considerations	N	Min	Max	Mean	Std. Deviation
Satisfaction with control over interior light within the workspace	57	-2	2	1.21	.700
Satisfaction with amount of natural light coming to workspace	57	-2	2	.96	1.195
OVERALL MEAN				**1.09**	

The results of computed arithmetic mean presented in Table 24above are represented graphically in Figure 14 below;

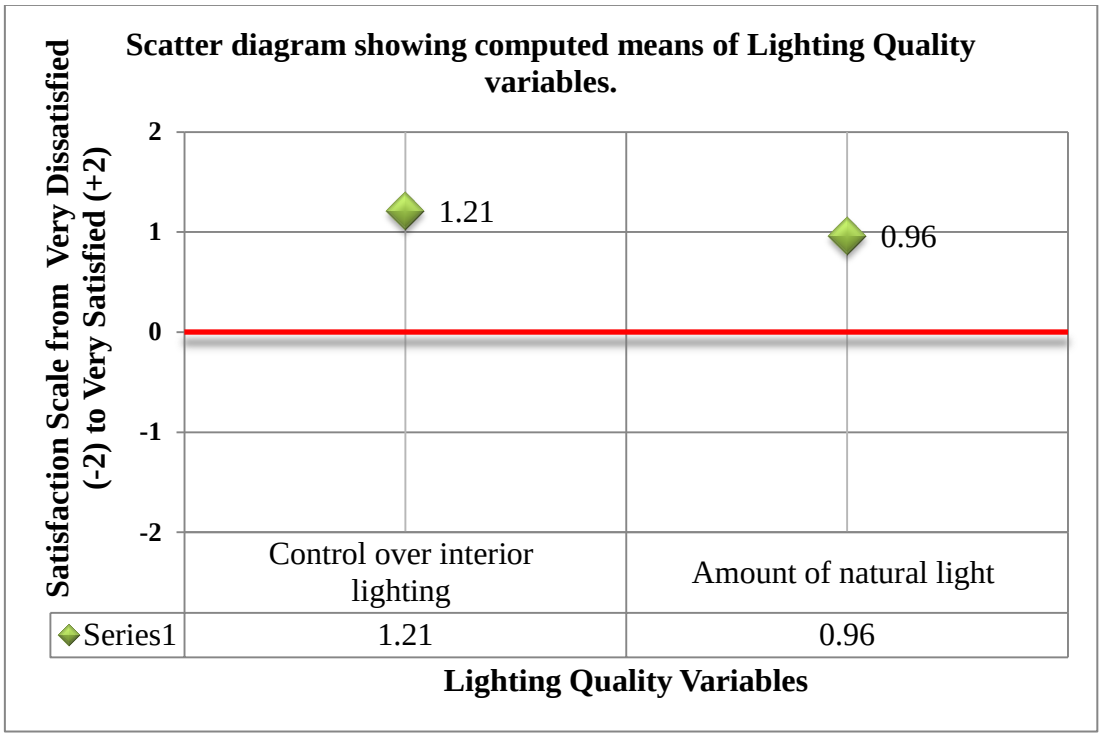

Figure 14: Scatter diagram is showing computed means of lighting quality variables. Source: (Author, 2016).

According to the results of computed arithmetic mean shown in Table 24 above and graphically represented in Figure 14 above, the occupants attained a mean score of **1.09** meaning that they were **satisfied** (according to satisfaction scale used in this study where ˉ**2**=Very Dissatisfied, ˉ**1=** Dissatisfied, **0**=Neutral, **1**= Satisfied and **2**=Very Satisfied) with the overall lighting quality of LEED-Certified buildings.

The study attributes the overall rating of **1.09 (satisfied)** to compliance with some of the standards and guidelines critical to the achievement of sufficient daylighting and interior lighting as recommended by LEED. The researcher observed that the case buildings (Eaton Place and World Bank Group Centre) had extensively used glass and aluminum curtain walls on all their facades. This ensured that the occupants were always visually connected with outdoors while reducing the use of electrical lighting due to the introduction of natural lighting into the workspaces.

Upon examination of specifications tithe building envelope particularly for World Bank Group Centre, the researcher established that the facades were fittedwith high-performance glass with low shading coefficients (SC) ensuring sufficient daylighting while guaranteeing optimal human thermal comfort. The researcher also observed that some workspaces in case buildings were fittedwith interior glare control devices such as Venetian blinds which contributed to visual comfort hence the high rating.

The researcher points out that opportunities are plenty to improve the satisfaction extent with lighting quality in case buildings from **satisfied** to **very satisfied**. It was observed that some of the sun shading devices had gathered a lot of dust and required cleaning. The introduction of light shelves (horizontal reflecting surfaces) is recommended to boost visual comfort.

Apart from sufficient daylighting, the researcher also observed that the case buildings had high-quality interior lighting which ensured occupants' visual comfort and general well-being translating to higher satisfaction. The individual shared spaces had multi-zone control systems which enabled users to adjust the lighting levels to meet the group and individual needs. The researcher suggests the individual workspaces be provided with more individual lighting controls to enable users to adjust the levels of lighting to suit individual tasks and preferences, as one of the areas of improvement.

4.8. Cleanliness and Maintenance Quality

The study sought to establish the extent of perceived occupants' satisfaction with the cleanliness and maintenance quality within the workspaces of LEED-Certified buildings in Nairobi. This information was useful in the assessment of the effect of cleanliness and maintenance quality on occupants' productivity. The results of the field survey conducted to establish the extent of occupants' satisfaction with the variables of cleanliness and maintenance quality are presented in Table 25 and Table 26 below.

Table 25: Occupants' satisfaction with cleanliness within the workspace. Source: (Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	6	10.5	10.5	10.5
Dissatisfied	3	5.3	5.3	15.8
Neutral	3	5.3	5.3	21.1
Satisfied	20	35.1	35.1	56.1
Very Satisfied	25	43.9	43.9	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table 25 above indicate that majority of the respondents were either very satisfied (43.9 percent) or satisfied (35.1 percent). An equal proportion of respondents were either neutral or dissatisfied each at 5.3 percent. The rest of the respondents were very dissatisfied (10.5 percent).

The percentage distribution of respondents' perceived satisfaction with the general cleanliness, on a five-point satisfaction scale used in this study, is graphically represented by the bar chart shown in Figure 15below.

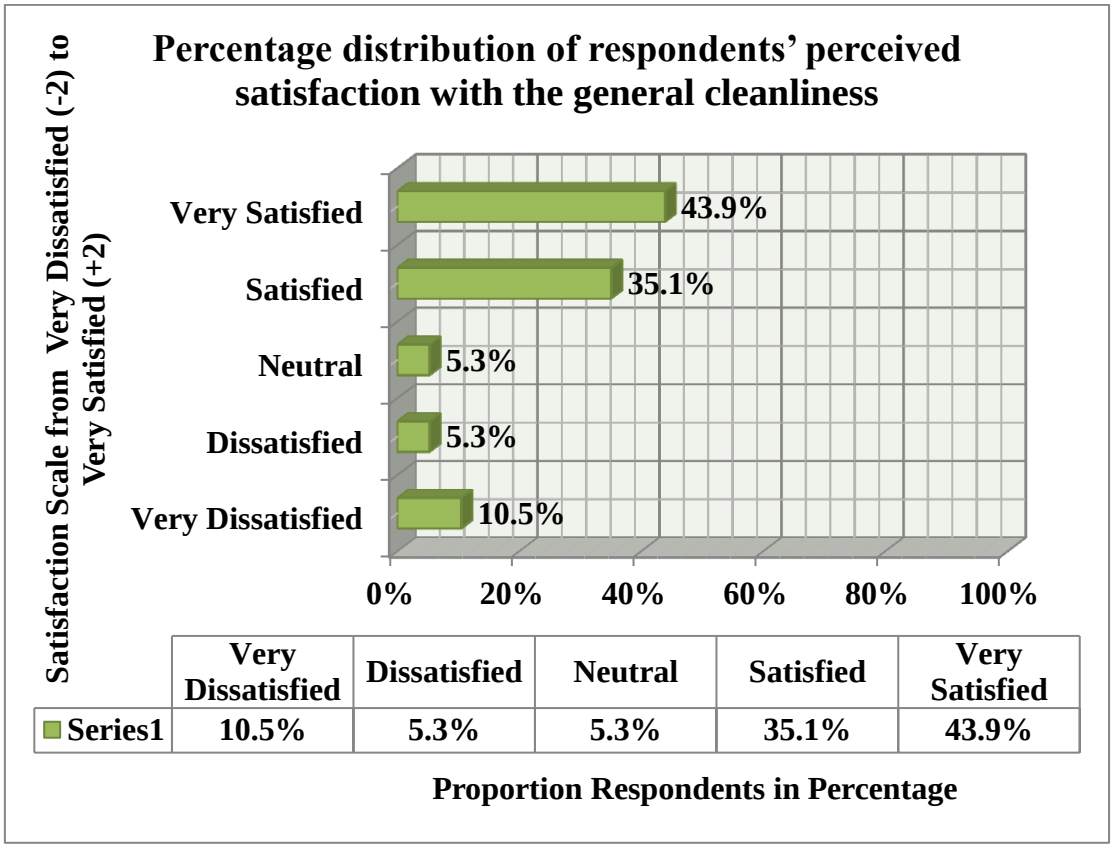

Figure 15: Combined bar chart and table showing the percentage distribution of respondents' perception of their extent of satisfaction with general cleanliness, on a five-point satisfaction scale. Source: (Author, 2016).

The results of the field survey conducted to establish the extent of occupants' satisfaction with the general maintenance within the workspace are presented in Table 26 below.

Table 26: Occupants' extent of satisfaction with maintenance within the workspace. (Source: Author, 2016).

	Frequency	Percent	Valid Percent	Cumulative Percent
Very Dissatisfied	2	3.5	3.5	3.5
Dissatisfied	2	3.5	3.5	7.0
Neutral	7	12.3	12.3	19.3
Satisfied	33	57.9	57.9	77.2
Very Satisfied	13	22.8	22.8	100.0
Total	**57**	**100.0**	**100.0**	

The results in Table 26 above indicate that a high proportion of respondents were satisfied (57.9 percent) followed by very satisfied respondents (22.8 percent). Equal

proportions of respondents were either dissatisfied or very dissatisfied each at 3.5 percent. The rest of the respondents were neutral (12.3 percent).

The percentage distribution of respondents' perceived satisfaction with the general maintenance habits, on a five-point satisfaction scale used in this study, is graphically represented by the bar chart shown in below.

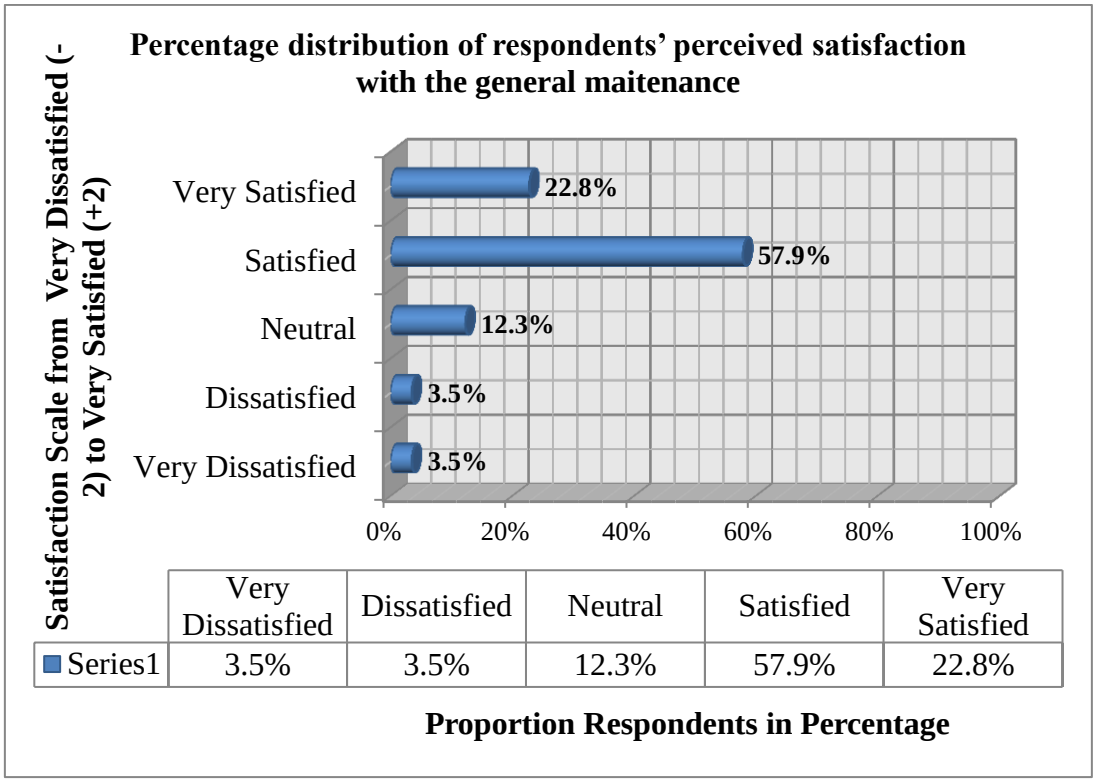

Figure 16: Combined bar chart and table showing the percentage distribution of respondents' perception of their extent of satisfaction with general maintenance, on a five-point satisfaction scale. Source: (Author, 2016).

Using data obtained from Table 25 and Table 26 above, the arithmetic means scores attained by the two variables (cleanliness and maintenance quality) in LEED-Certified buildings in Nairobi and their overall mean score were computed, and the results are presented inTable 27 below.

Table 27: Arithmetic mean and standard deviations for satisfaction levels of cleanliness and maintenance quality. Source: (Author, 2016).

Cleanliness and Maintenance Considerations	N	Min	Max	Mean	Std. Deviation
Satisfaction with General Cleanliness	57	-2	2	.96	1.295
Satisfaction with General Maintenance	57	-2	2	.93	.904
OVERALL MEAN				**0.95**	

The results of computed arithmetic mean presented in Table 27 above are represented graphically in Figure 17below;

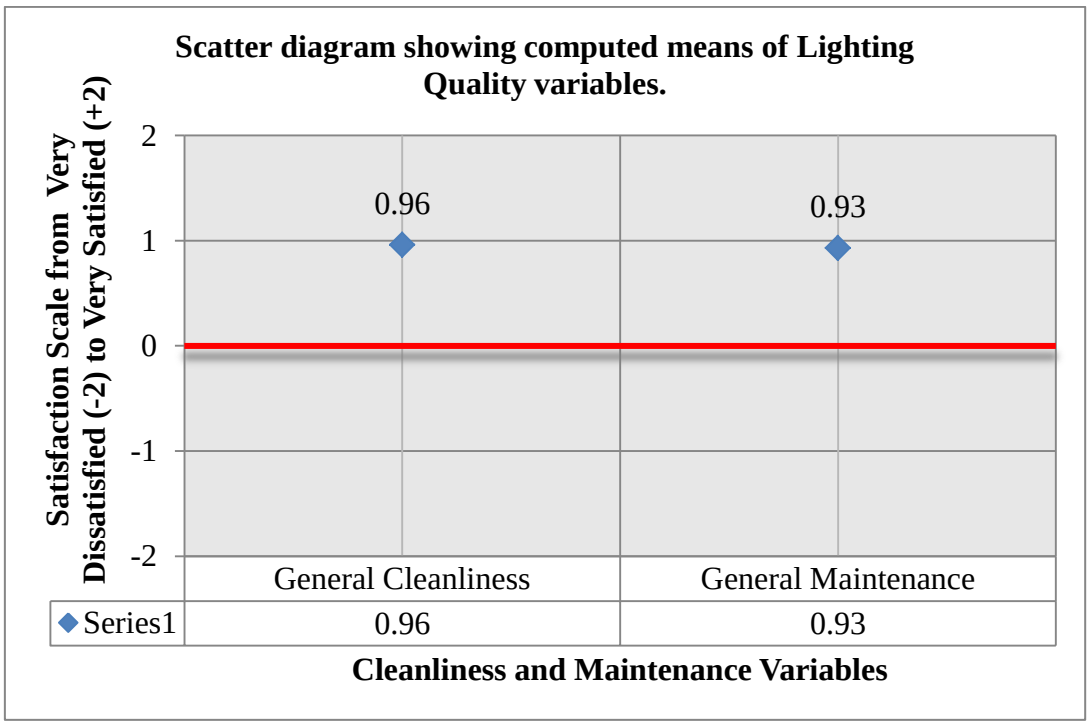

Figure 17: Scatter diagram showing computed means of cleanliness and maintenance variables. Source: (Author, 2016).

According to the results of computed arithmetic mean shown in Table 27 above and graphically represented in Figure 17 above, the occupants attained a mean score of **0.95** meaning that they were **satisfied** (according to satisfaction scale used in this study where ˉ**2**=Very Dissatisfied, ˉ**1=** Dissatisfied, **0**=Neutral, **1**= Satisfied and **2**=Very Satisfied) with the overall cleanliness and maintenance of LEED-Certified buildings.

The good rating (**satisfied)** of IEQ aspect of cleanliness and maintenance is attributed to the professional quality of services offered by contract cleaners engaged by the facility managers of LEED-Certified buildings in Nairobi. The researcher observed that the contract cleaners used sophisticated tools and cleaning equipment such as filtration vacuum cleaners, pedestrian scrubber dryers among others. Additionally, their equipment was not too noisy so as to disrupt workspace activities. The researcher also observed that the contract cleaner's staff were prompt and went about their duties in a manner that exuded professionalism and efficiency. The interviews with the facility manager of Eaton-place revealed that their contract cleaner was consistent in quality cleaning services, and they had extensive experience in the field of commercial cleaning in Nairobi.

Garden City Retail attained lower satisfaction rating with maintenance quality. The interviews with the tenants revealed that they were dissatisfied with the quality of floor finishes. They further pointed out that floor tiles in some common areas were falling off while the some sections of the roof near the main lobby leak during heavy rains.

4.9.Summary of Satisfaction with IEQ Credits

The data obtained from Table 14, Table 17,Table 21,Table 24 and Table 27above, showing the computed arithmetic means scores attained by each IEQ credit under investigation (Furniture and Workspace Layout, Acoustic Quality, Thermal Comfort and Air Quality, Lighting Quality, Cleanliness and Maintenance Quality) were tabulated and presented in Table 28below;

Table 28: Summary of arithmetic means of each IEQ credit. Source: (Author, 2016).

IEQ Credit	Mean	Extent of Satisfaction
Furniture and Workspace Layout	1.55	**Very Satisfied**
Acoustic Quality	0.89	**Satisfied**
Thermal Comfort and Air Quality	1.39	**Satisfied**
Lighting Quality	1.09	**Satisfied**
Cleanliness and Maintenance Quality	0.95	**Satisfied**

The results of computed arithmetic means of each IEQ credit as shown in in Table 28 above are represented graphically in Figure 18below;

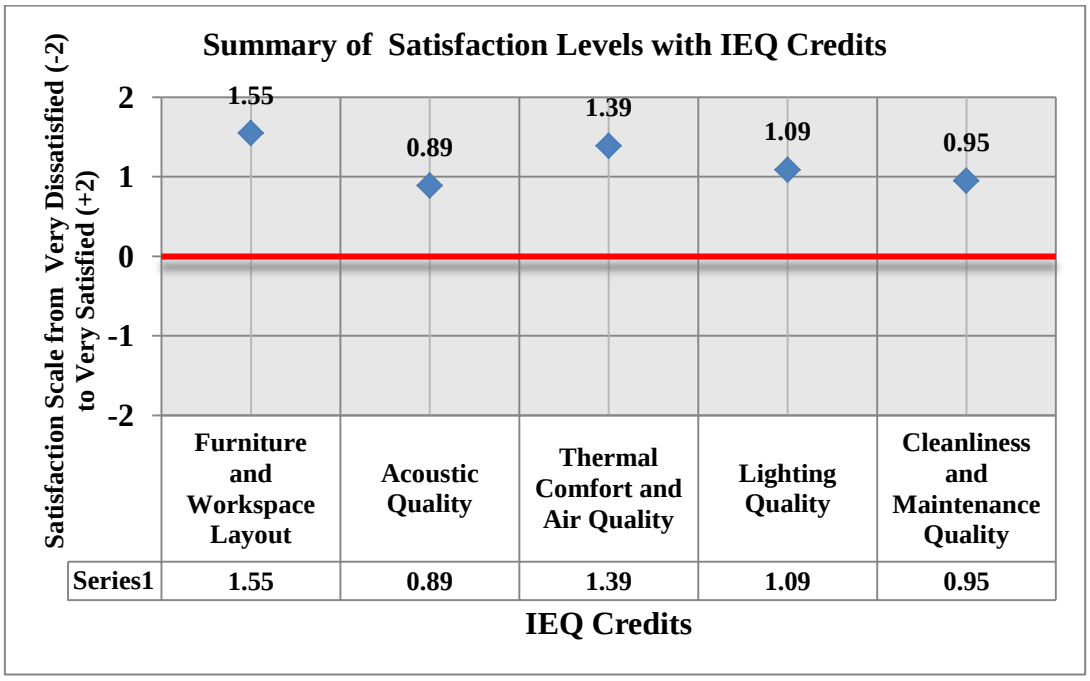

Figure 18: Scatter diagramshowing computed means of satisfactionwith each IEQ CreditSource: (Author, 2016).

4.10. Effect of IEQ Credits on Productivity

The study sought to establish the effect of IEQ elements on Productivity in the workspaces as observed by occupants of LEED-Certified buildings in Nairobi. This information was useful in the development of a model to test the significant relationship between the independent IEQ elements and productivity in LEED-Certified buildings in Nairobi.

The results of field survey on the effect of IEQ elements on productivity as perceived by occupants of LEED-Certified buildings in Nairobi are presented inTable 29 below.

Table 29: Effect of IEQCredits on occupants' productivity. Source: (Author, 2016).

	Extremely Interferes	Interferes	No Effect	Enhances	Extremely Enhances
Effect of and furniture and workspace layout on occupants' perceived productivity.	**3.5%**	**7.0%**	**14.0%**	**52.6%**	**22.8%**
Effect of workspace temperature and air quality in the workspace on occupants' perceived productivity.	**5.3%**	**3.5%**	**10.5%**	**61.4%**	**19.3%**
Effect of lighting quality in the workspace on occupants' perceived productivity.	**1.8%**	**0.0%**	**14.0%**	**49.1%**	**35%**
Effect of acoustic quality in the workspace on perceived productivity.	**0.0%**	**0.0%**	**7.0%**	**64.9%**	**28.1%**
Effect of cleanliness and maintenance of the building on occupants' perceived productivity.	**3.5%**	**1.8%**	**3.5%**	**22.8%**	**68.4%**

The results in Table 29above revealed that more than half of the respondents (52.6 percent) opine that furniture and workspace layout enhance their productivity at the workplace while 22.8 percent believe that they extremely enhance their productivity. The furniture and workspace layout have no effect on 14 percent of the respondents

though they interfere with the productivity of 7 percent of the respondents on the other hand. The rest of the respondents suppose that they extremely interfere with their productivity (3.5 percent).

Secondly, the majority of the respondents (61.4 percent) were of the opinion that that thermal comfort and air quality enhanced their productivity at the workplace while 19.3 percent believed that they extremely enhance their productivity. The thermal comfort and air quality, however, had no effect on 10.5 percent of the respondents though they interfered with the productivity of 3.5 percent of the respondents. The rest of the respondents reported that that thermal comfort and air quality extremely interfered with their productivity (5.3 percent).

Thirdly, a high proportion of the respondents (64.9 percent) reported that acoustic quality within their workspace enhanced their productivity compared to respondents who reported that it extremely enhanced (28.1 percent).Acoustic quality had no effect on only 7 percent of the respondents.

Finally, the majority of the respondents (68.4 percent) reported that cleanliness and maintenance quality of their workspaces extremely enhanced their productivity while 22.8 percent indicated that it enhanced their productivity. Cleanliness and maintenance quality had no effect on 3.5 percent of the respondents though they interfered with the productivity of 1.8 percent of the respondents. The results are illustrated inFigure 19 below;

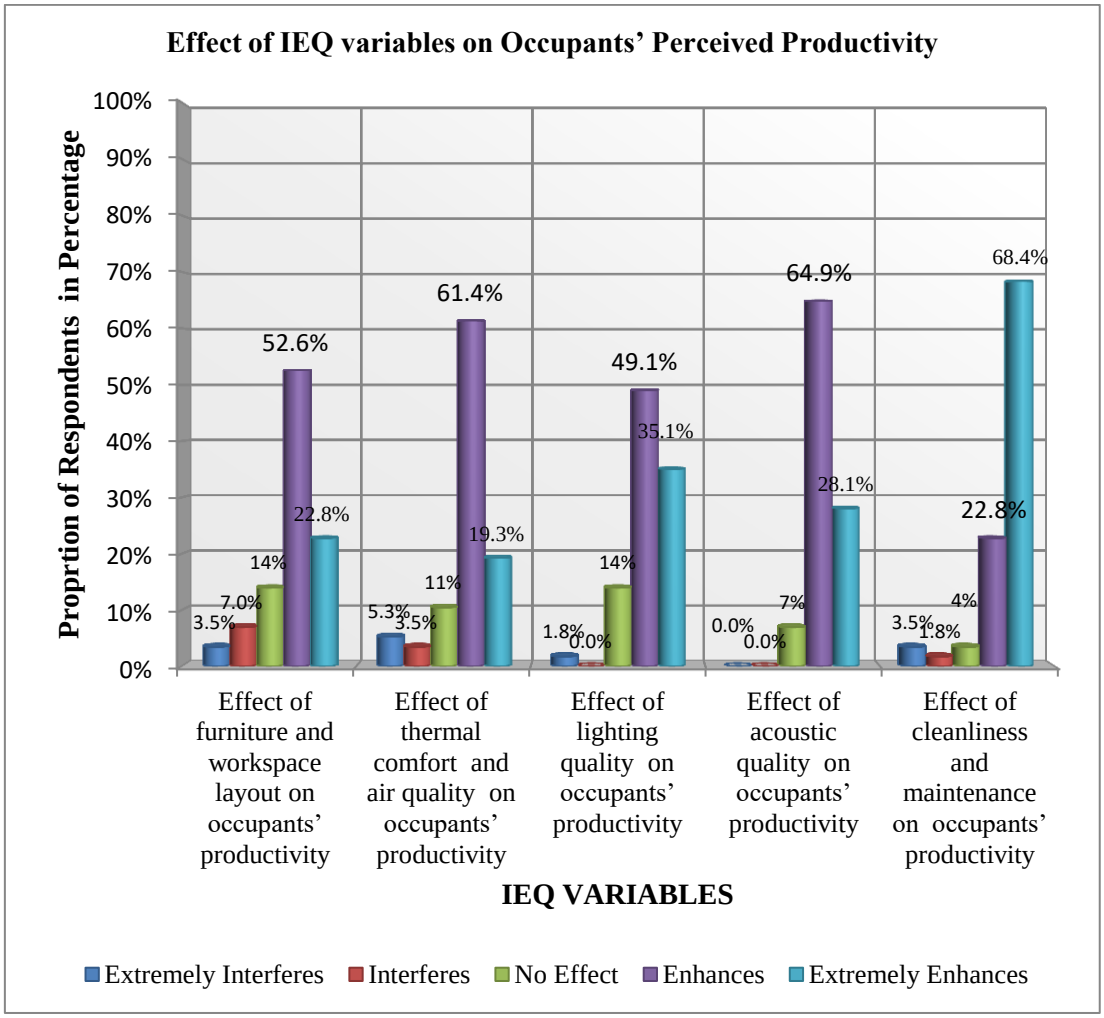

Figure 19: Column chart showing Effect of IEQ elements on occupants' productivity. Source :(Author, 2016).

Using data obtained from Table 29 above, the arithmetic means scores attained by the effect each of the five IEQ variables (Furniture and workspace layout, Acoustic Quality, Thermal Comfort and IAQ, Lighting Quality, cleanliness and maintenance quality) on occupants'productivity in LEED-Certified buildings in Nairobi and their overall mean score were computed. The results are presented inTable 30 below

Table 30: Results of computed arithmetic means of the effect of IEQ elements on occupants' productivity

	N	Minimum	Maximum	Mean	Std. Deviation
Effect of Furniture and workplace Layout on productivity	57	-2	2	.84	.978
Effect Of Thermal and Air Quality on Productivity	57	-2	2	.86	.953
Effect of Lighting Quality on productivity	57	-2	2	1.16	.797
Effect of Acoustic Quality on Productivity	57	0	2	1.21	.559
Effect of Cleanliness and Maintenance Quality on Productivity	57	-2	2	.82	.966
OVERALL MEAN				**0.98**	

The results of computed arithmetic mean presented in Table 30 above are represented graphically in Figure 20 below.

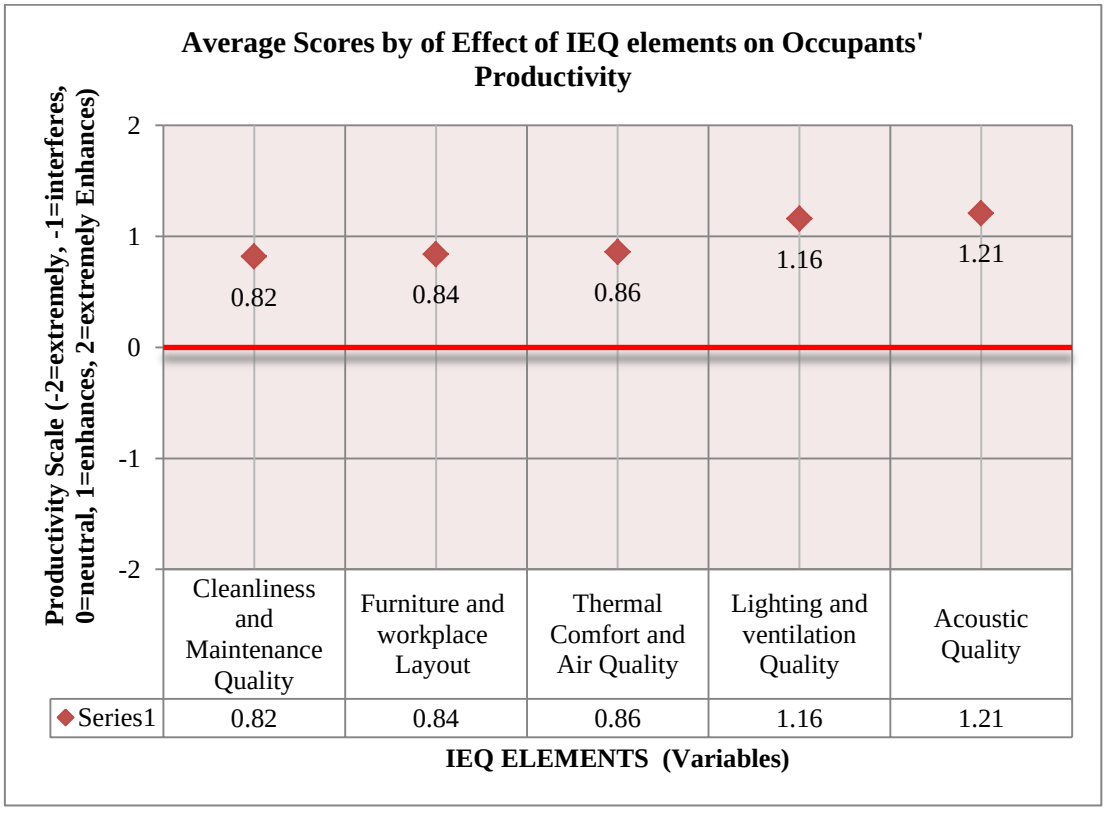

Figure 20: Scatter diagram showing survey results of average scores of IEQ elements on occupants' productivity

According to the results of computed arithmetic means shown in Table 30 above and graphically represented in Figure 20 above, the overall effect of IEQ variables averaged **0.98** meaning that the IEQ variables **enhance** (based on satisfaction scale used in this study where,˜**2**=Extremely Interferes,˜**1=** Interferes, **0**=No Effect, **1**= Enhances and **2**=Extremely Enhances) the perceived productivity of users of LEED-Certified buildings.

The interpretation of these findings hasbeen comprehensively discussed in Chapter Five (5.3.3Effect of IEQ Elements on Workforce Productivity) on page 92 of this research report.

4.11. Further Analyses

Besides descriptive statistics, the study sought to conduct further analyses. Correlational analysis was undertaken to determine the strength and direction of the relationship between the variables under study while multivariate regression analysis was undertaken to quantify the strength of association.

4.11.1. Pearson Product Moment Correlational Analysis

Given the number respondents were greater than 30, the population was assumed to be normally distributed and. Therefore, a Pearson Product Moment Correlational Analysis was conducted. The results of Pearson product moment correlational analysis are presented in Table 31 below.

Table 31: Correlation Coefficients for variables. Source: (Author, 2016).

		Occupants Productivity	Furniture and Workspace Layout	Thermal Comfort and Air Quality	Lighting Quality	Acoustic Quality	Cleanliness and maintenance Quality
Occupants Productivity	Pearson Correlation	1	0.030	0.407	0.074	0.074	0.21
Furniture and Workspace Layout	Pearson Correlation	0.03	1	0.103	0.45	0.75*****	0.41
Thermal Comfort And Air Quality	Pearson Correlation	0.407	0.103	1	.183*****	0.683*****	0.37*****
Lighting Quality	Pearson Correlation	0.074	0.45	0.183*****	1	0.56*****	0.63*****
Acoustic Quality	Pearson Correlation	0.074	0.75*****	0.683*****	0.56*****	1	0.59*****
Cleanliness and maintenance Quality	Pearson Correlation	0.21	0.41	0.37*****	0.63*****	0.59*****	1
*****to mean significant correlation at $p<0.05$							

The results of the correlational analysis as shown in Table 31 above indicate that thermal comfort, lighting quality, acoustic quality and **c**leanliness and maintenance quality have a significant correlation. However, furniture and workspace layout has a significant correlation with only acoustic quality and not the other variables.

4.11.2. Multivariate Regression Model

A multivariate regression model was developed to quantify the strength of association between the variables. The results of multivariate regression analysis are presented in Table 32 below.

Table 32: Multivariate Regression

Model	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.65	0.61	0.0125

Table 33: ANOVA Table

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.584	3	.195	1.050	.017
	Residual	9.822	53	.185		
	Total	10.406	56			

The results as shown in ANOVA Table 33 above, indicate that the independent variables (perceived occupants' satisfaction with IEQ elements) are significant predictors of dependent variable (perceived occupants' productivity) as shown by the significant level (.017) which is less than 0.05.

The results in Table 32 above indicates that the independent variables in the model account for only 65 percent of perceived occupants' productivity and hence the remaining 35 percent is attributed to the error term such as occupant's health and well-beingandthesocial dimension of theworkforce in those organisations.

These findings confirm the proof of the relationship between IEQ and productivity as described under the sub-heading "Productivity, "on **page 79 of this research report.**

This relationship though depicted as clear by a growing number of researchers, has seen other studies produce results indicating the contrary. A case in point is the findings of Onyeizu and Byrd (2014). Their study on the relative importance of various factors to productivity suggest that IEQ factors are not the only central factors of productivity which should be taken into account during evaluation of occupants' productivity. According to the researchers, other factors affecting productivity should be underscored. In fact, factors perceived to be vital to occupants' productivity were personal health and well-being, organisational

(ineffective management), convenience (defective equipment) and social (relations at the workplace). Apparently, IEQ elements ranked after these factors in respect of significance of the perception of productivity workforce in office buildings.

Similar findings have been reported by investigations by Haynes (2008). According to his research, the physical components of comfort and office layout do not necessarily enhance the productivity of individual process workers. The author observes that the behavioral environment which amounts to either distraction or interaction; has a greater effect on occupant productivity than the physical environment. The author suggests that this area of research should be further investigated as the social dimension appears to play a much more important role than IEQ in achieving productivity.

Another study by Adbou et al, (2006) revealed that factors such as labour-management relations and interaction among personnel are far more important to employee productivity while Alhoa& Polo-Kantola (2007) observed that there is a direct correlation between sleep deficiency and personnel performance.

According to Vischer (2008), a user's experience of the environment may be transformed by the deeds she/he is performing in that location. The author points out that part of the environmental experience include the results of the user's behavior.The characteristics of the workspace environment may affect how the users sense, reason and act. These features comprise of: social and economic factors, climatic conditions, cultural factors, the level of education, type of work, and time pressure among many others (Roaf 2005; Frontczak & Wargocki, 2011). Haynes (2007a) also observed that the nature of office work has transformed over the last century from that of a passive and static activityto greater dynamism. Therefore, the researcher suggests the need to strike a balance in the relationship between behavioral and physical environments so to achieve meaningful levels of productivity.

The results of the computation of coefficients of correlations are presented in Table 34 below.

Table 34: Table of Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	**.592**	**.259**		**2.287**	**.026**
Lighting Quality	.012	.125	.012	.097	.021
Thermal Comfort And Air Quality	.273	.086	.408	3.171	.003
Acoustic Quality	.002	.102	.002	.019	.061
Cleanliness and Maintenance Quality	.126	.225	.087	.013	.039

It, therefore, follows from the results in Table 34 above, that the thermal comfort and air quality in the workspace of the LEED-Certified building in Nairobi, are the most powerful predictors of productivity **(β=0.408)** while acoustic quality, on the other hand, is a least powerful predictor of productivity **(β=0.002).**

CHAPTER FIVE

SUMMARY OF MAJOR FINDINGS, DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

The purpose of this study was to carry out an evaluation of the performance of LEED-Certified buildings in Nairobi County, Kenya by examining the extent of perceived occupants' satisfaction with IEQ elements and their relationship with perceived occupant's productivity concerning workspaces. The concern of this research, therefore, is to examine whether LEED accreditation enhances IEQ conditions, which in turn improve comfort and consequently enhance the productivity of the building users. The research findings, conclusions, and recommendations are presented in this chapter.

5.2. Summary of Major Findings

The major findings of this study, conducted in accordance with the research objectives, are listed down in Table 35below;

Table 35: Summary of major findings. Source :(Author, 2016).

Research Objectives	Research Findings
i. To determine the level of perceived occupants' satisfaction with IEQ elements in workspaces of LEED-Certified buildings in Nairobi.	▪ Based on satisfaction scale used in this study where-**2**=Very Dissatisfied, **-1**= Dissatisfied, **0**=Neutral, **1**= Satisfied and **2**=Very Satisfied), the users of LEED-Certified buildings in Nairobi are **very satisfied** (2) with the furniture and workspace layout. ▪ The high rating **(very satisfied)** is attributed to the ergonomic considerations in the design and layout configurations of computer-based workstations in case buildings. ▪ The users of LEED-Certified buildings in Nairobi are **satisfied** with acoustic quality, thermal comfort and IAQ, lighting quality, cleanliness and maintenance quality of their workspaces. ▪ The moderate rating **(satisfied)** is attributed to sound building design techniques with respect to acoustics, human thermal comfort

	and IAQ and lighting considerations in case buildings. The thorough cleaning regime coupled with good maintenance habits adopted by maintenance department also contributes to high satisfaction rating.
ii. To establish the relationship between IEQ elements and perceived occupants' productivity in workspaces of LEED-Certified buildings in Nairobi.	▪ The study provides evidence that a relationship exists between IEQ and productivity in LEED-Certified buildings in Nairobi. ▪ The study indicates that the independent variables are significant predictors of the dependentvariable as shown by the significant levels (.017) which are less than 0.05.Therefore the null hypothesis is rejected (H0:The IEQ elements have no statistically significant effect on perceived occupants' productivity in LEED-Certified buildings in Nairobi, Kenya). ▪ Only 65 percent of productivity is accounted for, by the IEQ elements in LEED-Certified buildings in Nairobi. The rest is attributed to occupants' health and well-being, their educational levels, demographic factors, social dimensions among others.

5.3. Discussions of Research Findings

The discussions in this study are intended to explain the meaning of the research findings and why they are significant while relating them to similar studies of the relationship between IEQ and productivity in LEED-Certified buildings.

5.3.1. Importance of IEQ in Green Buildings

A comfortable indoor environment is crucial for the health of the users of a building as well as their productivity. According to USGBC (2016), IEQ comprises of the conditions inside a building such as IAQ, thermal conditions, lighting and ergonomics and their effect on occupants.

The estimate provided by Jacobs (2013), suggest that human beings spend more than 80percent of their time inside a building. Therefore, it is important to protect their health by providing a comfortable indoor environment so as to boost their productivity.

Several approaches designed to improve IEQ have been suggested in scientific studies undertaken by (Connolly et al, 2009; Rosbach et al, 2013). Among them is the use of regulatory tools through the adoption of relevant codes and certification schemes that establish minimum levels of compliance.

One such tool is the LEED certification system. According to Fawaz (2013) 95.7% of green buildings in Nairobi conform to LEED Green Building Standards. One of the aims of LEED is to improve the IEQ by ensuring quality thermal comfort, enhancing IAQ, lighting quality as well as effective acoustic performance.

The regular users of a building provide useful information on how well green buildings work, yet in Kenya; they are the most underutilised source of valuable information on the performance of green building. The major concern that this study sought to address was the need to attain a complete feedback loop so that developers, facility managers, designers, and policymakers can objectively gauge how well those green building features meet the needs of their users as well as the design intent. This information would also be useful to the management of organisations interested in improving the health, well-being, productivity and effectiveness of their workforce.

5.3.2. Occupants Satisfaction with IEQ Elements

The researcher noted in the literature review that the findings by Radwan, Issa and Hill (2014) verified empirically the accuracy of the claim that green buildings have much to offer regarding IEQ than conventional buildings. In their investigation, the researchers focused on the following parameters namely; literature, country of origin, year of publication, type, sample of buildings studied, and particular IEQ aspects studied. The IEQ aspects studied included Acoustics, Lighting, Air Quality, and Thermal Comfort. The findings of their study revealed that Air Quality was the IEQ aspect green buildings, those occupants were more satisfied with as compared to the conventional building. The result was showcased in seven out of ten studies reviewed in different countries. In assessing air quality, they examined the occupants' feedbacks in both mechanically and naturally ventilated building. The study revealed that although mechanically ventilated buildings operated more efficiently, occupants still preferred naturally ventilated buildings.

Contrastingly, Acoustics emerged as the weakest IEQ aspect in green buildings with six out of the eight studies revealing dissatisfaction from occupants. Occupants' were more satisfied with offices with high cubicles whereas building with low cubicles registered the lowest satisfaction levels by occupation with respect to acoustics. With respect to Thermal Comfort, six out of twelve studies revealed that occupants were satisfied with their green building's thermal comfort providing the need for more research. Finally, five out of eleven studies showed improved lighting in green buildings compared to their conventional ones. Most notably, the study showed that the Thermal Comfort and Air quality in green buildings are almost on average with that of conventional buildings with lighting and Acoustics registering poor performance. Frontczak and Wargocki (2011) conclude that the most important factor among other IEQ parameters is the thermal comfort. In addition, occupants' performance and satisfaction are majorly influenced by the office-furnish quality whereas IAQ affected the performance of occupants (Lee & Guerin, 2009).

The consistency of these findings with those of past studies in ranking order of IEQ aspects did not therefore come as complete surprise.Upon examination of the extent of perceived occupants' satisfaction with IEQ elements in workspaces of LEED-

Certified buildings in Nairobi, just like Lee and Guerin (2009), Frontczak and Wargocki (2011)and Radwan, Issa and Hill (2014),the findings ranked thermal comfort as one of the highest IEQ element (with arithmetic mean of 1.47) while acoustics was ranked the lowest (with arithmetic mean of 0.89).The researcher therefore recommends that appropriate measures be adopted with a view of enhancing acoustic performance of LEED-Certified buildings in Nairobi. These measures include compliance with the standards and guidelines recommended by LEED on aspects of Heating Ventilation and Air Conditioning (HVAC) background Noise, sound isolation, reverberation times, sound reinforcing and masking systems.

While the evidence of the linear relationship between IEQ elements and their extent is clear, some studies have produced findings which indicate the otherwise. Kim and De Dear (2011) showcased the non-linear relationship between occupant satisfaction and IEQ factors and classified the factors into Proportional and Basic Factors with respect to their impact on occupant satisfaction.

5.3.3. Effect of IEQ Elements on Workforce Productivity

The findings of this study (enhanced workforce productivity), occasioned by improved quality of indoor environment are consistent with the findings of similar studies undertaken in the past.

Past studies conducted by (Morgan, 1967), (Veitch& Gifford, 1996) (Prigent, 1997), (Fisk & Rosenfeld, 1998), (Fisk & Rosenfeld, 1998),(Loveland,2001), (Boubekri, Cheung,Reid, Wang & Zee, 2014) and (Andrew Jensen, 2016) among others demonstrate a robust relationship between exposure to daylight and accrued benefits in terms of enhanced productivity and improved quality of work life. The extensive glass facades in case buildings allowed sufficient daylighting into the workspace .This explains why the respondents, as observed by the researcher, appeared cheerful, alert and generally full of life. This observation also supported by studies conducted in the past which affirms that sufficient daylightleads to remarkable reduction of stress, anxiety, tiredness, lethargy and boredom while boosting their morale thereby enhancing their productivity.The studies conclude that the architectural design of work environments should place more emphasis on exposure of the workers to sufficient daylight so as to promote workers' productivity, health and well-being.

The findings of the impact of furniture design on productivity (enhanced productivity), are also consistent with the ones of past researchers such as (Scott, 2013),

The researcher noticed that the colour of workstations especially in World Bank Group Centre was vibrant. In addition, the design of the furniture had sufficient ergonomic considerations. The increased productivity did not therefore come as a complete surprise to the researcher, as the cool and bright colours have been known to lift the mood of employees, alleviate stress thereby boosting their productivity. Other studies also affirm that ergonomic furniture increases production reduces data entry error rates and boost job satisfaction among employees among other benefits.

The findings of the impact of optimal thermal environment and IAQ on productivity (improved productivity), are also consistent with findings of past studies by (Wargocki et al., 1999), (McCartney & Humphreys, 2002), (Hedge, 2004), (Haynes, 2008), (Lan, Wargocki & Lian, 2012) among others. According to Wargocki, Wyon and Fanger (2000), the air quality affects productivity. This position is supported by their findings which suggest that the overall performance of office tasks is estimated to increase by 1.9% for every two-fold increase in ventilation rate at constant pollution load.

The relationship between acoustic quality and improved performance has been thoroughly explored in studies conducted by Smith and Jones (1992), Gemmert and Galen (1997), Waye et al. (2001) and Vigeant and Bahnfleth (2015) among others. These studies reveal that low-frequency noise at levels synonymous with those of office-like environments may affect work performance and subjective perception of annoyance thus leading to diminishing productivity.

5.4. Conclusions

The study concludes that the assessment of the performance of indoor environment in LEED-Certified buildings is quite useful if the management of organisations within those buildings are keen on improving the productivity of their workforce. The results of the appraisal are also useful to facility managers, designers, and policy makers keen on improving the level human comfort within the indoor environment of green buildings in Nairobi County.

The role of building occupants was also found to be very critical in the appraisal of indoor environment of LEED-Certified buildings. This was proven by the fact that they provide valuable feedback essential for their successful management and enhancement of operational practices.

5.5. Recommendations

The study recommends that the occupant's satisfaction surveys be conducted more often not only on green buildings but also on conventional buildings to enable facility managers to come up with effective ways of improving the environmental performance as well as productivity of their occupants.

The study revealed that the users were **very satisfied** only with furniture and workspace layout while **satisfied** with the rest of IEQ aspects in LEED-Certified buildings in Nairobi. The study recommends that the facility managers and designers should look for ways of improving their compliance with standards and guidelines provided by LEED for each of IEQ element, so as to minimise the percentage of dissatisfied users.

5.6. Limitations of the study

In undertaking the study, the researcher faced the following challenges:

i. Majority of the selected LEED-Certified buildings housed banking institutions and highly secured. Accessing the respondents in those buildings took a lot of time due to the mandatory multiple security checks.
ii. Conducting interviews with key informants proved another challenge since most of them worked in busy organisations with regular meetings and sometimes trips outside the country.
iii. The LEED rating tool used to certify the green status of the buildings in Nairobi had not been localized. Therefore it may not have responded adequately to geographically distinct regional priority issues such as the tropical conditions.

5.7. Suggestions for Further Research

iv. This study revealed that the independent variables (thermal comfort and air quality, lighting quality, acoustic quality, cleanliness and maintenance) account for only 65 percent of perceived occupants' productivity in LEED-Certified buildings in Nairobi. The study therefore recommends that further study be conducted on other factors related to IEQ that may account for the remaining 35% such as the effect of exposure to Electromagnetic Fields (EMF), security and safety within the buildings and social dimensions.

v. This study recommends that further research be done on the effect of LEED-Certification on property values in Nairobi.

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APPENDICES

Appendix I: Letter of Introduction

UNIVERSITY OF NAIROBI
DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT
P.O. Box 30197, 00100 Nairobi, KENYA, ***Tel: No. +254-020-491 3531***
E-mail: *dept-recm@uonbi.ac.ke*

Ref: B53/81136/2012 **Date:** 15th June, 2016

To Whom It May Concern

Dear Sir/Madam

RE: LANGAT EZRA KIPROTICH

This is to certify that the above named is a student in the Department of Real Estate and Construction Management undertaking M.A. in Construction Management course.

He is carrying out a research entitled **"An Evaluation of The Performance of Leed Certified Buildings in Nairobi, Kenya"** in partial fulfillment of the requirements of the degree programme.

The purpose of this letter is to request you to allow him access any kind of material he may require to complete his research. The information will be used for research purposes only.

Please accord him the necessary assistance.

CHAIRMAN
DEPARTMENT OF REAL ESTATE
AND CONSTRUCTION MANAGEMENT
UNIVERSITY OF NAIROBI

Dr. Luke Obala
Ag. Chair &Senior Lecturer
Dept. of Real Estate and Construction Management

Date: 4TH JULY, 2016.

To: **Whom it May Concern,**

Dear (Respondent),

RE: ASSISTANCE TO FILL ACADEMIC QUESTIONNAIRE

I am student in the department of Real Estate and Construction Management, University of Nairobi pursuing post graduate studies leading to award of Master of Arts Degree in Construction Management. I am conducting an academic research titled '**An Evaluation of the Performance of LEED Certified Buildings in Nairobi, Kenya'.**

You have been selected to participate in this study and therefore you are kindly requested to fill the questionnaire attached. The information provided shall exclusively and solely be used for academic purposes.

Your participation in this research would be greatly appreciated but is voluntary. Your confidentiality and anonymity are ensured. Your identifiable information contained in the survey will only be used during the data collection phase of this study.

There are no known risks associated with participation in this study. Your responses are intended to complete the feedback loop and may be essential for the successful management and improvement of practices of green building in Nairobi, Kenya.

Thank you

Yours faithfully,

ARCH. LANGAT K. EZRA

Appendix II: Questionnaire

Questionnaire for Research Study on "An Evaluation of the Performance of LEED Certified Buildings in Nairobi, Kenya".

INSTRUCTIONS

i. Please read each statement carefully
ii. Tick an option you think best suits you

Your Name (*Optional*)_____

Email Address_____

1. PERSONAL WORKSPACE INFORMATION

1.1. Which of the following best describes your personal workspace?

- ☐ Enclosed office, private
- ☐ Enclosed office, shared with other people
- ☐ Cubicles with high partitions *(about 1.5 or more metres high)*
- ☐ Cubicles with low partitions *(lower than 1.5 metres high)*
- ☐ Workspace in open office with no partitions *(just desks)*
- ☐ Other (Specify)_____

2. WORKSPACE LAYOUT AND OFFICE FURNITURE

The following statements relate to workspace and furniture considerations within your workspace. Tick an option you think best suits you.

2.1. My workspace is open enough to interact with my colleagues while working.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
○	○	○	○	○

2.2. I am satisfied with the level of visual privacy within my workspace.

Very Satisfied	Satisfied	Not Sure	Dissatisfied	Very Dissatisfied
○	○	○	○	○

2.3. My furniture is flexible to adjust, rearrange or reorganize my workspace (chair, desk, computer, equipment, etc.)

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

3. THERMAL COMFORT AND AIR QUALITY

The following statements relate to thermal comfort and air quality considerations within your workspace. Tick an option you think best suits you.

3.1. I am able to control temperature or airflow in my workspace.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
○	○	○	○	○

3.2. I am satisfied with the overall temperature within my workspace.

Very Satisfied	Satisfied	No Effect	Dissatisfied	Very Dissatisfied
○	○	○	○	○

3.3. How satisfied are you with the air quality in your workspace (i.e. stuffy/stale air, cleanliness, odors)?

Very Dissatisfied	Dissatisfied	No Effect	Satisfied	Very Satisfied
○	○	○	○	○

4. LIGHTING

The following statements relate to lighting comfort considerations within your workspace. Tick an option you think best suits you.

4.1. My workspace is provided with efficient lighting so that I can work easily without strain on my eyes.

Strongly Agree	Agree	No Effect	Disagree	Strongly Disagree
○	○	○	○	○

4.2. I am satisfied with the level of control over the lighting on my desk (i.e. adjustable desk light on desk).

Very Satisfied	Satisfied	Not Sure	Dissatisfied	Very Dissatisfied
○	○	○	○	○

4.3. Ample amount of natural light comes into my workspace.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
○	○	○	○	○

5. ACOUSTIC QUALITY

5.1. How satisfied are you with the sound level in your workspace?

Very Satisfied	Satisfied	No Effect	Dissatisfied	Very Dissatisfied
○	○	○	○	○

5.2. How satisfied are you with the sound privacy in your workspace

Very Satisfied	Satisfied	Not Sure	Dissatisfied	Very Dissatisfied
○	○	○	○	○

6. CLEANLINESS AND MAINTANANCE

6.1. How satisfied are you with general cleanliness of the overall building?

Very Dissatisfied	Dissatisfied	Not Sure	Satisfied	Very Satisfied
○	○	○	○	○

6.2. How satisfied are you with general maintenance of the building?

Very Dissatisfied	Dissatisfied	Not Sure	Satisfied	Very Satisfied
○	○	○	○	○

7. OCCUPANTS PRODUCTIVITY

7.1. Overall, does the workspace layout and furniture enhance or interfere with your ability to get your job done?

Extremely Enhances	Enhances	No Effect	Interferes	Extremely Interferes
○	○	○	○	○

7.2. Overall, does the room temperature and air quality in your workspace enhance or interfere your ability to get your job done?

Extremely Enhances	Enhances	No Effect	Interferes	Extremely Interferes
○	○	○	○	○

7.3. Overall, does the lighting quality enhance or interfere with your ability to get your job done?

Extremely Enhances	Enhances	No Effect	Interferes	Extremely Interferes
○	○	○	○	○

7.4. Overall, does the acoustic quality in your workspace enhance or interfere with your ability to get your job done?

Extremely Enhances	Enhances	No Effect	Interferes	Extremely Interferes
○	○	○	○	○

7.5. Does the cleanliness and maintenance of this building enhance or interfere with your ability to get your job done?

Extremely Enhances	Enhances	No Effect	Interferes	Extremely Interferes
○	○	○	○	○

8. OVERALL INDOOR ENVIRONMENTAL QUALITY (IEQ)

8.1. All things considered, how satisfied are you with your personal workspace?

Very Dissatisfied	Dissatisfied	No Effect	Satisfied	Very Satisfied
○	○	○	○	○

8.2. Please estimate how your productivity is increased or decreased by the environmental conditions in this building (e.g. thermal, lighting, acoustics, cleanliness):

+10%	+5%	0%	-5%	-10%
○	○	○	○	○
← Increased				Decreased →

8.3. How satisfied are you with the building overall?

Very Dissatisfied	Dissatisfied	No Effect	Satisfied	Very Satisfied
○	○	○	○	○

Thank you for participating in this Survey.