FACTORS INFLUENCING USE OF INTERLOCKING RED BRICKS TECHNOLOGY IN HOUSING PROJECTS: A CASE OF ISIOLO COUNTY, KENYA

BY

REUBEN OMUKO OMBIRO

A Research Project Report submitted in partial fulfilment of the requirements for the award of the Degree of Master of Arts in Project Planning and Management of the University of Nairobi

2018

DECLARATION

I declare that this research project report is my original work and has not been submitted for a degree in any other university or college for examination or academic purposes.

Signature: é é é é é é é é é é é é é ..Date:é é é é é é é é é é é é é

Reuben Omuko Ombiro

REG. NO: L50/6711/2017

This research project report has been submitted for examination with my approval as the University Supervisor.

Signedé é é é é é é é é é é é é é Date é é é é é é é é é é é é é

Dr John Mbugua

Senior Lecturer

Open and Distant Education Learning Campus

DEDICATION

This research report is dedicated to the following special people:-

To my parents Mr. Lawrence Mose Ombiro, my mother Mrs. Silvia Ombiro and wife Doreen Onchomba and not forgetting my children Veronica Zainabu and Christine Moraa for their encouragement and understanding during the entire period of my study and continued prayerôs towards successful completion of this course. I would also like to thank my boss, Commissioner of Police Mr. Michael Kioko Kaitha and staffing officer Inspector Paul Ndungu Mugo for giving me humble time to study. May God bless them all.

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to persons who have contributed in one way or the other to achievement of this course. I would like to thank my supervisor Dr. John Mbugua for his guidance, patience and encouragement towards the course. I also thank my classmates for their moral support and encouragement that has contributed to the success of this project report.

Lastly, I would also like to extend my gratitude to Mr. Amos Gitonga who was also always ready to support by giving advice and guidance throughout the entire period of my study, may the almighty God be upon them.

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ABBREVIATIONS AND ACRONYMS

ABTM: Appropriate Building Technology and Materials

BDD: Block Dry Density

CBO: Community Based Organization

CIDP: County Integrated Development Plan

HABRI: Housing and Building Research Institute

HASS: Highly Accelerated Stress Screening

HVAC: Heating, Ventilation and Air Conditioning

ISSB: Interlocking Stabilized Soil Block

KES: Kenyan Shilling rates

KISIP: Kenya - Informal Settlements Improvement Project

KNBS: Kenya National Bureau of Statistics

TAM: Technology Acceptance Model

TWA: Total Water Absorption

USGBC: U.S. Green Building Council

WCS: Wet Compressive Strength

ABSTRACT

The failure of interlocking red bricks technology in Isiolo County construction project is mostly related to the problems attributed to technical data of ISSB technology is still insufficient, leading to skepticism of the technology amongst construction industry professionals. Unfortunately, some projects provide new accommodation that is unaffordable to many low-income households and thus failing its true cause. The purpose of the study was to establish the factors affecting the use of interlocking red brick technology in housing project in Isiolo County. The study was guided by the following objectives; to determine the effect of availability of technology, construction cost, access to equipment by CBOs and individuals, perception of the quality of building blocks and training on use of interlocking red bricks technology in housing project in Isiolo County. The study was grounded on the adoption and diffusion theory. The target population for this study composed of the county representatives, contractors and project management committee members.A sample size of 156 for the study with the population of 262 was obtained using Morgan and Krejcie (1970) model. The study was significant in disseminating interlocking red brick technology information and making the stakeholders aware of the availability of this technology.Primary data was obtained using self-administered questionnaires. The drop and pick method were preferred for questionnaire administration so as to give respondents enough time to give well thought out responses. Data was analyzed using Statistical Package for Social Sciences (SPSS Version 25.0). All the questionnaires received were referenced and items in the questionnaire were coded to facilitate data entry. After data cleaning which entailed checking for errors in entry, descriptive statistics such as frequencies, percentages, mean score and standard deviation was estimated for all the quantitative variables and information presented inform of tables. Inferential data analysis was done using multiple regression analysis. The study found that in Isiolo County the use of interlocking red bricks in housing projects is positively and significantly affected by availability of construction technology, cost of construction, access to construction equipment by individuals and quality of building blocks and training. The study concluded that availability of construction technology had the greatest effect on the use of interlocking red brick technology in house construction in Isiolo County, followed by access to equipment by CBOs and individuals then perception of the quality of building blocks then construction cost while training had the least effect to the use of ISSB construction technology in Isiolo County. The study recommends that National Government in conjunction with the County Government should ensure that the numbers of machines for supporting the use of interlocking red bricks technology are sufficient. That there is a need to harmonize the construction cost so as to promote the interlocking red bricks technology, that the County Government need to sensitize the residents to adopt use of the ISSBs in houses construction since they offer better internal climatic conditions than other modern materials and that training on ISSBs should be done since it forms an integral part of ensuring improved houses and imparting important skills, which the trained can use in income generating activities.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Meeting the need for adequate housing of the worldôs population requires sustained investment and continued innovation, particularly in appropriate technologies that lower the cost of construction and the cost of materials. Technology is an aspect of the environment that should be considered in developing strategic plans. The appropriate construction technology can be measured by the availability of locally made plant and equipment, skilled manpower resources, extent of local material resources and the degree of utilization of such local construction resources. With a growing number of organizations using the technology there is a need to improve communication and knowledge-sharing, to quantify and verify the benefits, and to develop efficient approaches for its promotion and adoption (Kibert, 2016).

The lack of technological know-how and the shortage of managerial manpower are considered to be one of the major problems and constraints facing the nation. The situation is aggravated by acute shortage of managerial manpower. As at today, the country still remains a net importer of technical manpower, virtually most spare parts are imported and most investment in research and development are made abroad, except those sponsored by the government in public owned institutions (Akanni, Oke&Akpomiemie, 2013).

The concept of construction project development may be impaired without a good knowledge and successful management of the impact of environmental factors influencing the performance of such projects. Industries producing red ceramic, are mostly classified as small and medium-sized companies, using antique technologies and equipment in both production process (extraction and preparation of raw materials, shaping, drying and burning), and relation to machinery and automation level. In this way the process generates a great amount of wastes from bricks, tiles and ceramic blocks incorrectly stored and broken or defective, which passed the full cycle of production and were discarded by presenting cracks, warping, low mechanical strength, deformation or any other defect that prevents its use by applicable standards and by quality required from market (Megha&Rajiv, 2013).

Deboucha and Hashim (2011) observed that although the stabilized earth blocks have been an area of interest, its potential as a commercial construction material and the ability to fulfill several functions such as structural integrity, thermal transmittance and durability, makes the material an excellent walling material when compared to other masonry materials used in construction today and this has brought about the resurgence of renewed research interest in recent years. Joseph (2010) observed that using compressed earth blocks, in place of conventional fired bricks, will to a large extent reduce the energy usage and carbon emissions.

Building construction follows the principle of dry stacking. In dry stacking construction, the interlocking blocks are laid without mortar thereby leading to considerable savings in cost associated with mortar. This method of construction has existed in for thousands of years. Pave and Uzoegbo (2010) observed that ancient dry-stack masonry consisted of robust construction and huge structural elements which were both material and time-consuming construction process. At the time, attention shifted from dry-stack construction to research on new materials and applying new methods of construction. Moreover, building with ISSB reduces the use of industrial products like cement and depends on local resources. It is considered to an environmental friendly technology, because it consumes less production energy, reduces deforestation, reduces the use of non-renewable resources and produce less waste from construction process than the main walling alternatives like (fired bricks, cement-sand blocks)

1.1.1 Global Perspective

Worldwide, the use of earth for construction is as old as mansô existence, further improvements have been done to give immense benefits and optimum end user satisfaction through its usage. Deboucha and Hashim (2011) observed that although the stabilized earth blocks have been an area of interest for researchers in the past, its potential as a commercial construction material and the ability to fulfill several functions such as structural integrity, thermal transmittance and durability, makes the material an excellent walling material when compared to other masonry materials used in construction today and this has brought about the resurgence of renewed research interest in recent years. Using compressed earth blocks, in place of conventional fired bricks, will to a large extent reduce the energy usage and emissions.

In addition, with latest technology available in Saudi Arabian construction industry, the growth of this particular sector is inevitable. With the availability of such technology, Saudi Arabia was able to attract several investors who are particularly interested in the growth of the construction industry in the forthcoming years (Ventures, 2011). According to Harris (2012), the construction costs in Saudi Arabia are the cheapest compared to other countries in the Middle East. On the other hand, it was also observed that Bahrainôs construction costs are the highest compared to any country in Middle East. It was indicated in the research that the difference in the construction cost between Saudi Arabia and Bahrain is almost half.

However, the potential impact of innovative technologies and construction methods on a step-wise (rather than gradual) reduction of overall construction times cannot be disregarded. However, the usual increased cost of new technology has to be balanced with the need to achieve reduced times. The right to adequate housing is a universal right, recognized at the international level and in more than one hundred national constitutions throughout the world. It is a right recognized as valid for every individual person. The universal Declaration of Human Rights of 1948 recognizes the rights to adequate housing as an important component of the right to adequate standard of living (Ouda 2009).

1.1.2 Regional Perspective

Many African countries have experienced a large increase of urban population during the last 50 years. The proportion of people living in informal settlements is in some cities as high as 60% (Muraguri 2011), which clearly demonstrates how the demand for low cost housing has been urgent for a very long time. The construction industry problems in developing economies can be classified into three layers as; problems of shortages or inadequacies in industry infrastructure (mainly supply of resources), problems caused by clients and consultants and caused by contractor incompetence inadequacies. The construction industry can be seen as a pathway through which societal goals of urban and rural development can be achieved while construction works carried out in the industry cover site acquisition, design, contract, site operations and management. Lemougna, Melo, Kamseu, and Tchamba (2011) observed that due to the permeability of stabilized earth blocks to water vapour, earth walls remarkably regulate the humidity of indoor air.

Other researchers like Zulo (2014) in South Africa states that as a result of innovations in construction, industries need to accept the changes in order to manage their resources

effectively. But, the adoption of green technology in construction sector is not in effect like other industries due to its unique features such as resistance to change, low level of technology awareness and training, one-off projects, and industry fragmentation (Betts,1999). Also, Kasim and Ern (2010) revealed that with the innovation in this technology to facilitate the management of construction site, resistance toward green construction adoption exist in the world of construction. As a result, the construction industry is blocked from progressing (Ang, 2009). Isikdag (2009) states that currently in most industrially developing countries like South Africa, organizations are aware of the competitive advantage presented by technology adoption but are still not willing to invest in it as expected. Equally, due to economic and social changes, construction environment is becoming more complex and sophisticated, needing advanced technology to meet organizational and operational demands (Ozumba&Shakantu, 2008).

The Nigeria construction industry is a wide range of loosely integrated organizations that collectively construct, alter and repair a wide range of different buildings and civil engineering projects. However, the construction industry in Nigeria following the oil boom in 1970/71 was characterized by the development projects which required the construction technology and resources of developed countries. Since then, Nigeriaôs economic growth over the last decade according to Isa, Jimoh and Achuenu (2013) has been high and the contribution of construction sector has risen steadily leading to sustainability.

The construction industry in Egypt is one of the main supports of Egyptian economy. The rapid growth of the Egyptian Construction Projects together with the unrest of the Egyptian society due to political and economic variables in the period that followed the 25th January Revolution calls for massive development in risk management techniques. These variables bring opportunities to researchers in the field of project management to develop effective risk management techniques to cope with risks associated with construction activities and to implement the projects in accordance with project objectives including time, cost, quality and safety. Another factor that adds additional risks to construction projects in Egypt is the participation of foreign partners with the local stakeholders (Khodeir& Mohamed,2015)

The construction industry plays a significant role in the economy of South Africa; as major construction activities account for about 80 % of total capital assets and 15 % of the Gross domestic products, in addition this industry provide high employment opportunities. Despite the significant contribution of this industry to the South African economy and its role in the countryôs development, the quality performance of the industry still remains low. Many

construction projects in developing countries encounter considerable time and cost overruns and fail to realize their intended benefit as a result quality suffers and these projects will be totally terminated and abandoned before or after their completion (Nyangwara&Datche, 2015).Adedeji and Fasakin (2008) also established that when interlocking earth blocks are used for construction, it has unparallel advantages such as shorter period of construction, lesser gang of labour and reduced cost of construction (Mwakipesile,2015)

Interlocking Stabilized Soil Block (ISSB) technology is one such technology that is gaining growing recognition, notably in East Africa. Compared with alternatives such as fired brick, it offers lower construction costs at comparable quality, is suitable for a wide range of environments, and dramatically reduces the impact on the environment. The technology has not yet been standardized in Uganda. The Good Earth Trust is coordinating with the Uganda National Bureau of Standards to produce standards for ISSB technology. In order to ease the integration of ISSB technology into more densely-populated urban areas, there is a need to produce more technical data including quality tests and appropriate building codes and standards.

1.1.3 Local Perspective

Kenya housing construction industry is facing enormous challenges in quality assurance from cases of collapsing buildings, unfinished and substandard constructed and uninspected houses. Cases of overruns in cost, schedule, technical quality and safety have also been rampant. Under the Vision 2030, the Kenyan government has committed to provide adequate, affordable and quality housing for all citizens, particularly the low-income groups. The Kenyan government has therefore incentivized developers to move down market by offering, among other things, tax breaks for housing units that cost less than KES 1.6 million (Githenya& Ngugi,2014). In 2007 Government of Kenya identified a set of incentives to encourage developers to enter the affordable/low-income housing sector but Developers say this has had little impact. It is widely believed that there is a dearth of low-cost appropriate technology in Kenya (Ayieko, 2012).

There is a need to promote awareness of appropriate construction technologies in civil society and the private sector. Appropriate technologies refer to materials, methods and/or practices which help protect the natural environment, take inspiration from the cultural values and practices in the area, make use of local resources, and contribute to local economic development. The construction industry is making the transition to technology and building

practices, but progress is slow. Recent market data shows that environmentally certified buildings represent 5.4 percent of the commercial office stock, and diffusion of such building practices is even more limited in other sectors, such as retail space and industrial warehouses. The World Bank representative flagged that KISIP (particularly component 4) as suitable to accommodate further initiatives on affordable housing related efforts. With general elections looming in late 2012 or early 2013 the political and institutional landscaping may change in the near future (Osiani, 2015). This can bring considerable opportunity. Affordable green housing is an issue for more than 80% of the population in Kenya and carries substantial democratic weight considering the rapid rise in the costs of utilities (Wainaina, 2015).

Even though construction is gaining market share, new construction and building refurbishment are still mostly conventional. This raises questions about the marginal costs and benefits of environmentally certified, green construction perhaps these market trends simply reflect economic rationality (Mwandeu, 2013). The economic literature on more efficient, green building has thus far solely focused on the measurement of outputs, and generally documents rental, occupancy and value premiums for green commercial buildings (Narncy, 2014). These marginal financial benefits reflect cost savings and risk perception, but perhaps also the higher input costs required to construct more efficient buildings (Wanjau&Mueni, 2011).

Oluoch (2010) noted that the Kenyan construction industry has in the past five years experienced a tremendous growth in terms of production so much that it defied a global economic recession to post a 6% growth in the year 2009 according to Kenya National Bureau of Statistics and 5% in 2010 according to World Bank Global Economic Prospects. The cost of any building design is determined primarily by the costs of labor and materials involved in erection. The rising cost of construction will impact both supply and demand, with the rise in cost, the cost of the building will rise.

1.1.4 Interlocking Stabilized Soil Block Technology in Kenya

The Ministry of Housing in Kenya established the Appropriate Building Materials and Technology (ABM & T) Programme in 2006 to address the high building costs by facilitating the provision of improved and affordable housing in both urban and rural areas. This was done by facilitating provision of equipmentôs and training on ISSBs to citizens and especially organized Community Based Organizations and individuals throughout the country. More and more people are using earth for construction.

Generally, people are re-discovering the benefits of having earth walls in developing houses as better properties can be obtained by using additives to the earth material. In addition, earth construction is possible with a wide variety of building methods. Housing design should not be based solely on imported forms, but rather on traditional forms of architecture as well for example, in 1998, 88% of the Yemeni families lived in the rural areas in their own made houses (Al-Sakkaf, 2009).

Ouda (2009) gives an overview of compressed earth blocks giving their advantages and disadvantages but he doesnôt look at how its implementations are done. Similarly, durability properties of stabilized earth blocks does not look at the implementation of the stabilized soil blocks but looks at advantages and disadvantages of using the stabilized soil blocks giving examples where they have been used, their strength testing and quality control and how to improve on their durability. To facilitate effective training and implementation of this technology, the then Ministry of Roads, Public Works and Housing in conjunction with Housing and Building Research Institute (HABRI) of the University of Nairobi organized a training workshop for the staff of the ministry in March 1997.

1.2 Statement of the Problem

In many developing countries, technologies adopted compose the main part of the total cost in construction projects. Housing construction projects has been poorly performing in Kenya evidenced by failure to meet the housing demand that continues to widen in the country with an estimation of housing demand in urban areas is approximately 150,000 units per year yet the current supply is about 30,000 units (HASS, 2013). According to KNBS (2013), the sector recorded a growth of 4.8 per cent in 2012 while cement consumption rose by 1.7 per cent (from 3,870.9 thousand tones in 2011 to 3,937.3 thousand tones in 2012). In order to meet the accelerating demand of low cost housing, and to improve the living conditions in informal settlements, various organizations are involved in slum upgrading projects. Some are small-scale, community initiatives carried out with support from NGOs, while others are large-scale, governmental programmes.

The use of interlocking red bricks technology in Isiolo County construction project is mostly related to availability of technology information which is still insufficient, leading to skepticism of the technology amongst construction industry professionals. Unfortunately, some projects provide new accommodation that is unaffordable to many low-income households and thus failing its true cause. Similarly, durability properties of stabilized earth

blocks do not look at the implementation of the stabilized soil blocks but looks at advantages and disadvantages of using the stabilized soil blocks giving examples where they have been used, their strength testing and quality control and how to improve on their durability. Adoption of the right technology is challenge to the running of the entire project. Isiolo County also suffers project failure which the County Integrated Development Plan (CIDP) (2014) attributes to poor management. If this continues, then Isiolo County will still remain underdeveloped. This indicates wastage of millions of shilling lost in the construction project failure.

Several studies have been carried out on construction projects such as; Aghimien (2015) Assessment of the Use of Compressed Stabilized Interlocking Earth Block for Building Construction in Nigeria, Githenya and Ngugi (2014) assessment of the determinants of implementation of housing projects in Kenya, Charagu (2013) who concluded that it is due to deficiency of the designs in construction sector. Mohamed (2012) did a study on green built technology and climate change management in Kajiado county and found out that in some areas of the county where this technology was applied, there is low level of environmental degradation and that the land remained fertile for agricultural activities and finally Ongôongôo (2014) carried out a study on factors affecting adoption of green technology by firms in central Kenya. However, none of the studies reviewed focused on the factors influencing the use of new construction technology in housing project in interlocked red bricks in Isiolo County creating a gap that this study sought to bridge.

1.3 Purpose of study.

The study sought to establish the factors affecting the use of interlocking red bricks technology in housing project in Isiolo County.

1.4 Objectives of the study

The study was guided by the following objectives;

i. To determine how availability of construction technology influence use of interlocking red bricks in housing projects Isiolo County.
ii. To establish how construction cost influence use of interlocking red bricks in housing projects Isiolo County.
iii. To assess how access to construction equipment by individuals influence use of interlocking red bricks in housing projects Isiolo County.

iv. To evaluate how quality of building blocks influence use of interlocking red bricks in housing projects Isiolo County.

v. To examine how training influence use of interlocking red bricks in housing projects Isiolo County.

1.5 Research Questions

The study sought answers on the following research questions.

i. To what extent does availability of technology influence use of interlocking red bricks in housing projects Isiolo County?

ii. How does construction cost influence use of interlocking red bricks in housing projects Isiolo County?

iii. How does access to construction equipment influence use of interlocking red bricks in housing projects Isiolo County?

iv. To what extent does quality of building blocks influence use of interlocking red bricks in housing projects Isiolo County?

v. How does training influence use of interlocking red bricks in housing projects Isiolo County?

1.6 Significance of the Study

For the different stakeholders in the housing sector, the study on the factors that affect the effective implementation of interlocking stabilized soil for improved shelter situation are very important because it would be a means of disseminating this technology thus making the stakeholders aware of the availability of this technology. For the Government of Kenya, the study findings would also be used by the government and particularly policy makers, planners and program implementers to formulate policies and strategies on use of ISSBs construction technology in housing project. It would help the Government in reviewing the effectiveness of the ISSBs programme and give guidance in decision making as well as policy formulation. It can also be used as a basis for packaging the ISSBs to benefit entrepreneurs interested in setting up small, medium and large-scale plants for making building materials and equipment.

The study likewise provides concrete information about the use of ISSB construction technology in housing project and especially to potential users of the ISSBs in order for them to make informed decisions about ISSBs technology. The study contributes to the body of knowledge in the subject of use of ISSB construction technology in housing project also other students/scholars can use it as a reference. The research findings lay some foundations for further research on factors affecting use of ISSB construction technology in housing project.

1.7 Delimitation of the Study

The study established factors affecting the use of ISSB construction technology in housing project in Isiolo County. The study specifically determined the effect of availability of technology, construction cost, access to equipment by CBOs and individuals, perception of the quality of building blocks and training. The study was carried in Isiolo County where the respondents were the county representatives, contractors and project management committee members. The study was carried out in a period of six months.

1.8 Limitations of the Study

The study encountered some limitations like at some point a portion of respondents were not agreeable to fill the questionnaire that hindered access to information that the study seeks. Respondents had to be spoken to first before administering the same. The respondents targeted in this study were reluctant in giving information fearing that the information being sought might be used to intimidate them or print a negative image about them. The researcher hoped to handle this by carrying an introduction letter from the University to assure them that the information they give was treated with confidentially and was used purely for academic purposes. In addition, the findings of this study were limited to the extent to which the respondents were willing to provide accurate, objective and reliable information. The researcher checked for consistency and test the reliability of the data collected.

1.9 Basic Assumptions of the Study

The researcher assumed that the respondents were cooperative enough to give the required information of the study. The researcher also assumed that all information collected from respondents were true to give a clear and true picture. The researcher further assumed that external factors like conflict did not arise as this would affect the process of data collection and hence the completion of the project. Finally, the researcher assumes that the respondents had adequate knowledge on the variable of the study.

1.10 Definition of Significant Terms Used in the Study

The following are the definitions of terms that were used throughout this study:

Availability of materials ï This term is used to denote the readiness of the appropriate requirement that would be needed in the green building technology. This term takes into consideration the proximity of the construction site and where the materials are sourced from.

Availability of Construction Technology: This is availability of the purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities.

Access to Equipment by Individuals: This is the ability of the individuals or the community-based organizations to be able to get to the equipment they need.

Construction cost: This term denotes the expenses incurred by a contractor for labor, material, equipment, financing, services, utilities, etc., plus overheads and contractor's profit. Costs such as that of land, architectural design, consultant and engineer's fee are not construction costs.

Perception of the quality of building blocks: This is the way in which the building blocks are regarded, understood, or interpreted based on their quality.

Training: This term denotes the action of teaching a person or animal a particular skill or type of behavior.

1.11 Organization of the Study

This study was organized into five chapters. Chapter one contains the introduction to the study. It presents background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the Study, delimitations of the study, limitations of the Study and the definition of significant terms. On the other hand, chapter two reviewed the literature based on the objectives of the study. It further looked at the conceptual framework and finally the summary. Chapter three covers the research methodology of the study. The chapter describes the research design, target population, sampling procedure, tools and techniques of data collection, pre-testing, data analysis, ethical considerations and finally the operational definition of variables. Chapter four presented analysis and findings of the study as set out in the research methodology. The study closed with chapter five which presents the discussion, conclusion, and recommendations for action and further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides an extensive literature and research related to institutional determinants of participatory monitoring and evaluation systems implementation among community-based development projects. This literature review summarizes a diverse spectrum of views about institutional determinants. The chapter is thus structured into theoretical, conceptual and empirical review. The study also presents the knowledge gap the chapter seeks to fulfill.

2.2 Use of interlocking red bricks Technology in Housing Projects

The construction industry activities in many countries may be used to regulate the economy. New construction technology influences the construction industry continues to grow in size encountering planning and budgeting problems. This is because it is common for projects not to be completed on time and within the initial project budget. Indeed, most architects have been trained and inclined to implement their design solutions for construction by using conventional approaches, including low income housing projects, even in developing areas where resources are meager. Thus, a majority of house building activities have largely depended on supplies of factory-made building materials, such as cement, steel and glass. The demand for factory-made materials greatly exceeds the supply, hence causing delays, wastage, escalating costs and even black marketeering. Until recently, appropriate technology subjects were not included in the curricula of architectural schools and as a result, architects are reluctant to deviate from existing 'proven' approaches when designing buildings.

With latest technology available in construction industry, he growth of this particular sector is inevitable. With the availability of such technology, several investors who are particularly interested in the growth of the construction industry in the forthcoming years are able to get involved (Ventures, 2011). According to Harris (2012), the construction costs in Saudi Arabia are the cheapest compared to other countries in the Middle East. On the other hand, it was also observed that Bahrainôs construction costs are the highest compared to any country in Middle East. It indicated in the research that the difference in the construction cost between Saudi Arabia and Bahrain is almost half.

2.3 Availability of Technology and Use of interlocking red bricks Technology in Housing Projects

Materials are the essential components of buildings construction. Chemical, physical and mechanical properties of materials as well as an appropriate design are accountable of the building mechanical strength. The design of buildings should thus begin with the selection and use of eco-friendly materials with related or better features than traditional building materials. Building materials are usually selected through functional, technical and financial requirements (Rodman, 2009). However, with sustainability as a crucial issue in the last decades, the building sector, directly or indirectly causing a considerable portion of the annual environmental deterioration, can take up the obligation to contribute to sustainable development by finding more environmentally benign methods of construction and building (Mutembei, 2014).

Among the directions for solutions is to be found in new material applications, recycling and reuse, sustainable production of products, Careful selection of eco-friendly sustainable building materials may be the fastest way for builders to start integrating sustainable design concepts in buildings (Obuke, 2014). Ordinarily, price has been the primary consideration when comparing related materials or materials selected for similar purpose. Nevertheless, the price of a building element signifies just the manufacturing and transportation costs, not social or environmental costs. Substantial initiatives have been carried out by the research community globally, in order to discover alternative sustainable building materials and low technology techniques, which result in a more sustainable and affordable construction complying with the comfort standards required today (Wainaina, 2015). Embracing building materials is a good alternative to meet to this objective. Therefore, Selection of construction materials that have minimum environmental burdens is useful in the sustainable development of a nation. The purpose of this paper is to highlight how sustainable building material can contribute to lessen the impact of environmental degradation and generate healthy buildings which can be sustainable to the occupant as well as our environment

Building and construction activities worldwide consume 3 billion tons of raw materials each year or 40 percent of total global use. Using new building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials (Ganiyu, 2016).

The relatively slow take-up of construction practices could thus be due to construction costs that are higher than the marginal benefits. Indeed, the general perception in the construction and real estate development industry is that green construction is expensive, especially if it involves the refurbishment of existing buildings. Given that green building is relatively novel in the construction industry, developers are understandably uncertain about the marginal cost of such building practices relative to traditional property development. Existing research on input costs is limited to a handful of case studies, typically comparing a small number of green buildings to conventional counterfactuals, without properly controlling for other building characteristics and features of the construction process. The findings from this research are thus hard to interpret or generalize (Mwendo, 2012).

2.4 Construction Cost and Use of interlocking red bricks Technology in Housing Projects

The housing construction industry in Mombasa County requires affordable building materials and the use of ISSBs techniques will generate more housing. The Mombasa County government may require an industrial policy that would promote production and availability of conventional and locally available building materials like cement, steel, stones, ISSBs and Micro Concrete Roofing Tiles. Most of the materials produced at the large-scale industries are usually expensive due to high electricity cost. Moreover, makers of cement, corrugated sheets, paints and steel products have seen prices of raw materials rise because of a surge in commodity prices due to the global economic crisis. The global recession that started in mid-2008 ended a five-year global commodity price boom of metals, fuels and food which kept the cost of building materials stable and low. Any upheaval in the Arab World likewise affects negatively the cost of construction materials due to rise in fuels which in turn have a spiral effect on electricity and other commodities. The rising prices slow down the construction of houses (Muinde, 2013).

On the other hand, transport cost constitutes a major construction cost of materials in Mombasa County. This can be attributed to the long distance of procuring the conventional building materials as well as the bulkiness of the construction materials. ISSBs are usually produced at the point of use greatly reducing the transport cost of the building materials. It also avoids breakages while transporting the materials thus reducing wastages (HABRI 2003). Some of the measures the Government can undertake includes; reviewing from time to time the taxation levels on building materials so as to reduce the cost construction for housing

arising from the building materials. All research actors should harness and document existing locally available building materials and technologies as well as disseminating this information to the users as appropriate. Promote and encourage small-scale enterprises to engage in production and application of the researched materials. Promote trainings in requisite skills and construction technologies through youth polytechnics, women groups, youth groups, community-based organizations and appropriate building technologies and materials centers (Hesborn, 2016).

The level of environment friendliness, given by the rating of the building, is not arrived at in a scientific manner by considering the options and their cost implications (Norma, 2003). Risk adverse owners, in spite of their desire to go green, are hindered by a lack of information on the various options and ability to decide which options to choose. This information, if made available as a decision support tool, can be valuable in bringing green buildings into the mainstream. The non-availability of such a tool is a major barrier in the growth of the green building movement removing market barriers to green development. In Singapore, the building projects have costs associated with land, designing and planning, execution and operation maintenance which extend over its lifetime. The cost of land is mostly invariant as options for sites are limited.

For public projects, the time gap between the decision to procure land and actual execution of work is generally so large that it remains an activity outside the planning scope of the project (Victor, 2012). This is due to changes in the external environment like changes in prices of material and technology, availability of new technology, change in the needs of the owner and often a change in the set of decision making people. However, if options are available over different locations, comparisons can be drawn for more energy efficient shape, orientation and other architectural features of the building (Kamonze, 2009). This aspect is beyond the scope of this work. Costs associated with designing, planning and project management are small compared to the cost of the building. For example, to achieve a green rating for the building, architects with experience of integrated design of buildings and green technology will have to be chosen. Inputs from electrical, structural, HVAC and acoustic experts are required at the initial stages itself. This will show up as cost increase for the planning stage. The important variable cost is what comes from the choice of material and technology (Oingane, 2011).

Different materials have different embodied energy. Embodied energy of a material is defined as the energy used up in creating the raw materials, manufacturing processes and

transportation at various stages (Chani, 2003). Some work has been done in the US to document the energy footprint of commercially available brands and making it available through commercial software in the public domain (Reddy &Jagadish, 2003). More efficient, green construction practices can have a substantial impact on environmental outcomes. Buildings represent 30 percent of global carbon emissions and 40 percent of raw materials and energy consumption (Kahn, Kok& Quigley, 2014). In general, the cost of switching to cleaner technologies is unclear, but it is predicted that such a switch is less costly in the long run than maintaining conventional technology (Glaeser& Kahn, 2010). Incentives for more efficient construction stem from government procurement policies in the US and EU (Simcoe &Toffel, 2012), increasingly strict building energy codes (Jacobsen &Kotchen, 2013), and popular demand for environmentally certified, green buildings (Kok, McGraw & Quigley, 2011).

2.3 Access to construction equipment by Individuals and Use of interlocking red bricks Technology in Housing Projects

Access to ISSBs equipments is critical to the improvement of houses as well as creating a means of earning a livelihood. Access to Hydraform machine is limited to the ones provided by the Ministry of Housing. These machines have the capacity to produce up to One Thousand, Five Hundred (1500) blocks per day and they can be used for mass production of ISSBs (Hydraform 2005). However, they are costly to purchase and maintain and they are far out of reach of the poor. The Ministry of Housing has come in handy as they are purchasing them. In Mombasa County, the Ministry has five Hydraform machines but they may not be enough to satisfy the growing demand. The Ministry is letting people use them for a period for free which is a step forward though this may not be tenable in the long run if the Ministry plans to buy more and ensure this programme is sustainable. The Ministry may need to come up with a business plan for each of the finished ABT & M Centers and funds realized used to purchase more of these machines as well as the maintenance of the existing ones.

On the other hand, Action Pack block Press is locally made by local companies such as Makiga Engineering. On purchase, a free training in operation and maintenance of the block press is provided as well as how to test the soil and produce Stabilized Soil Blocks. Action Pack block press costs about Kshs 85,000 and can be accessed by organized groups such women groups and youth groups (Makiga Engineering, 2011). Access or lack of access to the ISSBs equipment therefore would be the greatest factor in ensuring greater uptake off this

technology. As stated above, the Ministry of Housing equipment are too few while the cost of these equipments is prohibitive to most people in Mombasa County. There is need to increase the number of these equipmentôs to meet the demand.

Materials are the essential components of buildings construction. Chemical, physical and mechanical properties of materials as well as an appropriate design are accountable of the building mechanical strength. The design of green buildings should thus begin with the selection and use of eco-friendly materials with related or better features than traditional building materials. Building materials are usually selected through functional, technical and financial requirements (Rodman, 2009). However, with sustainability as a crucial issue in the last decades, the building sector, directly or indirectly causing a considerable portion of the annual environmental deterioration, can take up the obligation to contribute to sustainable development by finding more environmentally benign methods of construction and building (Mutembei, 2014).

Among the directions for solutions is to be found in new material applications, recycling and reuse, sustainable production of products or use of green resources, Careful selection of eco-friendly sustainable building materials may be the fastest way for builders to start integrating sustainable design concepts in buildings (Obuke, 2014). Ordinarily, price has been the primary consideration when comparing related materials or materials selected for similar purpose. Nevertheless, the price of a building element signifies just the manufacturing and transportation costs, not social or environmental costs. Substantial initiatives have been carried out by the research community globally, in order to discover alternative sustainable building materials and low technology techniques, which result in a more sustainable and affordable construction complying with the comfort standards required today (Wainaina, 2015). Embracing green building materials is a good alternative to meet to this objective. Therefore, Selection of construction materials that have minimum environmental burdens is useful in the sustainable development of a nation. The purpose of this paper is to highlight how sustainable building material can contribute to lessen the impact of environmental degradation, and generate healthy buildings which can be sustainable to the occupant as well as our environment

Building and construction activities worldwide consume 3 billion tons of raw materials each year or 40 percent of total global use. Using green building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts

associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials. Green building materials are composed of renewable, rather than nonrenewable resources (Mukoma, 2010).

2.4 Perception of the quality of building blocks and Use of interlocking red bricks Technology in Housing Projects

Building blocks have some basic merits and attractions associated with it such as; the basic raw material is soil; its source will remain abundant. This facilitates direct site-to-service application, thereby, lowering costs normally associated with acquisition, transportation and production. Home ownership can then be delivered at comparatively low costs. Secondly, the initial performance characteristics of the material such as the wet compressive strength (WCS) dimensional stability, total water absorption (TWA), block dry density (BDD) and durability are technically acceptable.

Houses constructed of ISSBs also offer better internal climatic conditions than other modern materials. Thirdly, promoting the use of ISSBs generates more direct and indirect employment opportunities within the local populace than would be in the case with other materials. Despite these advantages, there is the danger of the wrong perception that ISSBs are not permanent building materials. ISSBs may be strongly associated with the traditional none stabilized soil construction in the minds of many such as the mud and wattle construction It is worth to note that most of the buildings constructed using conventional building materials are unaffordable by a majority of our population. This has led to the development of alternative relatively cheap, decent and durable on site produced materials. The cost effectiveness of stabilized soil blocks has been proved by comparing the bill of quantities of construction involving soil blocks with that of fired brick. Compared to fired bricks, SSBs are 30% cheaper and even 60% cheaper than concrete blocks and they are faster to build with - (UN-HABITAT, 2009).

Research, development and dissemination of building materials and technologies (dubbed appropriate technology or alternative technology) world over is characterized by involvement of many organizations, including international, national and non-governmental organizations. The common aim has been the lowering of construction, especially in regard to housing so as to make it affordable to a majority of people who are predominantly in the low-income cadre. The potential beneficiaries of the appropriate technology are invariably drawn from economically weaker sections of society, who have very limited purchasing power to afford

houses that are constructed with conventional building materials and technologies. For indeed as Angel puts it, wherever appropriate technology has started taking root, four main attitudes are identifiable: Rejection of the concept, acceptance of the idea in principle, active involvement in knowledge, mobilization and experimentation, and willingness to apply the concept as a normal part of business administration and community activity.

More effort is required to bring appropriate technology at par with conventional technology. Low cost building materials for housing have not been sufficiently institutionalized, unlike conventional technology whose dissemination has largely been affected through commercial organizations and the profit mechanism. In addition, there has been insufficient emphasis on the development of support structures, political and economic backing and the implementation machinery ï hence a constraint which is highly inhibitive to the process of dissemination and full embracing of the technology. There has been no systematic research to assess the marginal cost of more efficient, green construction in an empirically rigorous manner. This hampers the understanding by policy makers, developers and real estate owners regarding the input and output costs of green construction, which may slow down the diffusion of energy efficient and sustainable building practices in the building stock, and thus the necessary reduction of the carbon externality from the built environment (Gichana, 2013).

2.5 Training and Use of interlocking red bricks Technology in Housing Projects

Training on ISSBs forms an integral part of ensuring improved houses and imparting important skills, which the trained can use in income generating activities. It is aimed at disseminating the ISSBs technology to the public and to those who need better housing at reasonable costs. It also aims at increasing the production and utilization of these technologies and materials with a view to improve houses and provide a means of earning a living (Ministry of Housing, 2011). This training programme is greatly boosted by the Government of Kenya through the Ministry of Housing which provides equipment, fuel and facilitates its officers to conduct ISSBs training, demonstration and technical assistance to community groups for free. On the other hand, the beneficiaries are expected to meet the cost of training materials such as soil, cement and water as well as provide labour.

It is therefore important to train as many people as possible in order to provide the critical mass that would in turn help in the dissemination of this technology with a view to increase it adoption and uptake. Architects, engineers, and planners in the green building field typically have, at minimum, a bachelorôs degree in a related field, like civil engineering (Lavign,

2015). Many also have a masterôs or other advanced degree, as well as the leadership in energy and environmental design (LEED) accredited professional credential (Bob, 2012). Developed and maintained by the nonprofit U.S. Green Building Council (USGBC), LEED is a green building certification program that recognizes best-in-class building strategies and practices, and it offers both certifications to building projects and credentials for green building professionals.

Building owners and operators face many financial and environmental challenges in todayôs economy (Zami, 2010). Rising energy costs strain current budgets and make it difficult to predict future expenses. Greenhouse gas (GHG) legislation has the potential to increase costs for an ownerôs entire building portfolio, even in areas where electricity prices have been stable (Yiftachel, 2008). Federal, state, and local building standards will raise the bar for new construction, such as Executive Order 13514, which requires federal agencies to construct net-zero-energy buildings by 2030. Green buildings represent a significant opportunity to solve todayôs problems and effectively plan for the future, but an organization must start with a comprehensive strategy. As the cost of energy and building materials rises, and as concern for the environment especially climate change grows, green architects and designers will likely be in increasing demand as companies, towns and cities and institutions of higher education look to renovate or construct new buildings that use less energy and water, are made of sturdy, eco-friendly materials and are able to handle the impacts of climate change (like higher temperatures, more frequent extreme precipitation and storm water runoff (Zami, 2009).

Building construction jobs include laborers, managers and operating and equipment engineers. These professionals work onsite to turn green building designs into a reality. Construction laborers typically earn about $29,160 per year, while construction managers can expect a salary of about $82,790 (U.S Civil engineering Report, 2015). Although many construction professionals develop experience via trade programs, apprenticeships and training on the job, many (especially managers) also hold bachelorôs degrees in fields like construction management, business management or engineering (Zami& Lee, 2009). Many construction managers also get the LEED Green Associate credential or the National Center for Construction Education and Researchôs Sustainable Construction Manager certification, according to the Bureau of Labor Statistics. The Bureau of Labor Statistics estimates that jobs for architects will grow by 15 percent between 2012 and 2022, and it follows that green construction professionals will also be in demand: After all, someone has to build what the

green architects design (Yu, 2010). Green building is expected to represent 55 percent of all commercial and institutional construction by 2016. According to this report, residential green construction is also on the rise: itôs expected that by 2016, green homes will comprise 29 to 38 percent of the market (McGraw-Hill Construction, 2013).

2.6 Theoretical Orientation

This section discusses the theoretical foundation on which the study is anchored. The study will be grounded on the adoption and diffusion theory.

2.6.1 Adoption and Diffusion Theory

According to Rogers (2003), adoption is the process in which an innovation is communicated thorough certain channels over time among the members of a social system and it involves three stages which are knowledge, persuasion, and decision. This definition also indicates that innovation, communication channels, time, and social system are the four key components of the diffusion of innovations (Robinson & John, 2004). This model suggests that adoption is not a single act but a process that occur over time with potential adopters going through when interacting with innovation. The Knowledge stage has the potential adopters finding out about innovation and gaining basic understanding of what it is and how it works (Jenkins & Willis, 2008). The second stage which is persuasion and the adopters form positive or negative impression of the innovation and it is only in the third stage that innovation is adopted or rejected (Abukwe, 2015. The adoption and diffusion theory relate well with use of new technology hence it can be used to determine the level of training which is available to make the use of new technology a reality.

An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them (Anderson, Varnhagen, & Campbell, 1998). The newness characteristic of an adoption is more related to the three steps (knowledge, persuasion, and decision) of the innovation decision process. In addition, Rogers (2003) claimed there is a lack of diffusion research on technology clusters. A technology cluster consists of one or more distinguishable elements of technology that are perceived as being closely interrelated (Bennett & Bennett, 2003). Uncertainty is an important obstacle to the adoption of innovations. An innovationôs consequences may create uncertainty; consequences are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation (Carter, 1998). To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make

them aware of all its consequences. Therefore, adoption and diffusion theory is relevant to this study in relation to availability of technology and use of new construction technology in housing project.

2.7 Conceptual Framework

A conceptual framework refers to the extent to which a study conceptualizes the relationship between contextual variables in the study and shows the relationship graphically or diagrammatically (Kombo& Tromp, 2009). The relationship describes the association between the independent variables and the dependent variables. Furthermore, it also shows other factors, moderating and intervening variables that can play in and affect both independent and dependent variables in this study. The conceptual framework of the study can be summarized in the Figure 1.

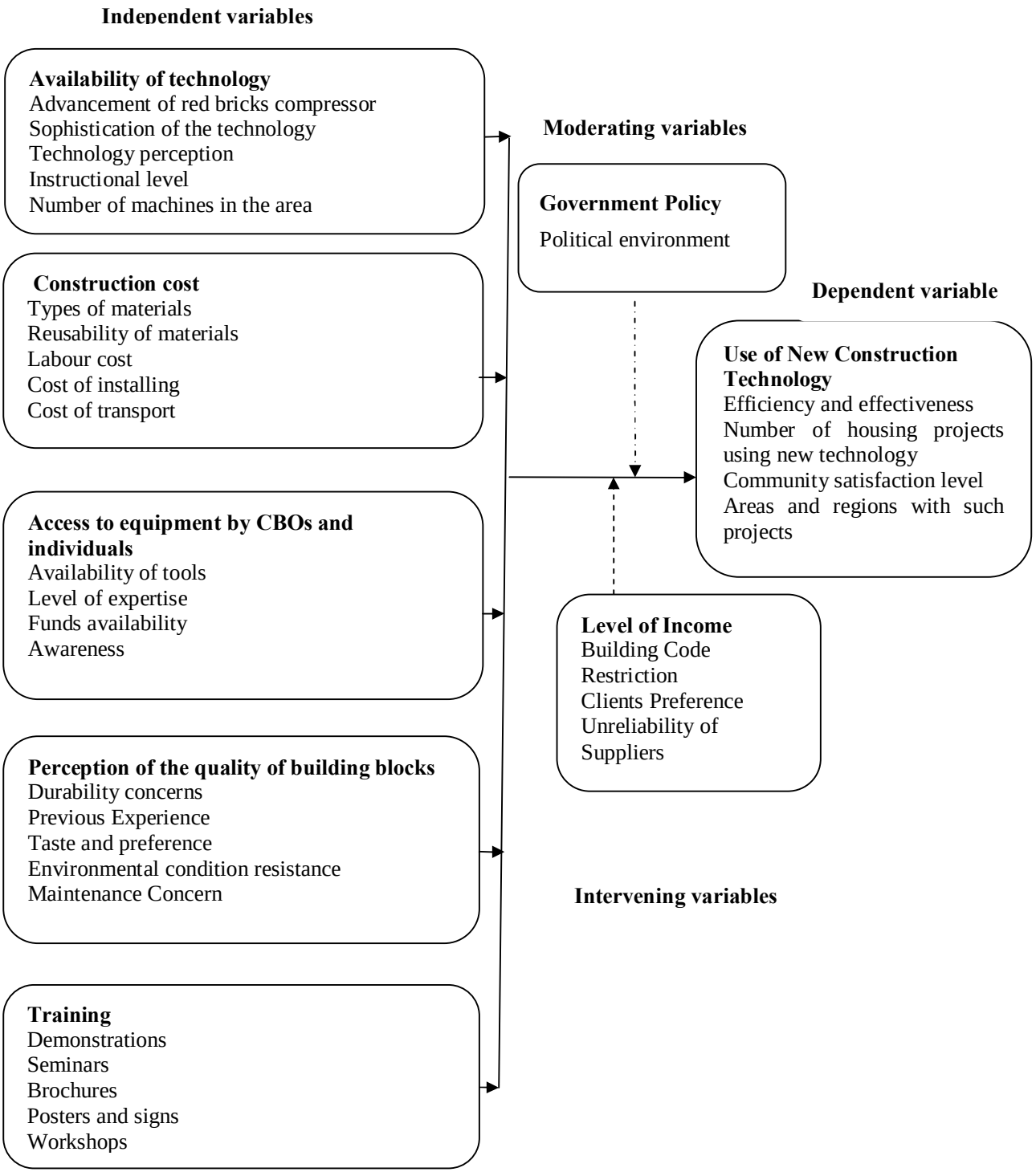

Figure 1: Conceptual framework

2.9 Gaps in the literature

Previous studies such as Aghimien (2015); Githenya and Ngugi (2014); Charagu (2013); Mohamed (2012); Ongôongôo (2014) carried out a study on construction technology, however, none of the studies reviewed focused on the factors affecting the use of interlocking red brick technology in housing project in Isiolo County creating a gap that this study seeks to bridge.

2.8 Summary of the literature

The study was grounded on the adoption and diffusion theory. The Knowledge stage has the potential adopters finding out about innovation and gaining basic understanding of what it is and how it works. An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. In summary, high construction costs have obvious negative implications for the major players in particular, and the industry in general. Project abandonment, drop in building activities, bad reputation and inability to secure project finance are all implications of high construction cost. However, an application of the proffered solutions would restore clientsô confidence in consultants, reduce investment risks and generally boost the viability and sustainability of the industry.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the procedures and techniques that were used in the collection, processing and analysis of data. Specifically, the following subsections are included; research design, target population and sampling, data collection instruments, data collection procedures and finally data analysis.

3.2 Research Design

The study adopted a descriptive research design.A descriptive design is concerned with determining the frequency with which something occurs or the relationship between variables (Polit& Beck, 2013). A descriptive analysis attempts to describe characteristics of subjects or phenomena, opinions, attitudes, preferences and perceptions of persons of interest to the researcher (Creswell, 2012). Thus, this approach is suitable for this study, since the study intends to collect comprehensive information through descriptions which was helpful for identifying variables. Singleton (2009) describes a descriptive research design as a comprehensive design that enables large and diverse amounts of data to be collected within a short time frame and analyzed quantitatively, giving a credible presentation of results.

3.3 Target Population

According to Sekaran and Bougie (2010), a population is the total collection of elements about which we wish to make inferences. The target population for this study composed the county representatives, contractors and project management committee members in Isiolo County as shown in Table 3.1.

Table 3. 1: Target Population

Managerial Level	Frequency	Percentage
County representatives	13	5.0
Contractors	71	27.1
Project Management Committee members	178	67.9
Total	**262**	**100.0**

Source: Isiolo County (2018)

3.4 Sample size and Sampling Procedures

Sampling is a deliberate choice of a number of people who are to provide the data from which a study drew conclusions about some larger group whom these people represent. The section focused on the sampling size and sampling procedures.

3.4.1 Sampling Size

Sample size can be defined as the number of observations used for calculating estimates of a given population (Smith, 2009). Basing the determination of sample size with Morgan and Krejcie (1970) model, a sample size of 156 respondents were targeted. This was done according to the Krejcie Model. According to Krejcie Model:

$$n = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where: n = desired sample size

N = Target population **(262)**

P = Population proportion **(0.5)**

d = degree of accuracy expressed as a proportion **(0.05)**

X^2 = 3.841 at 95% confidence level

Therefore $n = \frac{3.841 \times 401 \times 0.5(0.5)}{0.05^2 (262) + 3.841 \times 0.5 \times 0.5}$

n = 156.7

For convenience, the researcher rounded off the sample size ***'n'*** to 156 which was guided by Mugenda&Mugenda (2003) that 30% of the population can be used to determine a representative sample size of the whole population.

Table 3. 2: Sampling Frame

Managerial Level	**Frequency**	**Ratio**	**Sample size**
County representatives	13	0.59	8
Contractors	71	0.59	42
Project Management Committee members	178	0.59	106
Total	**262**		**156**

3.4.2 Sampling Procedures

The study selected the respondents using stratified proportionate random sampling technique. Stratified random sampling is unbiased sampling method of grouping heterogeneous population into homogenous subsets then making a selection within the individual subset to ensure representativeness. The goal of stratified random sampling is to achieve the desired representation from various sub-groups in the population. In stratified random sampling subjects are selected in such a way that the existing sub-groups in the population are more or less represented in the sample (Singleton, 2009). The study used simple random sampling to pick the respondents in each stratum.

3.5 Research Instruments

The quality of the research depends on the quality of data hence the importance of data collection process. Data collection tools are the instruments which are used to collect the necessary information (Creswell & Creswell, 2017). This refers to the means the researcher used to gather the required data or information. Although several tools exist for gathering data, the choice of a particular tool depends on the type of research. For the purpose of this study, the researcher used a semi structured questionnaire as the primary data collection tool. The questionnaire was structured to include both closed, open-ended and matrix questions to allow variety.

The structured questions were normally close ended with alternatives from which the respondent is expected to choose the most appropriate answer (Creswell & Creswell, 2017). Unstructured questions were open-ended and present the respondent with the opportunity to provide their own answers. Matrix questions were also utilized. This type of questions presents the respondent with a range of questions against which they are expected to respond based on a predetermined rating scale. The most commonly used was the Likert scale. These types of scales are used to measure perceptions, attitudes, values and behavior (Wang, 2015). These types of questions are popular with the respondents and researchers as they are easy to fill in, economical and provide easy comparability. The Likert type of questions enabled the respondents to answer the survey easily and for ease in data interpretation. The survey questionnaire was appropriate since it allows data from the sampled groups to be collected in a quick and efficient manner.

3.5.1 Pilot Testing

The questionnaire designed by the researcher based on the research questions were pilot tested to refine the questions before it can be administered to the selected sample. A pilot test

was conducted to detect weakness in design and instrumentation and to provide proxy data for selection of a probability sample. Creswell and Creswell (2017) asserted that, the accuracy of data to be collected largely depended on the data collection instruments in terms of validity and reliability. This comprised 10% of the sample size. A construct composite reliability co-efficient (Cronbach alpha) of 0.7 or above, for all the constructs, is considered to be adequate for this study (Rousson, Gasser &Seifer, 2012).

3.5.2 Validity of Research Instruments

To ascertain the validity of questionnaire, a pilot test was carried out (Somekh& Cathy, 2015). The content validity of the research instrument was evaluated through the actual administration of the pilot group. The study used both face and content validity to ascertain the validity of the questionnaires. Face validity is actually validity at face value. As a check on face validity, test/survey items are sent to the pilot group to obtain suggestions for modification (Creswell & Creswell, 2017). Content validity draws an inference from test scores to a large domain of items similar to those on the test.

3.5.3 Reliability of Research Instruments

Reliability of the questionnaire was evaluated through administration of the said instrument to the pilot group. The acceptable reliability coefficient is 0.7 and above (Song *et al*., 2014). The questionnaire was administered to a pilot group of 15randomly selected respondents from the target population and their responses used to check the reliability of the tool. This comprised 10% of the sample size. A construct composite reliability co-efficient (Cronbach alpha) of 0.7 or above, for all the constructs, is considered to be adequate for this study (Rousson, Gasser &Seifer, 2012). Reliability coefficient of the research instrument was assessed using Cronbachôs alpha (Ŭ) which is computed as follows:

$$J = k/k\text{-}1 \times [1 - \times (S^2)/\times S^2 sum]$$

Where: Ŭ= Cronbachôs alpha

k = Number of responses

$\times (S^2)$ = Variance of individual items summed up

$\times S^2 sum$ = Variance of summed up scores

3.6 Data Collection Procedures

The research data was collected using semi-structured questionnaires. In order to ensure uniformity in response and to encourage participation, the questionnaires were kept short and structured with mostly multiple-choice selections in a Likert scale. The questionnaires were

preferred in this study because respondents of the study are literate and quite able to answer questions asked adequately. According to Creswell and Creswell (2017), questionnaires are commonly used to obtain important information about a population under study. The researcher obtained an introductory letter from the University to collect data. The researcher personally administered the questionnaires to the respondents, allow the respondents to fill them and then collect them later: the drop and pick later method.

3.7 Data Analysis Techniques

The completed questionnaires were edited for completeness and consistency. The data was then analyzed using descriptive statistics and inferential statistics. The descriptive statistical tool (SPSS V.25.0) helped the researcher in the analysis of the data. This generated quantitative reports through tabulations, percentages, and measure of central tendency. The findings were presented using tables and graphs for further analysis and to facilitate comparison. A multiple regression model was applied to determine the relative importance of each of the independent variables with respect to the use of interlocking red brick construction technology. The linear regression analysis is chosen as the approach to analyze the data. The regression model was as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where:-

Y= Use of New Construction Technology

$ɓ_0$=constant

$ɓ_1$, $ɓ_2$, $ɓ_3$, $ɓ_4$and$ɓ_5$= regression coefficients

X_1= Availability of technology

X_2= Construction cost

X_3= Access to equipment by CBOs and individuals

X_4= Perception of the quality of building blocks

X_5= Training

ủ=Error Term

3.8 Ethical Considerations

In order to conduct the study, the researcher observed the following standards of behaviour in relation to the rights of those who become subject of the study or are affected by it: First, in dealing with the participants, they were informed of the objective of the study and the confidentiality of obtained information, through a letter to enable them give informed

consent. Once consent was granted, the participants maintained their right, which entailed but was not limited to withdraw or decline to take part in some aspect of the research including rights not to answer any question or set of questions and/or not to provide any data requested; and possibly to withdraw data they have provided. Caution was observed to ensure that no participant is coerced into taking part in the study and, the researcher seeks to use minimum time and resources in acquiring the information required. Secondly, the study adopted quantitative research methods for reliability, objectivity and independence of the researcher.While conducting the study, the researcher ensured that research ethics are observed. Participation in the study was voluntary. Privacy and confidentiality was also observed. The objectives of the study were explained to the respondents with an assurance that the data provided was used for academic purpose only.

3.9 Operationalization of Variables

The operationalization of variables is shown in Table 3.3.

Table 3.3: Operationalization of variables

Objectives	Type of Variable	Indicator	Measuring of Indicators	Tools of analysis	Type of analysis
To determine the effect of availability of technology on use of interlocking red brick technology in Isiolo County.	Independent	Availability of technology	Advancement of red bricks compressor Sophistication of the technology Technology perception Instructional level Number of machines in the area	Percentages Mean score	Descriptive statistics Regression analysis
To establish the effect of construction cost on use of interlocking red brick technology in in Isiolo County.	Independent	Construction cost	Types of materials Reusability of materials Labour cost Cost of installing Cost of transport	Percentages Mean score	Descriptive statistics Regression analysis
To assess the effect of access to	Independent	Access to equipment by CBOs and	Availability of tools Level of	Percentages Mean score	Descriptive statistics Regression

equipment by CBOs and individuals on use of interlocking red brick technology in Isiolo County.		individuals	expertise Funds availability Awareness		analysis
To evaluate the effect of perception of the quality of building blocks on use of interlocking red brick technology in Isiolo County.	Independent	perception of the quality	Durability concerns Social cultural practices Previous Experience Taste and preference Environmental condition resistance Maintenance Concern	Percentages Mean score	Descriptive statistics Regression analysis
To examine the effect of training on use of interlocking red brick technology in Isiolo County.	Independent	Training	Demonstrations Seminars Brochures Posters and signs Workshops	Percentages Mean score	Descriptive statistics Regression analysis
	Dependent	Use of interlocking red brick technology implementation	Efficiency and effectiveness Number of housing projects using new technology Community satisfaction level Areas and regions with such projects	Mean score	Descriptive statistics Regression analysis

CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter focuses on the data analysis, interpretation and presentation of the findings. The main purpose of the study was to establish the factors affecting the use of interlocked red brick technology in housing project in Isiolo County. The researcher used descriptive and inferential statistics to analyze the data and the findings were presented in tables.

4.2 Response Rate

The researcher administered 156 questionnaires to the county representatives, contractors and project management committee members as shown in Table 4.1.

Table 4. 1: Response Rate Analysis

Managerial Level	Administered	Returned	Response Rate
County representatives	8	4	50.0
Contractors	42	26	61.9
Project Management Committee members	106	84	79.2
Total	**156**	**114**	**73.1**

From the results, out of the 156 administered questionnaires, only 114 were returned back. This gave a response rate of 73.1%. This implies that the response rate obtained was good and enabled generalization of the findings as it is in line with Sproul (2011) who holds that a response rate above 50% is good.

4.3 Reliability Analysis

Reliability of the questionnaire was evaluated through administration of the said instrument to the pilot group. The acceptable reliability coefficient is 0.7 and above (Song et al., 2014). A construct composite reliability co-efficient (Cronbach alpha) of 0.7 or above, for all the constructs, is considered to be adequate for this study. The results were as shown in Table 4.2.

Table 4. 2: Reliability Analysis

	Cronbach's alpha	Decision
Availability of construction technology	0.711	Reliable
Construction cost	0.778	Reliable
Access to construction equipment	0.701	Reliable
Quality of building blocks	0.833	Reliable
Training	0.767	Reliable

From the results, quality of building blocks was more reliable with an Alpha value of 0.833, followed by construction cost with an Alpha value of 0.778 then training with an Alpha value of 0.767, then availability of construction technology an Alpha value of 0.711 while access to construction equipment with an Alpha value of 0.701 had the least reliability. This, therefore, depicts that the research instrument was reliable and no amendments were required.

4.4 Demographic Information

The study sought to enquire on the respondentsô general information so as to ascertain the eligibility of the respondents to participate in this study. It was also used to assess how reliable the data collected from the respondents would be. The respondentsô demographic information sought in this study included gender, how long they have been working with interlocking red bricks technology, their highest level of education and their age bracket. This information was presented in sections 4.4.1, 4.4.2, 4.4.3, 4.4.4.

4.4.1 Gender of the Respondents

The researcher sought to establish gender distributions of the respondents to assess the gender biasness in data collection. The findings were indicated in Table 4.3.

Table 4. 3: **Gender of the Respondents**

	Frequency	Percent
Male	87	76.3
Female	27	23.7
Total	114	100.0

From the results above in Table 4.3, majority of the respondents were male as shown by 76.3% while the rest were female as illustrated by 23.7%. This implies that the study was unbiased based on gender since it considered both male and female. Also, itôs clear that there were more males as compared to females since the housing projects are dominated by men as a result of the nature of the job.

4.4.2 Highest Level of Education

The respondents were also asked to indicate their highest level of education. Their responses were as shown in Table 4.4

Table 4. 4: Highest Level of Education

	Frequency	Percent
Diploma	18	15.7
Degree	81	71.1
Masters	15	13.2
Total	**114**	**100**

From the findings, 71.1% of the respondents indicated that their highest level of education was degree, 15.7% of the respondents indicated that their highest level of education was diploma and 13.2% of the respondents indicated that their highest level of education was masters. This implies that majority of the respondents had met the minimum education requirements for them to be either county representatives, contractors or a member of project management committee. Their level of education which saw most of them to be having a degree meant that they had knowledge about interlocked red bricks and hence they were to comprehend the subject under study and give correct information.

4.4.3 Respondents' Period Working with Interlocking Red Bricks Technology

The respondents were again requested to indicate how long they have been working with interlocking red bricks technology. Their responses were as shown in Table 4.5

Table 4. 5: Period Working with Interlocking Red Bricks Technology

	Frequency	Percent
Less than 3 years	24	21.1
3 to 9 years	29	25.4
9 to 12 years	50	43.9
Above 12 years	11	9.6
Total	**114**	**100**

As per the above results, majority of respondents indicated that they have been working with interlocking red bricks technology for a period of 9 to 12 years as shown by 43.9%. Further the respondents indicated that they have been working with interlocking red bricks technology for a period of 3 to 9 years as shown by 25.4%, for a period of less than 3 years as shown by 21.1% and for a period of more than12 years as shown by 9.6%. This shows that most of the respondents had been working with interlocking red bricks technology for 9 to 12 years. The respondents who have worked with interlocking red bricks technology for a long

period are in a better position to respond to queries and give reliable information based on the subject under study since their experience enhances their knowledge on the same.

4.4.4 Age Bracket of the Respondent

Further the respondents were required to indicate their age bracket. Their responses were as shown in Table 4.6

Table 4. 6: Age Bracket of the Respondent

	Frequency	Percent
20 ï 30 years	16	14.1
31 - 40 years	31	27.2
41 ï 50 years	47	41.2
51 ï 60 years	20	17.5
Total	**114**	**100**

The findings show that, 41.2% of the respondents were aged between 41 and 50 years, 27.2% of the respondents were aged between 31 and 40 years, 17.5% of the respondents were aged between 51 and 60 years whereas 14.1% of the respondents were aged 20 to 30 years. Therefore, this shows that the study covered approximately all the required age bracket hence the information obtained was from a wide scope hence making it accurate and reliable. The more aged the respondents the more they have been involved in housing projects either directly or indirectly hence making the information they provide to be relied upon.

4.5 Factors Affecting the Use of interlocking red bricks Construction Technology in Housing Project

This section presents the findings for availability of construction technology, construction cost, access to construction equipment, quality of building blocks and training.

4.5.1 Availability of Construction Technology

The respondents were asked to indicate the extent to which availability of technology affect the use of interlocking red bricks technology in Isiolo County. Their collective responses were presented in Table 4.7.

Table 4. 7: Extent of Availability of Construction Technology Effect

	Frequency	Percent
Low extent	7	6.1
Moderate extent	28	24.6
Great extent	43	37.7
Very great extent	36	31.6
Total	**114**	**100**

From the findings, the respondents indicated that availability of construction technology affect the use of interlocking red bricks technology in Isiolo County in a great extent (37.7%), in a very great extent (31.6%), in a moderate extent (24.6%) and in a low extent (6.1%). This shows that availability of construction technology affects the use of interlocking red bricks technology in Isiolo County greatly.

Moreover, the researcher asked to tell the extent to which various attributes of availability of construction technology affect the use of interlocking red bricks technology in Isiolo County. Their replies were shown in Table 4.8.

Table 4. 8: Extent of Availability of Construction Technology Aspects Effect

	Mean	Std. Dev.
Advancement of red bricks compressor	4.290	0.859
Sophistication of the technology	3.833	0.786
Technology perception	3.474	0.568
Instructional level	2.544	0.582
Number of machines in the area	4.412	0.750

From the findings, the respondents indicated that number of machines in the area as expressed by a mean of 4.412 and advancement of red bricks compressor as expressed by a mean of 4.290 have a great effect on the use of interlocking red bricks technology in Isiolo County. Moreover, the respondents indicated that sophistication of the technology as expressed by a mean of 3.833 also affects the use of interlocking red bricks technology in Isiolo County greatly. Nevertheless, the respondents indicated that technology perception as expressed by a mean of 3.474 and instructional level as expressed by a mean of 2.544 have a moderate effect on the use of interlocking red bricks technology in Isiolo County.

4.5.2 Construction Cost

The respondents were requested to indicate the extent to which construction cost affect the use of interlocking red bricks technology in Isiolo County. Their collective responses were presented in Table 4.9.

Table 4. 9: Extent of Construction Cost Effect

	Frequency	Percent
Low extent	19	16.7
Moderate extent	47	41.2
Great extent	27	23.7
Very great extent	21	18.4
Total	**114**	**100**

From the results, the respondents revealed that construction cost affect the use of interlocking red bricks technology in Isiolo County moderately as shown by 41.2%, greatly as shown by 23.7%, very greatly as shown by 18.4% and lowly as shown by 16.7%. This shows that construction cost affects the use of interlocking red bricks technology in Isiolo County moderately.

The respondents were also asked to indicate the extent to which various attributes of Construction cost affect the use of interlocking red bricks technology in Isiolo County. Their answers were presented in Table 4.10.

Table 4. 10: Extent of Effect of Construction cost Aspects

	Mean	Std. Dev.
Types of materials	4.053	0.850
Reusability of materials	3.956	0.876
Labor cost	2.553	0.581
Cost of installing	4.105	0.802
Cost of transport	3.798	0.854

The respondents indicated that cost of installing as illustrated by a mean score of 4.105 and types of materials as illustrated by a mean score of 4.053 greatly affect the use of interlocking red bricks technology in Isiolo County, reusability of materials as illustrated by a mean score of 3.956. Further the respondents indicated that cost of transport as illustrated by a mean score of 3.798 has a great effect on the use of interlocking red bricks technology in Isiolo County while labor cost as illustrated by a mean score of 2.553 lowly affects the use of interlocking red bricks technology in Isiolo County.

4.5.3 Access to Equipment by CBOs and Individuals

The respondents were requested to indicate the extent to which access to equipment by CBOs and individuals affect the use of interlocking red bricks technology in Isiolo County. Their answers were presented in Table 4.11.

Table 4. 11: Extent of Access to Equipment by CBOs and Individuals Effect

	Frequency	**Percent**
Low extent	11	9.6
Moderate extent	42	36.8
Great extent	45	39.5
Very great extent	16	14.1
Total	**114**	**100**

The respondents indicated that access to equipment by CBOs and individuals greatly affect the use of interlocking red bricks technology in Isiolo County as shown by 39.5% and

moderately as shown by 36.8%. The respondents further indicated that access to equipment by CBOs and individuals affect the use of interlocking red bricks technology in Isiolo County very greatly as shown by 14.1% and lowly as shown by 9.6%. This reveals that Access to equipment by CBOs and individuals greatly affect the use of interlocking red bricks technology in Isiolo County.

Further the respondents were asked to indicate the extent to which various aspects of access to equipment by CBOs and individuals affect the use of interlocking red bricks technology in Isiolo County. Their indications were presented in Table 4.12.

Table 4. 12: Extent of Aspects of Access to Equipment by CBOs and individuals Effects

	Mean	Std. Dev.
Availability of tools	4.097	0.862
Level of expertise	3.684	0.845
Funds availability	2.491	0.584
Awareness	4.026	0.867

As per the findings, the respondents indicated that availability of tools as shown by an average of 4.097, awareness as shown by an average of 4.026 and level of expertise as shown by an average of 3.684 affect the use of interlocking red bricks technology in Isiolo County greatly. Moreover, the respondents indicated that funds availability as shown by an average of 2.491 affect the use of interlocking red bricks technology in Isiolo County lowly.

4.5.4 Perception of the Quality of Building Blocks

The respondents were requested to indicate the extent to which perception of the quality of building blocks affects the use of interlocking red bricks technology in Isiolo County. Their reactions were presented in Table 4.13.

Table 4. 13: Extent of Perception of the Quality of Building Blocks Effect

	Frequency	Percent
Low extent	18	15.8
Moderate extent	21	18.4
Great extent	48	42.1
Very great extent	27	23.7
Total	**114**	**100**

From the findings, the respondents indicated that perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County in a great extent as shown by 42.1%, in a very great extent as shown by 23.7% and in moderate great extent as shown by 18.4%. The respondents further showed that perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County in a low extent as

shown by 15.8%. This shows that perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County in a great extent.

The researcher further asked the respondents to indicate the extent to which various aspects of perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County. Their responses were presented in Table 4.14.

Table 4. 14: Extent of Perception of the Quality of Building Blocks Aspects Effect

	Mean	Std. Dev.
Durability concerns	4.105	0.802
Social cultural practices	3.754	0.847
Previous Experience	2.412	0.545
Taste and preference	3.921	0.951
Environmental condition resistance	4.175	0.767
Maintenance Concern	2.807	0.608

The respondents revealed that environmental condition resistance as indicated by a mean of 4.175, durability concerns as indicated by a mean of 4.105 and taste and preference as indicated by a mean of 3.921 affects the use of interlocking red bricks technology in Isiolo County greatly.

The respondents indicated that social cultural practices as indicated by a mean of 3.754 affects the use of interlocking red bricks technology in Isiolo County greatly while maintenance Concern as indicated by a mean of 2.807 affects the use of interlocking red bricks technology in Isiolo County moderately. However, the respondents indicated that previous Experience as indicated by a mean of 2.412 affects the use of interlocking red bricks technology in Isiolo County lowly.

4.5.5 Training

The respondents were asked to indicate the extent to which training affects the use of interlocking red bricks technology in Isiolo County. Their responses were presented in Table 4.15.

Table 4. 15: Extent of Training Effect

	Frequency	Percent
Low extent	12	10.5
Moderate extent	22	19.3
Great extent	56	49.1
Very great extent	24	21.1
Total	**114**	**100**

From the findings, the respondents indicated that training affect the use of interlocking red bricks technology in Isiolo County in a great extent as shown by 49.1%, in a very great extent as shown by 21.1% and in moderate great extent as shown by 19.3%. The respondents further showed that Training affect the use of interlocking red bricks technology in Isiolo County in a low extent as shown by 10.5%. This shows that training affect the use of interlocking red bricks technology in Isiolo County in a great extent.

The researcher further requested the respondents to indicate the extent to which various aspects of training affect the use of interlocking red bricks technology in Isiolo County. Their responses were presented in Table 4.16.

Table 4. 16: Extent of Training Aspects Effect

	Mean	Std. Dev.
Demonstrations	2.456	0.567
Seminars	3.623	0.601
Brochures	4.149	0.789
Posters and signs	3.895	0.866
Workshops	4.219	0.784

The respondents indicated workshops as illustrated by a mean of 4.219, brochures as illustrated by a mean of 4.149, posters and signs as illustrated by a mean of 3.895 and seminars as illustrated by a mean of 3.623 affects the use of interlocking red bricks technology in Isiolo County in a great extent. Moreover, the respondents indicated that demonstrations as illustrated by a mean of 2.456 lowly affect the use of interlocking red bricks technology in Isiolo County.

4.5.6 Use of New Construction Technology

The study also requested the respondents to indicate the trend of the various aspects of use of new construction technology for the last five years. Their responses are presented in Table 4.17.

Table 4. 17: Trend of Use of New Construction Technology Aspects

	Mean	Std. Dev.
Efficiency and effectiveness	4.2018	0.8433
Number of housing projects using ISSB technology	3.8509	0.82261
Community satisfaction level	3.2018	0.73086
Areas and regions with such projects	4.1579	0.81555

As per the findings, the respondents indicated that efficiency and effectiveness as shown by a mean of 4.2018, areas and regions with such projects as expressed by a mean of 4.1579 and number of housing projects using ISSB technology as illustrated by a mean of 3.8509 have

improved for the last five years while community satisfaction level as indicated by an average of 3.2018 had been constant for the last five years.

4.6 Inferential Statistics

The study conducted multicollinearity that arises when at least two highly correlated predictors are assessed simultaneously in a regression model. Further researcher conducted regression analysis was used to establish the relations between the independent and dependent variables while correlation was conducted to assess the degrees of association between the variables. The findings were as shown in the subsections that follow.

4.6.1 Test for Multicollinearity

Multicollinearity occurs when several independent variables correlate at high levels with one another, or when one independent variable is a near linear combination of other independent variables (Keith, 2006). The study utilized Collinearity Statistics to find out whether the independent variables are adequately correlated to show a substantial causal correlation. The results for multicollinearity test were presented in Table 4.18.

Table 4. 18: Collinearity Statistics

Model		Collinearity Statistics	
		Tolerance	VIF
1	Availability of construction technology	0.127	7.875
	Construction cost	0.166	6.008
	Access to equipment by CBOs and individuals	0.103	9.749
	Perception of the quality of building blocks	0.183	8.762
	Training	0.138	7.226

Based on the coefficients output, availability of construction technology had a VIF value of 7.875, construction cost had a VIF value of 6.008, access to equipment by CBOs and individuals had a VIF value of 9.749, Perception of the quality of building blockshad a VIF value of 8.762 and traininghad a VIF value of 7.226. The VIF values for all the variables were less than 10 implying that there were no Multicollinearity symptoms.

4.6.2 Multiple Regression Analysis

This was applied to determine the relative importance of availability of construction technology, construction cost, and access to equipment by CBOS and individuals, perception of the quality of building blocks and training with respect to the use of ISSB construction technology. The findings were presented in Table 4.19, 4.20 and 4.21.

Table 4. 19: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.827	0.684	0.669	2.288

The outcome of table 4.19 found that adjusted R-Square value (coefficient of determination) is 0.669, which indicates that the independent variables (availability of construction technology, construction cost, access to equipment by CBOS and individuals, perception of the quality of building blocks and training) explain 66.9% of the variation in the dependent variable (use of ISSB construction technology). This implies that there are other factors that affect the use of ISSB construction technology attributed to 33.1% unexplained.

Table 4. 20: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1268.88	5	253.776	46.745	.000
	Residual	586.33	108	5.429		
	Total	**1855.21**	**113**			

The results shown in Table 4.20revealed that p-value was 0.000 and F calculated was 58.972. Since the p-value was less than 0.05 and F-calculated was greater than F-critical (2.2984), then the overall model was statistically significant.

Model coefficients provide un-standardized and standardized coefficients to explain the direction of the regression model and to establish the level of significance of the study variables. The results are captured in Table 4.21.

Table 4. 21: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.951	0.217		4.382	.000
Availability of construction technology	0.882	0.352	0.913	2.506	.014
Construction cost	0.633	0.281	0.717	2.253	.026
Access to equipment by CBOs and individuals	0.799	0.196	0.834	4.077	.000
Perception of the quality of building blocks	0.713	0.233	0.738	3.060	.003
Training	0.576	0.204	0.659	2.824	.006

As per the SPSS generated table above, the equation ($\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 ++ \beta_5 X_5\ \varepsilon}$) becomes:

$$Y = 0.951 + 0.882\mathbf{X_1} + 0.633\mathbf{X_2} + 0.799\mathbf{X_3} + 0.713\mathbf{X_4} + 0.576\mathbf{X_5}$$

The findings showed that if all factors (Availability of construction technology, Construction cost, Access to equipment by CBOs and individuals, Perception of the quality of building blocks and training) were held constant at zero use of ISSB construction technology will be 0.951. The findings presented also show that taking all other independent variables at zero, a unit increase in the availability of construction technology would lead to a 0.882 increase in the scores of Use of ISSB Construction Technology. This variable was significant since the p-value 0.014 was less than 0.05.

The findings also show that a unit increase in the score of construction cost would lead to a 0.633 increase in the score of use of ISSB construction technology. This variable was significant since 0.025<0.05. Further, the findings show that a unit increases in the scores of access to equipment by CBOs and individuals would lead to a 0.799 significant increase in the score of use of ISSB construction technology since p-value (0.000) was less than 0.05.

The study also found that a unit increase in the score of perception of the quality of building blocks would significantly lead to a 0.713 increase in the score of use of ISSB construction technology since p-value (0.003) was less than 0.05. Moreover, the study revealed that a unit change in training would significantly change the use of ISSB construction technology by 0.576 since the p-value (0.006) was less than 0.05.

Overall, it was established that availability of construction technology had the greatest effect on the use of ISSB construction technology in Isiolo County, followed by access to equipment by CBOs and individuals then perception of the quality of building blocks then construction cost while training had the least effect to the use of ISSB construction technology in Isiolo County.

CHAPTER FIVE
SUMMARY, OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives that summary of the data findings, discussion of the data findings, conclusion drawn from the findings highlighted and recommendation made there-to. The conclusions and recommendations drawn are focused on addressing the objective of the study.

5.2 Summary of the Findings

Under this, the study focused on the key variables discussed in chapter four and gives a summary of those findings.

5.2.1 Availability of Construction Technology

The study sought to determine how availability of construction technology influence use of interlocking red bricks in housing projects Isiolo County. The study found that availability of construction technology affects the use of interlocking red bricks technology in Isiolo County greatly. It was also established that the number of machines in the area, advancement of red bricks compressor and sophistication of the technology have a great effect on the use of interlocking red bricks technology in Isiolo County. Moreover, the study found that technology perception and instructional level have a moderate effect on the use of interlocking red bricks technology in Isiolo County.

5.2.2 Construction Cost

The study sought to establish how construction cost influence use of interlocking red bricks in housing projects in Isiolo County and established that it affects the use of interlocking red bricks technology in Isiolo County moderately. The study also revealed that cost of installing, types of materials, reusability of materials and cost of transport have a great effect on the use of interlocking red bricks technology in Isiolo County while labor cost was revealed to lowly affects the use of interlocking red bricks technology in Isiolo County.

5.2.3 Access to Equipment by CBOs and Individuals

The study further sought to assess how access to construction equipment by individuals influence use of interlocking red bricks in housing projects in Isiolo County. It was clear that access to equipment by CBOs and individuals greatly affect the use of interlocking red bricks technology in Isiolo County. The study insinuated that availability of tools; awareness and level of expertise affect the use of interlocking red bricks technology in Isiolo County greatly. Moreover, the study indicated that funds availability affect the use of interlocking red bricks technology in Isiolo County lowly.

5.2.4 Perception of the Quality of Building Blocks

Moreover, the study sought to evaluate how quality of building blocks influence use of interlocking red bricks in housing projects Isiolo County. It was revealed that perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County in a great extent. Further the study found that environmental condition resistance, durability concerns and taste and preference affect the use of interlocking red bricks technology in Isiolo County greatly. Moreover, it was established that social cultural practices affect the use of interlocking red bricks technology in Isiolo County greatly while maintenance concern as affects the use of interlocking red bricks technology in Isiolo County moderately. However, the respondents indicated that previous experience affects the use of interlocking red bricks technology in Isiolo County lowly.

5.2.5 Training

Further, the study sought to examine how training influence use of interlocking red bricks in housing projects Isiolo County. The study established that training affect the use of interlocking red bricks technology in Isiolo County greatly. The study also revealed that workshops, brochures, posters and signs and seminars affect the use of interlocking red bricks technology in Isiolo County greatly. Moreover, the study revealed that demonstrations lowly affect the use of interlocking red bricks technology in Isiolo County.

5.3 Discussion of the Findings

Under this section the findings will be linked with the literature review to check the consistency or agreement of the findings with previous studies.

5.2.1 Availability of Construction Technology

The study found that availability of construction technology affects the use of interlocking red bricks technology in Isiolo County greatly. It was also established that the number of

machines in the area, advancement of red bricks compressor and sophistication of the technology have a great effect on the use of interlocking red bricks technology in Isiolo County. This is consistent with Obuke (2014) who revealed that new material application, recycling and reuse, sustainable production of products, Careful selection of eco-friendly sustainable building materials may be the fastest way for builders to start integrating sustainable design concepts in buildings.

Moreover, the study found that technology perception and instructional level have a moderate effect on the use of interlocking red bricks technology in Isiolo County. This concurs with Rodman (2009) who notes that materials are the essential components of buildings construction. Chemical, physical and mechanical properties of materials as well as an appropriate design are accountable of the building mechanical strength. The design of buildings should thus begin with the selection and use of eco-friendly materials with related or better features than traditional building materials.

5.2.2 Construction Cost

The study established that it affects the use of interlocking red bricks technology in Isiolo County moderately. The study also revealed that cost of installing, types of materials, reusability of materials and cost of transport have a great effect on the use of interlocking red bricks technology in Isiolo County. This is in line with HABRI (2003) that reveals that transport cost constitutes a major construction cost of materials in Mombasa County. This can be attributed to the long distance of procuring the conventional building materials as well as the bulkiness of the construction materials. ISSBs are usually produced at the point of use greatly reducing the transport cost of the building materials. It also avoids breakages while transporting the materials thus reducing wastages.

The study also found that labor cost was revealed to lowly affect the use of interlocking red bricks technology in Isiolo County. This is consistent with Norma (2003) who found that level of environment friendliness, given by the rating of the building, is not arrived at in a scientific manner by considering the options and their cost implications. Risk adverse owners, in spite of their desire to go green, are hindered by a lack of information on the various options and ability to decide which options to choose.

5.2.3 Access to Equipment by CBOs and Individuals

It was clear that access to equipment by CBOs and individuals greatly affect the use of interlocking red bricks technology in Isiolo County. The study insinuated that availability of

tools, awareness and level of expertise affect the use of interlocking red bricks technology in Isiolo County greatly. This conforms to Wainaina (2015) who agrees that substantial initiatives have been carried out by the research community globally, in order to discover alternative sustainable building materials and low technology techniques, which result in a more sustainable and affordable construction complying with the comfort standards required today.

Moreover, the study indicated that funds availability affects the use of interlocking red bricks technology in Isiolo County lowly. This correlate with Mukoma (2010) who noted that integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials. Green building materials are composed of renewable, rather than nonrenewable resources.

5.2.4 Perception of the Quality of Building Blocks

It was revealed that perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County in a great extent. Further the study found that environmental condition resistance, durability concerns and taste and preference affect the use of interlocking red bricks technology in Isiolo County greatly. This is similar with Gichana (2013) who argues that more effort is required to bring appropriate technology at par with conventional technology. Low cost building materials for housing have not been sufficiently institutionalized, unlike conventional technology whose dissemination has largely been affected through commercial organizations and the profit mechanism.

Moreover, it was established that social cultural practices affect the use of interlocking red bricks technology in Isiolo County greatly while maintenance concern as affects the use of interlocking red bricks technology in Isiolo County moderately. However, the respondents indicated that previous experience affects the use of interlocking red bricks technology in Isiolo County lowly. This conforms to UN-HABITAT (2009) that reports that development and dissemination of building materials and technologies (dubbed appropriate technology or alternative technology) world over is characterized by involvement of many organizations, including international, national and non-governmental organizations. The common aim has been the lowering of construction, especially in regard to housing so as to make it affordable to a majority of people who are predominantly in the low-income cadre.

5.2.5 Training

The study established that training affect the use of interlocking red bricks technology in Isiolo County greatly. The study also revealed that workshops, brochures, posters and signs and seminars affect the use of interlocking red bricks technology in Isiolo County greatly. This is in line with Ministry of Housing (2011) who argues that training programme is greatly boosted by the Government of Kenya through the Ministry of Housing which provides equipment, fuel and facilitates its officers to conduct ISSBs training, demonstration and technical assistance to community groups for free. On the other hand, the beneficiaries are expected to meet the cost of training materials such as soil, cement and water as well as provide labour

Moreover, the study revealed that demonstrations lowly affect the use of interlocking red bricks technology in Isiolo County. This concurs with Zami (2010) who notes that as the cost of energy and building materials rises, and as concern for the environment especially climate change grows, green architects and designers will likely be in increasing demand as companies, towns and cities and institutions of higher education look to renovate or construct new buildings that use less energy and water, are made of sturdy, eco-friendly materials and are able to handle the impacts of climate change.

5.4 Conclusion

The study concluded that in Isiolo County the use of interlocking red bricks in housing projects is positively and significantly affected by availability of construction technology. The use of interlocking red bricks technology in Isiolo County was revealed to be greatly affected by number of machines in the area, advancement of red bricks compressor as well as sophistication of the technology. Also, the technology perception and instructional level were established to moderately affect the use of interlocking red bricks technology.

Further the study concluded that cost of construction affects the use of interlocking red bricks in housing projects Isiolo County significantly. The cost of construction was in form of installation costs, material types and its reusability as well as transport costs which were established to have affected the interlocking red bricks technology use greatly. Labor cost however was revealed to lowly affect the use of interlocking red bricks technology in Isiolo County.

Moreover, the study concluded that in Isiolo County, the use of interlocking red bricks in housing projects was affected by access to construction equipment by individuals. Tools

availability, community awareness and level of expertise were revealed to have a great effect on the extent to which the interlocking red bricks technology is used in Isiolo County although the funds availability was revealed to lowly affect it.

The study also concluded that quality of building blocks greatly and significantly affects the use of interlocking red bricks in housing projects Isiolo County. In Isiolo County, the use of interlocking red bricks technology was found to be greatly affected by environmental condition resistance, durability concerns and taste and preference as well as social cultural practices. Also, it was clear affect the use of interlocking red bricks technology was moderately affected by maintenance concern while previous experience had a low influence on how the interlocking red bricks technology is used in Isiolo County.

The study further concluded that in Isiolo County, use of interlocking red bricks technology in Isiolo County greatly was greatly affected by workshops, brochures, posters and signs as well as seminars. Moreover, the study revealed that demonstrations lowly affect the use of interlocking red bricks technology in Isiolo County. Finally, the study concluded that availability of construction technology had the greatest effect on the use of new construction technology in Isiolo County, followed by access to equipment by CBOs and individuals then perception of the quality of building blocks then construction cost while training had the least effect to the use of new construction technology in Isiolo County.

5.5 Recommendations

The study recommends that the National Government in conjunction with the county government should ensure that the number of machines for supporting the use of interlocking red bricks technology is sufficient. This will ensure that all the county residents have an access to the machines hence promoting the interlocking red bricks technology in the county which in turn creates jobs for the jobless youths.

The study also recommends that there is a need to harmonize the construction cost so as to promote the interlocking red bricks technology. This can be done by subsidizing the cost of the transport, labor and the installation costs where the Government reviews from time to time the taxation levels on building materials so as to reduce the cost construction for housing arising from the building materials.

The study recommends that the county Government need to sensitize the residents to adopt use of the ISSBs in houses construction since they offer better internal climatic conditions

than other modern materials. Also use of ISSBs generates more direct and indirect employment opportunities within the local populace than would be in the case with other materials.

The study also recommends that training on ISSBs should be done since it forms an integral part of ensuring improved houses and imparting important skills, which the trained can use in income generating activities. It also disseminates the ISSBs technology to the public and to those who need better housing at reasonable costs and increases the production and utilization of these technologies and materials with a view to improve houses and provide a means of earning a living.

The study recommends that more efforts should be made to promote intensified training in requisite skills and construction technologies through Youth Polytechnics, Women and Youth Groups, Community-Based Organizations and Appropriate Technology Building Centers.

The study recommends that there should be allocation of funds to research institutions to facilitate research on building materials and technologies, and also consider imposing a research levy on the building construction industry. The Government should establish a National Research Coordination Secretariat within the ministry concerned with housing to coordinate and disseminate research findings.

The public, private and voluntary sectors should be encouraged to utilize the research materials in their housing and other development programs while large scale builders and constructors should be sensitized on this technology. All research actors should harness and document existing locally available building materials and technologies as well as disseminate this information to the users as appropriate.

5.6 Recommendation for Further Research

This study was limited to Isiolo County. Therefore, the same study needs to be replicated in other counties in Kenya to establish the factors influencing use of interlocking red bricks technology in housing projects.

Interlocking Stabilized Soil Blocks is being mostly trained on the youth more so young men and therefore more research needs to be done on gender training of these technologies and the incentives that can be given to encourage gender parity.

The effect of sea corrosion on roofing materials is evident in Isiolo County and for a holistic improvement of houses in the county; study on roofing materials that withstands the unique climatic condition needs to be carried out such as Micro Concrete Roofing (MCR) Tiles.

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APPENDICES

APPENDIX I: LETTER OF TRANSMITTAL

Reuben Omuko Ombiro

P.O BOX 215

ISIOLO

Dear Sir/ Madam,

RE: ACADEMIC RESEARCH PROJECT

I am a Master of Arts in Project Planning and Management student at University of Nairobi. I wish to conduct a research entitled factors affecting the use of ISSB construction technology in housing project. A case of interlocking red bricks technology in Isiolo County. A questionnaire has been designed and will be used to gather relevant information to address the research objective of the study. The purpose of writing to you is to kindly request you to grant me permission to collect information on this important subject from your organization.

Please note that the study will be conducted as an academic research and the information provided will be treated in strict confidence. Strict ethical principles will be observed to ensure confidentiality and the study outcomes and reports will not include reference to any individuals.

Your acceptance will be highly appreciated.

Yours faithfully,

Reuben Omuko Ombiro

L50/6711/2017

Appendix II: Research Questionnaire

This questionnaire is to collect data for purely academic purposes. The study seeks to investigate the *factors affecting the use of ISSB construction technology in housing projecta case of interlocking red bricks technology in Isiolo County.* All information will be treated with strict confidence. Do not put any name or identification on this questionnaire.

SECTION A: DEMOGRAPHIC INFORMATION

(Please tick (ã) appropriate answer)

1) Please indicate your gender: Female [ ] Male [ ]
2) For how long have you been working with interlocking red bricks technology?

   Less than 3 years [ ] 3 to 9 years [ ]

   9 to 12 years [ ] Above 12 years [ ]
3) State your highest level of education

   Certificate [ ] Diploma [ ] Degree [ ] Masters [ ] PhD [ ]

Others (Specify) ----------

4) Please Indicate your age bracket 20-30 yrs [ ] 31-40 yrs [ ]

   41-50 yrs [ ] 51 ï 60 [ ]

SECTION B: FACTORS AFFECTING THE USE OF ISSB CONSTRUCTION TECHNOLOGY IN HOUSING PROJECT

Availability of technology

5) To what extent does availability of technology affect the use of interlocking red bricks technology in Isiolo County?

   Not at all [ ] Low extent [ ]

   Moderate extent [ ] Great extent [ ]

   Very great extent [ ]

6) To what extent do the following affect the use of interlocking red bricks technology in Isiolo County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Advancement of red bricks compressor					
Sophistication of the technology					
Technology perception					
Instructional level					
Number of machines in the area					

7) In your view how do the above aspects of availability of technology affect the use of interlocking red bricks technology in Isiolo County?
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Construction cost

8) To what extent does construction cost affect the use of interlocking red bricks technology in Isiolo County?

Not at all [ ] Low extent [ ]

Moderate extent [ ] Great extent [ ]

Very great extent [ ]

9) To what extent do the following affect the use of interlocking red bricks technology in Isiolo County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Types of materials					
Reusability of materials					
Labor cost					
Cost of installing					
Cost of transport					

10) In what way does construction cost affect the use of interlocking red bricks technology in Isiolo County?

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Access to equipment by CBOs and individuals

To what extent does access to equipment by CBOs and individuals affect the use of interlocking red bricks technology in Isiolo County?

Not at all [ ] Low extent [ ]
Moderate extent [ ] Great extent [ ]Very great extent [ ]

11) To what extent do the following affect the use of interlocking red bricks technology in Isiolo County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Availability of tools					
Level of expertise					
Funds availability					
Awareness					

12) In what way does access to equipment by CBOs and individuals affect the use of interlocking red bricks technology in Isiolo County?

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Perception of the quality of building blocks

To what extent does perception of the quality of building blocks affectthe use of interlocking red bricks technology in Isiolo County?

Not at all [ ] Low extent [ ]
Moderate extent [ ] Great extent [ ]
Very great extent [ ]

13) To what extent do the following affect the use of interlocking red bricks technology in Isiolo County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Durability concerns					
Social cultural practices					
Previous Experience					
Taste and preference					
Environmental condition resistance					
Maintenance Concern					

14) In your view how does perception of the quality of building blocks affect the use of interlocking red bricks technology in Isiolo County?

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Training

15) To what extent does training affect the use of interlocking red bricks technology in Isiolo County?

Not at all [ ] Low extent [ ]

Moderate extent [ ] Great extent [ ]

Very great extent [ ]

16) To what extent do the following affect the use of interlocking red bricks technology in Isiolo County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Demonstrations					
Seminars					
Brochures					
Posters and signs					
Workshops					

17) In your view how does training affect the use of interlocking red bricks technology in Isiolo County?

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Use of New Construction Technology

18) What is the trend of the following aspects of use of new construction technology for the last 5 years? Where, 5 = greatly improved, 4= improved, 3= constant, 2= decreased, 1 = greatly decreased

	1	**2**	**3**	**4**	**5**
Efficiency and effectiveness					
Number of housing projects using new technology					
Community satisfaction level					
Areas and regions with such projects					

Thank you for participating