ADOPTION OF INTERLOCKING SOIL TECHNOLOGY IN DEVELOPMENT OF ADEQUATE AND SUSTAINABLE HOUSING PROJECTS IN NANDI COUNTY, KENYA

BY

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A THESIS SUBMITTED TO DEPARTMENT OF MANAGEMENT SCIENCE AND ENTREPRENEURSHIP, SCHOOL OF BUSINESS AND ECONOMICS, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE IN PROJECT PLANNING AND MANAGEMENT

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DECLARATION

Declaration by Candidate

This thesis is my original work and has not been presented for any research study in any other university or institution for academic credit.

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DEDICATION

This work is dedicated to my parents for laying a good foundation for life during my formative years. It is also dedicated to my husband for his support and encouragement and to our children for understanding and patience during my studies.

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ABSTRACT

Adequate and sustainable housing projects take into account the social, economic and environmental aspects of development to provide housing that has adequate privacy, space, infrastructure, affordability and accessibility. Adoption of appropriate technologies such as the interlocking soil technology requires resource mobilization, capacity development, legitimization, entrepreneurial experimentation and market formation. A combination of population explosion, rapid urbanization, widespread poverty and escalating costs of providing housing has rendered access to adequate and sustainable housing an elusive dream to the majority of Kenyans especially those on the low and lower middle income groups. One of the strategies the Kenyan government has adopted to address this challenge is the promotion of the interlocking stabilized soil block technology in housing projects. The programme was conceptualized, planned and implemented across the country. The uptake of the technology has however been slow. This study sought to evaluate the adoption of the interlocking soil technology and development of adequate and sustainable housing projects in Nandi County. The objectives of the study were to examine the level of knowledge of the process of production, to assess the level of community participation, to evaluate the benefits attributed to the technology and to analyse the challenges of costs and information dissemination faced in the implementation of the technology in Nandi County. The study was guided by the Innovation Diffusion and the Systems Theories. The study adopted a mixed research design. The target population was 81,672 households in three sub-counties. The sample for the study was 155 households based on Yamane's Formula. Simple random sampling technique was used to select the respondents using excel randomization formula. Primary data was collected using questionnaires, an interview schedule and observation. Data was analyzed descriptively using percentages, frequencies, the mean and standard deviation and inferentially using regression and correlation analysis. Respondents demonstrated an average knowledge of the processes of production and felt that community participation was not embraced at all stages of project development. The findings of the study also indicated low effectiveness and efficiency of information dissemination. Most of the respondents seemed to appreciate the benefits of the interlocking blocks but felt that the costs associated with use of the technology were not affordable. The interviewees were of the view that the level of knowledge of the processes and community participation was low and the intended users had not been able to fully understand the benefits of the technology. They also felt that the costs of the technology were high and information dissemination techniques were not effective. The correlation analysis using the Karl Pearson's coefficient of correlation indicated a positive and significant relation between the dependent and independent variables. The regression model yielded an R^2 of 0.849 indicating that the independent variables accounted for 84.9% of the variation in the dependent variable. The ANOVA results established an F-significance value of $p<0.005$ indicating that the regression model was statistically significant. The study concluded that there were low levels of knowledge of the processes, low community participation, a good appreciation of the benefits of the interlocking soil blocks, ineffective information dissemination and high costs. The study recommended that more effort should be put in promoting knowledge of the processes and community participation, publicizing the benefits of the technology and addressing the challenges of cost and information dissemination.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABMTS	Appropriate Building Materials and Technologies
CBOS	Community Based Organizations
HABRI	Housing and Building Research Institute
ISSBs	Interlocking Stabilized Soil Blocks
KNBS	Kenya National Bureau of Statistics
MDGs	Millennium Development Goals
MLHUD	Ministry of Land, Housing and Urban Development
NGOS	Non-Governmental organizations
ROM	Republic of Malawi
SPSS	Statistical Package for Social Sciences

OPERATIONAL DEFINITION OF KEY TERMS

Adequate Housing: Encompasses adequate privacy, space, security of tenure, services, facilities, infrastructure, affordability, habitability, accessibility, location and cultural adequacy.

Appropriate Building Technologies and Materials (ABM&Ts): Building processes, materials and tools which are cost-effective, safe, innovative, green/environmentally friendly as well as acceptable to the climate, socio-economic conditions, and natural resources of an area. In this study, ABM & T referred to Interlocking Stabilized Soil Blocks (ISSBs) for walling.

Conventional Building Technology: Technologies pertaining to convention or general agreement; established by general consent or accepted usage. A conventional method of construction is one that has been in use for a long time. The most common conventional materials of construction are stone, timber, sand, Bitumen, steel among others.

Dissemination: To disperse throughout or to spread awareness on interlocking stabilized soil blocks.

Interlocking Stabilized Soil Blocks (ISSBs): Construction blocks made of a mixture of soil and a stabilizing agent and are compressed by different types of manual or mechanized press machines.

Habitable room: any room within a dwelling unit used or intended to be used for the purposes of working, living or sleeping, other than kitchen or laundry room i.e. living room and bedroom.

Integration: adoption and widespread use of the interlocking stabilized soil blocks

Perception: a belief or opinion often held by many people on the interlocking stabilized soil blocks.

Project success: a project that meets the basic criteria of time, cost and scope and client satisfaction with the final product or service.

Stabilizing Agent: A substance (i.e. lime, cement, bitumen, gypsum, pozzolana, organic fibres etc.) that when added to a soil mix will increase its strength and durability.

Stabilization: The action of modifying the properties of soil by adding another material that improves its strength and durability for construction purposes.

Sustainable housing projects: Housing projects that take into account the social, economic and environmental aspects of development.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter articulates significant aspects that lay the foundation to the study namely; the background of the study, statement of the problem, objectives of the study, research hypothesis; significance of the study, justification of the study, scope of the study, assumptions and limitations of the study.

1.2 Background of the Study

Since early times man has made relentless efforts to obtain shelter for protection from harsh climatic conditions and wild animals. The struggle for shelter has increased progressively as the human race advances in numbers and cultural diversity.

Various strategies have been applied since independence in Kenya to address the shelter problem. These include slum clearance and mobilization of resources for housing development through aided self help and cooperative efforts advocated for by the Sessional paper No.5 of 1966/67 and Sessional Paper No. 3 of 2004. Other strategies include research on locally available building materials and construction techniques, housing for civil servants through home ownership schemes in urban areas as well as institutional and pool housing schemes in remote stations.

In the 1990s it became clear that the public sector was unable to meet the housing challenge through direct provision of housing. The solution had to be sought within an enabling approach where the government facilitates other actors, including the formal and informal private sector to invest in shelter. Improvement of housing for the Kenyan population continues to be a major concern to the government because shelter is a strategically important social and economic investment. Article 43 1(b) of the 2010 Constitution provides that every person has the right to accessible and adequate housing and to reasonable standards of sanitation.

This right is reinforced by Kenya's development blue print, the Kenya Vision 2030, under the housing and urbanization section of the social pillar which aims to provide the country's population with adequate and decent housing in a sustainable environment. According to the UN-Habitat Agenda, adequate housing means more than just a roof over one's head. It encompasses adequate privacy and space and housing conditions.

Housing conditions are an indicator of the degree to which people live in humane conditions therefore it is an important factor in evaluating the adequacy of housing. Materials used in the construction of the floor, roof and wall materials of a dwelling unit are also indicative of the extent to which they protect occupants from the elements and other environmental hazards. They have implications for provision of other services such as connections to water supply, electricity and waste disposal. The conditions also determine safety, health and well being of occupants since low provision of these essential services leads to a higher incidence of diseases, fewer opportunities for business services and lack of a favourable environment for learning (KNBS and SID, 2013).

Despite many efforts put in place since independence in 1963, the Kenyan housing sector is characterized by poor access to adequate housing. This is manifested by lack of affordable and decent rental housing options, low level of urban home ownership, extensive and inappropriate dwelling units including slums and squatter settlements and poor quality housing in rural areas (Republic of Kenya, 2004). Housing deficit derives from a number of causes which include low level of investment in the sector by the public and private sectors, out dated legal and regulatory framework, inaccessibility to affordable housing finance, high cost of construction inputs, poor governance, rapid urbanization, poor economic performance and poverty. Research on low cost building materials and construction techniques has also been limited.

According to the Housing Policy of 2004, urban housing needs are 150,000 units per year while estimated production is only 20,000-30,000 annually giving a shortfall of over 120,000 units. This shortfall has been met through proliferation of squatter and informal settlements and overcrowding. According to the Kenya Integrated Household and Budget Survey of 2006, 59 % of people in urban areas of Kenya are accommodated in one roomed houses as shown in Table 1.1.

Table 1.1 Percentage of persons accommodated and the number of rooms

	One room	**Two rooms**	**Three rooms**	**Four-five rooms**
Kenya	35.1	27.6	22.4	12.8
Rural	27.2	31.0	25.6	14.1
Urban	59.0	17.2	12.9	8.9

Source: Kenya National Bureau of Statistics (2006)

According to the Kenya National Housing Survey of 2012/2013, (KNBS, 2013) it is estimated that building materials account for approximately 40% of the construction costs. Between 2007 and 2009, costs of building materials had increased by as much as 40% resulting in increased cost of housing. This explains why only 39.5 % of the Kenyan population has used stone and brick/block while Nandi County has only 14.1 % as tabulated in Table 1.2

Table1.2 Percentage distribution of households by wall material

	Stone	Brick/ Block	Mud/ Wood	Mud/ Cement	Wood only	Corrugated iron sheets	Grass	Tin	Other
Kenya	22.4	17.1	34.8	6.2	9.8	6.5	1.1	0.3	1.9
Nandi	3.4	10.7	78.8	4.7	2.1	-	-	-	0.5

Source: Kenya National Bureau of Statistics 2012/2013

One of the strategies the government has currently adopted to address the housing situation is establishment of housing technology centres in each constituency which is a vision 2030 flagship project. This aims to increase access to affordable, adequate and quality housing by promoting location-specific building materials and low-cost housing. This is based on the fact that conventional building materials are produced in some large scale industries and end up being costly due to high costs of production and transport to construction sites for incorporation into the housing structure. On the other hand, Kenya is endowed with abundant natural resources that can meet the demand for basic building materials and reduce the costs associated with construction of houses (Republic of Kenya, 2004).

To mainstream this strategy, the government in 2006 introduced an Appropriate Building Materials and Technology (ABMT) project focusing on the interlocking stabilized soil blocks. It aimed at addressing high building material costs which account for approximately 40% of construction costs (KNBS, 2013) by facilitating provision of improved and affordable housing in both urban and rural areas. Appropriate building materials and technology centres were established in constituencies, equipment procured, and training has been on going to transfer skills and empower community groups to construct affordable houses. This study sought to evaluate adoption of the interlocking soil technology and development of sustainable housing projects in Nandi County.

1.3 Statement of the Problem

Sustainable housing has the potential to produce good quality housing at a price that is affordable both in the short term and long term. It aims at economic, social and environmental sustainability from planning to implementation phases and at the same time result in housing that is affordable, accessible and environmentally less damaging. A sustainable house is cost efficient in its life cycle, comfortable, cheap to maintain and comply with physical and bio-cultural aspects of the environment.

Adequate housing encompasses the elements of security of tenure and availability of services, materials facilities and infrastructure. It also takes into consideration the factors of affordability, habitability, accessibility, location and cultural adequacy. An adequate house in essence should guarantee adequate basic infrastructure such as water supply, sanitation and waste management facilities, protection from the cold, damp, heat, rain, wind and other threats to health and structural hazards. It should also be in an adequate and accessible location with respect to work and basic facilities, all of which should be available at an affordable cost.

The unprecedented proliferation of slums and other informal settlements is the physical manifestation in cities of a chronic lack of adequate and sustainable housing. A combination of population explosion, rapid urbanization, widespread poverty and escalating costs of providing housing has rendered access to decent housing an elusive dream to the majority of Kenyans especially those in the low and lower middle income groups.

The housing problem in low income areas is mainly that of acute shortage in the number of affordable, decent and habitable dwellings, inadequate infrastructure, overcrowding and extensive slums and squatter settlements. Slums are blighted by a lack of durable housing, insufficient living space, lack of clean water and inadequate sanitation. In rural areas, the main housing problem is the poor quality of the shelter fabric.

Annual production of housing for the low and lower middle income groups is 17% against a demand of 83% while informal settlements house approximately 60% of the urban population. In the year 2015/2016, 56% of Kenyan urban households lived in one-roomed dwelling units with a national average of 40%. Nationally, 64% of Kenyans live in mud, wood, corrugated iron sheet, grass or tin walled houses. The situation is slightly worse in Nandi County with 69% of the households living in houses with earth floors and 78% in mud/wood or mud/cement walls in the year 2013.

One of the strategies adopted by the government to improve the housing situation, as an enabler in the development process, was to popularize the use of appropriate building materials that are locally available and low cost building technologies with a bias in interlocking stabilized soil blocks (Republic of Kenya, 2004). This was done through procurement of machines and establishment of housing technology centres in each constituency (Government of Kenya, 2007). This study evaluated the adoption of interlocking soil technology in development of sustainable housing projects in Nandi County.

1.4 Purpose of the Study

The purpose of this study was to evaluate the adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

1.5 Objectives of the Study

The specific objectives of this study were to:-

i. Examine influence of the level of knowledge of the process of production of ISSB on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.
ii. Assess extent to which participation and perception by the community influences adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.
iii. Evaluate effect of the benefits of ISSB on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.
iv. Analyse influence of the challenges associated with ISSB on adoption o interlocking soil technology for development of adequate and sustainable housing projects in Nandi County.

1.6 Research Hypotheses

i. H_1: Knowledge of the processes of production of ISSB has a significant influence on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.
ii. H_1: Participation and perception of the community has a significant influence on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

iii. H_1: Benefits derived from ISSB have a significant influence on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

iv. H_1: Challenges associated with ISSB have a significant influence on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

1.7 Significance of the Study

It is anticipated that the study will inform policy decisions on adoption of the interlocking soil blocks technology under the Appropriate Building Materials and technology (ABMT) programme as provided by the Kenya Vision 2030. This is through interrogating issues that may have hindered successful adoption of the interlocking soil technology

1.8 Justification of the Study

The constitution of Kenya 2010 and the Kenya Vision 2030 seek to provide the country's population with adequate and decent housing in an adequate and sustainable environment. Improvement in housing stock is a strategically important social and economic investment. This is because housing conditions are an indicator of the degree to which people live in humane conditions. Materials used in the construction of the floor, roof and walls of a dwelling unit are also indicative of the extent to which occupants are protected from weather elements and other environmental hazards.

Housing conditions have implications for provision of other services such as connections to water supply, electricity and waste disposal and also determine safety, health and well being of occupants.

Adoption of the interlocking stabilized soil technology as a strategy in addressing the prevailing housing situation has been slow. It is important to establish factors hindering the uptake of the interlocking soil technology so that steps can be taken to address these factors and ensure that more Kenyans are able to enjoy adequate housing and the accompanying social and economic benefits.

1.9 Scope of the Study

The study took place in Nandi County and specifically three sub-counties of Emgwen, Chesumei and Aldai where the government has put up appropriate building materials and technology centres.

1.10 Basic Assumptions of the Study

The study was guided by the following assumptions:-

i. That respondents would cooperate and questionnaires issued were to be filled in and submitted back on time
ii. That the respondents gave correct and valid information
iii. That the sample picked represented the entire population

1.11 Limitations of the Study

This study was limited by the choice of objectives and scope. The study focused on only four of the possible factors influencing adoption of the interlocking technology in development of adequate and sustainable housing projects in Nandi County. These four factors formed the objectives of this study. Another limitation of this study was the scope since it concentrated on only three out of six sub-counties in Nandi County.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature on project evaluation and project success, sustainable development and housing sustainability, appropriate technology, adoption of appropriate technology, theories and empirical research.

2.2 Key Concepts

This section discusses the key concepts as used in this study namely adequate and sustainable housing and adoption of interlocking soil technology.

2.2.1 Project Evaluation and project success

PMI (2013) defines a project as a temporary endeavour undertaken to create a unique product, service or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project's objectives have been achieved, will not or cannot be achieved or when the need for the project no longer exists. The Oxford Learner's Dictionary defines evaluation as the act of forming an opinion of the amount, value or quality of something after thinking about it carefully. Gawler, (2005), states that evaluation attempts to determine as systematically and objectively as possible the worth or significance of an intervention or policy.

Project evaluation is a systematic and objective assessment of an ongoing or completed project, program or policy, its design, implementation and results (European Commission, 2002). Evaluations are done to exercise control and enable learning and enlightenment for strategic, tactical, symbolic or constitutive reasons (Dahler-Larsen, 2012).

Evaluations are conducted with a view to enhance project impact and develop recommendations for guidance of similar projects in future. It also provides an analysis of accountability with respect to the use of project funds and to draw lessons learned from the implementation process. It is an important component of project cycle management that allows project performance and effects to be measured and to learn from experience, adjust interventions, share lessons learnt with others and inform policy (European Commission, 2002).

Project evaluation can be used ex-post in hindsight to document project work after a project is finished, interim to correct, adjust or align project work during a project or ex-ante in advance to prioritize between alternative projects before one or several projects can be started (European Commission, 2002).

The principles governing evaluation include impartiality and independence, credibility, usefulness and participation of stakeholders (Gawler, 2005). Evaluations are governed by five criteria (European Commission, 2002). These include relevance, efficiency, effectiveness, impact and sustainability.

According to Shenhar, A.J, Dvir D, and Levy, O. (1997), project success means different things to different people; therefore it is important to apply a multidimensional framework to assess project success. PMI (2013) states that project success is measured by product and project quality, timeliness, budget compliance and degree of customer satisfaction. This definition supports Baccarini (1999) assertion that project success criteria should examine both project management success and product success. The definition of project success should therefore broaden the iron triangle model to also include management of stakeholder satisfaction, benefit to organization that owns the project and long term impacts on project environment.

2.2.2 Sustainable Developments and Housing Sustainability

Sustainable development can be defined as development that meets the needs of today without compromising the need of future generations to meet their own needs (United Nations, 1987). To achieve sustainability, a balance needs to be struck between economic, environmental and social factors in equal harmony. Gawler, (2005) defines sustainability with respect to a project as a situation where a project continues to deliver benefits for an extended period after the main part of external support has been completed or after the end of project period. Sustainability factors are a key to good project design and need to be taken into account in order to ensure both the feasibility and long term success of the project.

Sustainable housing has the potential to produce good quality housing at a price that is affordable both in the short and long term. It aims at economic, social and environmental sustainability from planning to implementation phases and at the same time result in housing that is affordable, accessible and environmentally less damaging. Pakir and Tabassi (2012) define a sustainable house as that which is cost-efficient in its lifecycle, comfortable, cheap to maintain and comply with physical and bio-cultural aspects of the environment.

2.2.3 Appropriate Technology

Appropriate technology advocates use of creative and sound engineering and technical solutions that focuses on the social, environmental, political and economic aspects in solving the problems facing society. It is an approach to development that emphasizes job creation and optimum use of existing skills and resources; it also builds on the skills and resources to raise the productive capacity of a community (Bhalla, 1979).

Appropriate technology is designed with special consideration to the environment, ethical, cultural and economic aspects of the community it is intended for. Due to these considerations appropriate technology typically requires fewer resources, is easier to maintain, and has a lower overall cost and less of an impact on the environment compared to industrial practices. Appropriate technology fits small-scale, grassroots, community-centred economics: technology as if people mattered.

Morawetz (1974) defined appropriate technology as the set of techniques which makes optimum use of available resources in a given environment. Pellegrini (1979) suggested that technology should be considered appropriate when its introduction in a community creates self-reinforcing processes internal to the same community which supports growth of local activities and development of indigenous capabilities as decided by the community.

Betz, McGowan and Wigand, (1984) on the other hand equates appropriate technology with providing technical solutions that are appropriate to economic structures of those influenced and ability to finance the activity, to ability to operate and maintain the facility, to the environmental conditions involved and to the management capabilities of the population.

Appropriate technology has one or more of the following characteristics: low investment cost per workplace, low capital investment per unit of output, organizational simplicity, and high adaptability to a peculiar social and cultural environment, sparing use of natural resources, low cost of final product or high potential for employment, (Jequier and Blanc 1983). Appropriate technology is affordable, easy to maintain, compatible with existing infrastructure, efficient in the use of scarce natural resources and environmentally friendly.

Bhalla (1979), states that appropriate technology as defined by its proponents is tailored to serve the particular needs of a given region or community. This definition implies that an effort is made to secure the best alternative there is for the set of circumstances peculiar to that region or community. Appropriate technology should also not be viewed as a second-best solution and neither should its role be overstated. This is because appropriate technology is not a universal substitute for the conventional modern technology.

The building sector has undergone a radical change in the type of construction materials and methods used for urban dwellings over the past few decades in most countries. Alternative appropriate building materials are increasingly being employed to replace the conventional and traditional building materials.

The United Nations (UN) commission on Human Settlement report for instance emphasized the need to promote appropriate technology in the construction industry in developing countries as one of the ways of promoting sustainable construction (UNCHS, 1993). The strategies aim to employ simple building blocks manufacture technology which will not only reduce the building costs but also curb the environmental effects. Subsequently, policy and regulatory strategies have been made by decision makers in most countries based on the international proposals to promote sustainable development since the early 1990s.

In Malawi for example, policy and regulatory strategies are in place to promote the development of industries that are based on domestic raw materials and use of technology that is appropriate for the local environment. There are also strategies that encourage the use of cement blocks in order to decrease use of burnt bricks to curb deforestation (Government of Malawi, 2004).

The State Department for Housing in its website, defines appropriate building materials and technologies as the processes, materials, elements and tools that are compatible with the local socio-cultural, economic as well as physical and ecological environment of an area (Ministry of Land, Housing and Urban Development (MLHUD), 2015). Essentially appropriate building materials should be affordable, innovative, safe, environmentally friendly and with significant socio-economic multipliers.

Such technologies realize reduction in building costs invariably through use of innovativeness, appropriate designs, equipment, construction techniques, incremental construction, on-site local materials and use of semi-skilled or self-labour. Examples of appropriate building materials and technologies include stabilized soil blocks, interlocking concrete blocks, expanded polystyrene panels, precast concrete panels, compressed agricultural fibre; monolithic construction, pre-cast fabricated housing, and recycled plastic products.

2.2.4 Adoption of Appropriate Technology

Technology adoption may fail due to a number of reasons (Kemp, Schot and Hoogma, 1998). These include technological factors, demand, cultural or perceptions factors, skills and knowledge, production factors, infrastructure and maintenance factors, undesirable social and or environmental effects and policy and regulatory framework.

According to Kemp, Schot and Hoogma (1998), technological factors affect adoption of new technology where the technology does not work well, is unstable or lacks complementary technologies needed to make it effective. Demand on the other hand affects technology adoption in that people may not want the new technology for example where it is too expensive or there exist working alternatives.

Cultural issues or perception is another factor in that new technology may not fit with people's values and preferences for example lower income groups may think they are being foisted with second rate technologies. Production factors also influence technology adoption in that firms may not want to scale up production perhaps because they think customers do not want it or because it could compete with existing core products so the technology cannot benefit from economies of scale. The infrastructure for delivering the product and/ or spare parts may be inadequate or the maintenance network may not exist and this affects adoption of new technologies. Undesirable social and /or environmental effects also affect adoption of new technologies in that technologies intended to solve one problem may introduce new ones.

Croxton (2013) puts forward some key drivers of successful technology development and adoption. The first driver is resource mobilization. It is important to mobilize relevant human, financial and other resources including identifying people with relevant skills and offering training to enhance knowledge and skills on a new technology.

The second driver is capacity development and diffusion. It is essential to develop and expand the breadth and depth of stakeholder's knowledge in both technology and application sectors with an explicit focus on changing behaviour and perceptions. This is in line with Kemp, Schot and Hoogma (1998) proposition that skills and knowledge also affects technology adoption. This is because people may not know what the technology can offer or do not have the skills to use and/ or maintain it.

The third and fourth drivers are entrepreneurial experimentation and market formation respectively. According to Croxton (2013), this entails developing an institutional infrastructure that favours entrepreneurial activity, firm establishment and growth and developing market places, identifying customers and users and developing viable business models. The government in promoting interlocking stabilized soil blocks among other issues aims to create sustainable employment for the Kenyan people through the technology (MLHUD, 2015).

The fifth driver is legitimization and governance which aims to raise the social acceptance for technology, develop mechanisms for influencing such acceptance and ensure compliance with requirements of relevant institutions and policies. Kemp, Shot and Hoogma (1998) supports this view by stating that policy and regulatory framework may also affect adoption in that a new technology may not fit with existing regulations and policies. Policies may be a disincentive to invest in new technology.

Morton (2007) identified lack of recognized earth building regulation as an inhibitor to the adoption of the technology in the United Kingdom. A study in Uganda identified several barriers to earth building including need for new legislation, technical training, public awareness of sustainability and knowledge sharing (CRATerre, 2005). According to Zami and Lee (2007), people's mistaken perceptions and cultural problems and lack of knowledge, skills and understanding among professionals, government, donors and users are some of the inhibitors to adoption of contemporary earth construction.

Appropriate building materials and technologies for housing in Kenya have not been sufficiently institutionalized, unlike conventional technology whose dissemination has largely been effected 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 hence a constraint which is highly inhibitive to the process of dissemination and full embracing of the technology (Rono, 2004).

According to Rono (2004), provision of support structures and infrastructure for dissemination of appropriate building materials and technology for housing has been a responsibility of a number of actors in form of government agencies, non-governmental organizations, research and development institutes and community based organizations.

Political will and support from both central government and local authorities for dissemination of low cost building materials and technologies is essential in promoting adoption of the technology. The support may include enactment of enabling legislation to remove any planning and building regulations that may hinder the use of the alternative building materials and technologies. Adoption and effective dissemination of appropriate technology requires involvement and active participation of the target groups. Through the concept of self-help by way of production and use of appropriate technology, low income individuals and households have been important show-cases for the technology (Muturi, 1993).

2.3 Theories

This study used two theories to explain adoption of new technology and evaluation of projects. These are the Innovation Diffusion and the Systems Theories.

2.3.1 Innovation Diffusion Theory

The Innovation Diffusion Theory by Rogers (1995) provided a comprehensive structure for understanding individual adoption and diffusion. The strength of the Innovation Diffusion theory is in the broad foundation it provides to understand the factors that influences the choices that an individual makes about an innovation.

Rogers (1995) described the adoption process as being inseparable from the diffusion process. Diffusion is composed of individual adoptions. Diffusion describes the adoption process across a population over time.

The adoption decision process describes five stages that individuals go through during their evaluation of an innovation. These are awareness, persuasion, decision, implementation and confirmation. Stage one is when an individual becomes aware of an innovation. The awareness of an innovation is influenced by personal characteristics, socio-economic factors and access to change agents like the mass media.

Stage two is persuasion, when an individual gains enough knowledge about the innovation's salient characteristics to make a personal judgement the outcome of which is a favourable or unfavourable view of the innovation. Stage three, decision, is an outcome of an individual's choosing to adopt or reject an innovation. Stage four, implementation, is when an individual acts on his/her decision. Stage five is confirmation where an individual reflects on his or her decision and implementation process and re-evaluates whether to continue or discontinue with the innovation adoption.

There are four major components which interact to describe how individual adoptions combine to represent diffusion (Rogers, 1995). The first component is the innovation itself; that is the relative advantage, compatibility, complexity, trial-ability and observe-ability of an innovation. Other components are communication channels, social systems and time.

This theory has relevance to this study in that it sought to investigate how some of the components that influence diffusion such as communication channels, relative advantage, social systems and complexity influence adaption of interlocking technology in development of sustainable housing projects. The theory thus anchored the hypotheses relating to knowledge, community perception and participation, benefits, costs and information dissemination in development of adequate and sustainable housing projects.

2.3.2 Systems Theory

The Systems Theory's view of project evaluation is a representation of a project as an open system relating to and depending on its environment (Bertalanffy, 1956). An open system comprises of inputs, processes, outputs, outcome, feedback and the environment. Inputs are resources from the environment such as money, technology, facilities and personnel which are transformed into tangible or intangible outputs through project processes.

Outcome is the resulting impact on its stakeholders derived from the project's output. The environment is interacting with the project either fostering and or constraining the project processes and is influenced by factors such as social norms, organizational culture, and political structures. Feedback mechanisms indicate how responses from the project and the environment can be used to regulate input, processes, output and outcome (Bertalanffy, 1968).

This theory is construed to have relevance in this study given that one of the parameters for evaluating project success is stakeholder satisfaction with the project based on the outcomes. The theory has anchored hypothesis relating to the influence of community participation and the benefits derived from the interlocking technology on development of adequate and sustainable housing projects.

2.4 Empirical Literature Review

2.4.1. Knowledge of Production Processes

Project scope deals with extent of work required to create a unique product, service or result. According to Schwalbe (2010), scope refers to all the work involved in creating the products of the project and processes used to create them in order to meet an identified objective.

Olauluwa (2013) defines scope as the total aggregation of deliverables to be produced by the project. A deliverable in this context is identified as a quantifiable outcome of a project which results in partial or full achievement of cost budgeting and project objectives.

PMI (2013) gives scope two perspectives-project and product scope: Project scope is defined as the work that needs to be accomplished to deliver a product, service or result with the specified features and functions. Product scope on the other hand, is defined as the features or functions that characterize a product, service or result.

According to PMI (2013), a lack of knowledge or proper definition of project or product scope at the conceptualization stage contributes to unsuccessful projects. A properly defined and managed scope leads to delivery of quality projects in agreed cost and within specified schedules to the stakeholders (Vasista, 2017). Ward (1995) was of the view that the scope of a project must be understood by all participants or stakeholders who have to make decisions throughout the project.

Inadequate or poor scope definition negatively correlates to project performance (Agarwal and Rathod, 2006). If scope is not controlled, final project costs tend to be higher because of changes that interrupt project rhythm, cause rework, increase project time and lower the productivity as well as the morale of the field workers (Ward, 1995).

The scope of construction of a house using the ISSB entails designing, production of blocks and construction. Production of blocks involves identification of the soils, sieving, proportioning, mixing, moulding and curing. Production of quality blocks is the first step toward the successful construction of any housing project using ISSB hence knowledge of the scope of block production is paramount.

As Gooding and Thomas (1995) aptly put, production of the ISSB relies on a significant degree of knowledge coupled with a rigorous pre-production testing program. Several aspects should be taken into consideration before launching an operation to produce compressed stabilized soil building blocks. These include the amount and type of stabilizer required, soil properties and its suitability for stabilization , building standards , quality of blocks required and Load bearing requirements of construction to be put up (Adam, 1983).

The first step in production of stabilized soil blocks is identification of suitable soil which is a basic material required to manufacture blocks. According to UNHCR (2009), the manufacture of good quality compressed stabilized soil blocks requires the use of soil containing fine gravel and sand for the body of the block together with silt and clay to bind the sand particles together. An appropriate type of stabilizer must be added to decrease the linear expansion that takes place when water is added to the soil sample.

Planning the production of interlocking stabilized soil blocks starts with identification of the site and properties of the soil there (Adam, 1983). Soil samples from trial holes must always be taken to check adequacy of soil and to be able to estimate available amounts. Soil composition can vary greatly even within a small area so several test holes must be dug to give a full picture of the type of the soil within a burrow pit. Soil samples should then be tested to determine the composition, suitability and amount of stabilizer to be introduced into the mix (Gooding and Thomas, 1995). Testing methods include sedimentation test, shrinkage test and lab tests.

After testing, the soil is excavated in readiness for production. Murram soil is recommended for the making of cement-stabilized blocks. This type of soil is found at sub-levels; therefore one must first remove the top soil to reach it. Various types of excavating tools can be used in a quarry depending on the size of the proposed project. For large projects, heavy earth moving equipment can be used. For small scale projects, simple tools can be employed for digging and handling earth in preparation for stabilization (Adam, 1983).

The next step is the training of the labour force given that production of interlocking stabilized soil blocks is a process based activity (UNHCR, 2009). Training forms one of the most important factors to achieve quality blocks and structures and the steps leading to good soil blocks must be carefully performed to ensure quality (Gooding and Thomas, 1995). Training by Hydra Form South Africa, a company that produces equipment for production of the interlocking stabilized soil blocks; is often conducted over a period of 10-12 days and includes training on preparation, block making and building (Hydraform, 2011).

Training by Hydraform encompasses finding suitable materials, safety briefing, machine operation, test production, sieving, mixing, block production and curing, machine maintenance, block yard management, block testing and quality control, and building concepts (Hydraform, 2011). The trainings should be fully supported with permanent reference material to ensure there is standardization and consistency in training and in the process of production (Gooding and Thomas, 1995).

After soil has been excavated it has to be sieved to remove particles that are too large. The sieving process is important in order to achieve good compact and smooth finish (Adam and Agib, 2001). The simplest sieving device is a screen made from a wire mesh, nailed to a supporting wooden frame and inclined at approximately 45^0 to the ground. The material is thrown against the screen, fine material passes through and the coarse oversized material runs down the front. Alternatively the screen can be suspended horizontally from a tree or over a pit. The later method is only suitable in the case where most material can pass through easily otherwise too much coarse material is collected, and the screen becomes blocked and needs frequent emptying.

After sieving, the soil should be proportioned to ensure uniformity in the compressed stabilized soil blocks produced. The weight or volume of soil, stabilizer and water used in the block making process should be measured at the same physical state for subsequent batches of blocks. After establishing the exact proportion required for each material, it is advisable to build a measuring device. The dimensions for each measuring box should be such that their content when full is equivalent to the proportion which should be mixed with other materials measured in other gauge boxes. Water may be measured in a small tank or container (UNHCR, 2009).

Thorough mixing of all the materials is done after proportioning in order to produce good quality blocks (Sangori, 2012). Dry materials should be mixed first until they are a uniform colour, then water is added and mixing continued until a homogenous mix is obtained. Mixing can be performed by hand on a hard surface with spades, hoes or shovels or by using a concrete mixer. It is much better to add a little water at a time, sprinkled over the top of the mix from a watering can with a rose spray on the nozzle (Adam, 1983). The wet mix should be turned over many times with a spade or other suitable tool. A little more water may then be added and the whole mixture turned over again. The process should be repeated until all the water has been mixed in.

When lime is used as a stabilizer, it is advisable to allow the mix to stand for a short while before moulding starts to allow better moistening of soil particles with water. However, if cement is used for stabilization, it is advisable to use the mix as soon as possible because cement starts to hydrate immediately after it is wetted and delays will result in the production of poor quality blocks (Adam and Agib, 2001).

Before production, the soil mix must be checked for each batch of block so as to attain the optimum moisture content (Gooding and Thomas, 1995). One way to do this is to take a handful of soil mix and squeeze it in the hand to make a ball and then drop it onto a hard surface from a height of about one meter. If the sample breaks into four or five major lumps, it shows that the moisture content or the soil mix is close to the optimum moisture content (Adam, 1983).

When satisfied with the mix, production can start by introducing an optimum quantity into the machine mould. To manufacture blocks of uniform size and density, special precautions must be taken to fill the mould with the same amount of mix for each compaction by using a small wooden box as a measuring device. The mix is then compressed. The machine contains a stop which demarks full compression. When removing the block, check its texture and quality (Sangori, 2012)

After production the blocks have to be cured properly (Gooding and Thomas, 1995). To achieve maximum strength, compressed stabilized soil blocks need a period of damp curing where they are kept moist in order to achieve maximum strength (Mule, 2013) This is done by stacking blocks in layers of five and covering with grass or polythene paper in order to ensure the moisture of the soil mix is retained within the body of the block (UNHCR, 2009). If the blocks are left exposed to hot dry weather conditions, the surface material will lose its moisture and the clay particles tend to shrink causing surface cracks on the block faces. The curing period is approximately twenty eight days. The blocks should be fully cured and dry before being used for construction (Sangori, 2012).

In the study by Gooding and Thomas (1995), problems were observed with raw material testing, cement optimization, mixing, batching, mould filling, compaction and curing. The study found that these problems could be reduced if producers were more informed, better skilled, equipped with better production and testing equipment and more diligent in quality control.

As Ward (1995) states, projects do not achieve much success because of lack of a clear definition for project and product scope as well as improper control of them. It is important to clearly define the product scope in the production of ISSB in order to ensure success of the product and project. As David (2014) states, although relatively simple, the production must be carried out with great care to ensure sufficient quality. Appropriate mix proportions for the material components, thorough mixing, proper use of the block press and then curing under optimal conditions are all important in order to achieve strong, well-shaped and durable blocks.

This study sought to evaluate whether the product scope in terms of the process of block production has influenced the adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

2.4.2 Community Participation and Perception

This section explained how the concepts of community participation and community perception influence the successful implementation of projects.

2.4.2.1 Community Participation

Chamala (1995) defined participation as a social process whereby specific groups with shared needs living in a defined geographical area actively pursue identification of their needs, take decisions and establish mechanisms to meet these needs.

According to the World Bank (2004) participation in relation to development is a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them.

Paul (1987), further defined community participation in relation to projects as an active process whereby beneficiaries influence the direction and execution of development projects rather than merely receiving a share of project benefits.

Lane (1995) emphasized the meaningful participation of individuals and groups at all stages of the project development process including that of initiating action. According to Lane (1995), the only way to ensure that individuals have the power to attack the root causes of underdevelopment is to enable them to influence all decisions, at all levels that affect their lives. Community participation can take place during any of the following activities:-needs assessment, planning, mobilization, training, implementing and monitoring and evaluation.

Stakeholder analysis is a useful tool that can help to identify the key groups and individuals that can be actively involved in community participation initiatives. These may include community workers, committees or user groups (Oakley, 1995). A participation matrix could be drawn as a tool to identify how the different stakeholders may be involved at different stages of a programme.

The concept of community participation is viewed as a basis for project success. Stalker, (2004) is of the opinion that overall, community participation is fundamentally important to project success, especially as measured by consumer satisfaction and overall project effectiveness. Oakley (1995) asserts that community participation results to project success in terms of increased efficiency and effectiveness, and better targeting of projects to peoples' real needs.

In terms of project efficiency, White (1981) states that with participation more will be accomplished and services can be provided more cheaply. According to Chamala (1995) involving stakeholders in programmes at all levels, from local to national, provide a more effective path for solving sustainable resource management issues. Efficiency results when resources are used less wastefully by focusing only on those projects that people genuinely want and need. Thus participatory projects are seen as being more cost effective (Oakley, 1995, World Bank, 1994).

Participation enhances project effectiveness through community ownership of development efforts (Kelly and Van Vlaenderen, 1995). It also results in better targeting of project measures to peoples' real needs through their involvement in the planning phase (Nour, 2011). According to Ife (2009), community participation is of vital importance because it results to better decisions and people are more likely to implement decisions that they have made rather than those imposed on them. Motivation is also enhanced during setting up of goals in participatory decision making process. Participation also improves communication and cooperation.

Arnstein (1969) explained the different levels of community participation in what is termed the ladder of citizen participation as illustrated in figure 2.1. The ladder has eight rungs each corresponding to a different level of participation. The rungs at the bottom of the ladder are the ones with least citizen participation or non-participation, and include manipulation and therapy. Informing, consultation and placation occupy the middle rungs of the ladder and is termed as ‘tokenism’ where people are allowed to participate only to the extent of expressing their views but have no real say that matters. The last three rungs, partnership, delegated power and citizen control at the top of the ladder are termed as ‘citizen power’ and this is where true and meaningful participation takes place

Categorization of the various types of involvement by stakeholders is extremely crucial in clarifying the confusion between non-participation and true citizen power and to identify the real motives behind participatory projects which are often used by critics as shortcomings of the concept of community participation.

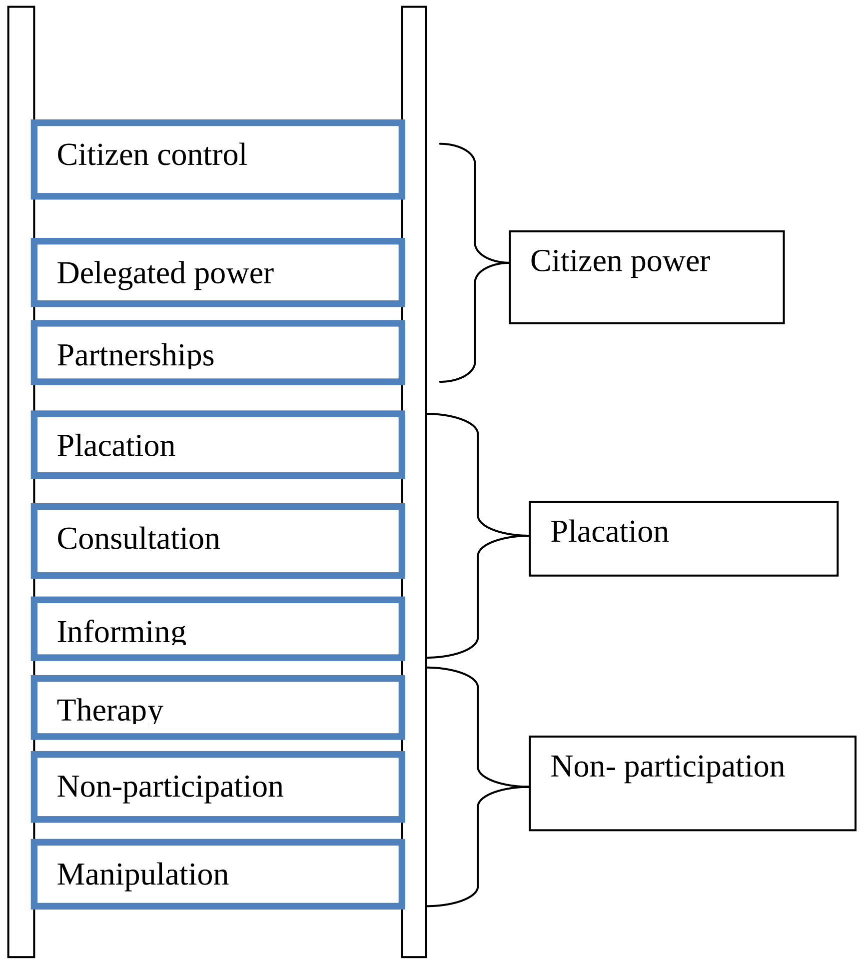

Figure 2.1 Eight rungs on the ladder of citizen participation
Source: .R Arnstein, 1969

UNHCR while promoting the interlocking stabilized soil block technology in Northern Uganda experienced various challenges relating to community participation (UNHCR 2009). These challenges included mobilizing communities to participate in the project and sensitizing the community on appropriate technologies. There was also difficulty in devising methods of increasing individual and or organizational ownership of projects. Another challenge was in coping with community scepticism regarding the new technology.

One of the lessons learnt was that using mostly local labour increases community pride and ownership of project and hence success of the project. Another lesson was that disseminating the technology through community leaders using the concept of circles of influence and providing ISSB training to local communities especially the youth helps in promoting the technology.

David (2014) while studying construction of low cost houses in informal settlements in Nairobi Region, states that for a housing project to be truly successful, the opinions and engagement of the beneficiaries are obviously of great importance. This collaboration should involve all project stages from planning through to construction. In addition to being a prerequisite for successful implementation, community involvement also brings extensive capacity building to its members such as organizing skills, long term planning abilities, experience of communication with local authorities and the knowledge of their own capability to improve their living situation. Community involvement is essential in order to create sustainability and bring self-help qualities that reduce the need for external support.

Disregarding or insufficiently embracing community involvement in the implementation process may to a large extent impair both progress and results of a housing project. Top-down management can be very discouraging for the beneficiaries as it indicates a sense of indifference towards their opinions. Top-down management may also lead up to improper decisions, lack of information and unfulfilled goals and consequently widespread discontent with the project (David, 2014).

2.4.2.2Community Perception

Cole (2005) defines perception as the process of organizing, interpreting and integrating external stimuli received through the senses. According to the author, what people think is happening is more important than what they see happening. This implies that people interpret events going around them and that interpretation informs their perception. Graham and Bennett (1998) opined that people perceive the world in terms of their least satisfied needs and that their perceptions tend to recognize goals that will satisfy their needs.

According to Goodley (1971) perception is defined as the process of awareness of objects or other data through the medium of senses. Perception is not only a process of seeing but also of hearing, smelling and tasting. The author further notes that perception relates to external stimuli, culture, beliefs, and languages, past experiences, attitude and length of residence in a given location.

Robbin (1996) defined perception as a process by which individuals organize and interpret their sensory impressions in order to give meaning to their environment. What one perceives may be different from objective reality and interpretation of what one sees is influenced by various factors. First perception is influenced by the situation; that is the time, work setting and social setting. Secondly the object or target influences perception in terms of shape, size shade, sound, movement and background. Thirdly, personal characteristics of the perceiver including attitude, motives, interests, experience and expectations influence perception. Two people looking at the same situation will most likely perceive it differently based on these factors.

The perception of stakeholders towards a project in terms of acceptance will greatly determine its success. Manley (1975) found that the degree to which clients are personally involved in the implementation process will cause great variation in their project support.

Soil has been and continues to be the most widely used building material throughout most developing countries because it is locally available and easily accessible. According to Minke (2009), the population living in soil houses is over 50%. Soil is cheap, available in abundance and simple to form into building elements. Houses built using soil provides adequate shelter against hot and cold weather conditions due to its high thermal capacity and insulating properties (Adam, 1983). Soil construction is energy efficient, environmentally friendly and safe; qualities that are particularly relevant and important with the ever growing need for increased awareness to reduce energy consumption worldwide.

Soil cement blocks have frequently been promoted as low-cost walling material. However this ignores the social status associated with permanent building; namely that the owners are prepared to spend ten years building a house rather than use ‘low cost’ materials because of the social stigma(Gooding and Thomas,1995).

Soil is increasingly categorized as a building material for low-cost housing and consequently mistaken as low-quality. For example, Hadjri, Osmani, Baiche and Chifunda (2007) conclude that Zambia still faces issues concerned with perceptions and attitudes towards earth building. In their study on attitudes towards earth building for Zambian housing provisions, their respondents would not consider living in earth houses due to widespread socio-cultural perception that modern building materials and techniques are substantially better than traditional ones (Hadjri, 2007).

Similar situations exist in other parts of Africa such as Nigeria. Experiments to improve the durability and affordability of earth building have been undertaken and earth building has been promoted as an alternative for low cost housing for the poor (Olotuah, 2002).

In Sudan, Adams and Agib (2001) found that there is low acceptability of earth buildings because it is considered by many to be a second class and generally inferior building material. An explanation for the prejudice against alternative materials is lack of public knowledge on their efficacy based on numerous research findings. There is need to elevate the profile of the technology through use of the technology in more ostentatious projects. Social attitudes also need to be addressed through publicity, public consultations and demonstration projects.

Soil is not classified as a permanent building material under current building regulations and is often not recognized by authorities as an acceptable, durable building material (Adam, 1983).In areas where soil walling is common, it is seen as a temporary structure built because no other alternative material could be afforded. This classification prevents its legal use in urban districts leaving the home occupier vulnerable to dispossession and the dwelling vulnerable to demolition. Finance organizations are also highly unlikely to lend money for the construction of any property built from material not considered permanent.

In many developing countries, building standards which often rule out application of soil as an acceptable building material have been formulated. Gooding and Thomas (1995) in a study in nine countries found that soil-cement is disadvantaged by the incorrect perception that it is not a permanent building material. It is strongly associated with traditional un-stabilized soil construction. There is also scepticism of the technology amongst construction industry professionals because technical data on ISSB technology is still insufficient (UNHCR, 2009).Standardization and publicizing technical data is essential to promote use amongst professionals in the building industry.

Sufficient technical data should also help to promote building techniques maximizing the advantage of ISSB (UN-Habitat, 1992). In order to ease the adoption 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.

Although there are some signs of change whereby compressed stabilized earth may be permitted for construction, it will first be necessary for countries to convince the authorities of the potential of this material especially when compared to un-stabilized methods of soil construction. In practice it is advisable to build some community buildings first so that the local people can see for themselves the quality and durability of the material and experience first-hand the quality of construction which this method of construction can offer (Adam, 1983).

This study sought to establish whether community participation and perception had any impact on the adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

2.4.3 Benefits of Interlocking Stabilized Soil Blocks

The importance of project benefits on project success addresses the weight organizations should place on customer requirements and real needs which includes meeting performance measures, functional requirements and technical specifications (Pinto and Mantel 1990).

According to Raz, Shenhar and Dvir (2002), the most important dimension of project success is the end user benefit. The authors observed many cases where projects are executed as planned, on time, on budget and achieve the planned goals but turn out to be complete failures because they failed to produce actual benefits to the customer.

Pinto and Mantel (1990) concluded that the perceived value of the project and client satisfaction is a dimension in assessing success of a project and these factors should be taken into consideration while undertaking projects. Managerial activities designed to maximize project success should maximize managerial variables that maximize the benefits to the customer.

Shenhar, Dvir and Levy, (1997) postulated that there is a growing understanding among project managers that the most important stakeholders are the project customers. The common notion of measuring project success by evaluating the implementation process alone is therefore no longer valid. Management should therefore look both at the short term and long term benefits of the project and judge its performance on the outcomes of all dimensions.

Pinto and Mantel (1990) agree by stating that the many projects have failed because they did not fulfil customer expectation even though they were well executed. The impact of a project on a customer goes beyond meeting project specifications to reflect the satisfaction of the customer with the final product in terms of responding to customer needs and solving their problems.

Customer satisfaction is the acid test of the original concept of the project. If the project is well accepted by the users, the project is perceived to be successful (Lim and Mohamed 1999). According to the authors, the level of perceived success seems to be correlated to the level of users' satisfaction; with a higher level of user satisfaction correlating with a higher level of perceived success of the project.

According to Adams (1983), construction of a house using the interlocking stabilized soil blocks offers many benefits to its users. First, soil is available in large quantities in most regions. Soil is cheap and affordable in that in most parts of the world it is easily accessible even to low income groups and in some locations it is the only material available. Soil is also easy to use, is suitable for construction of most parts of the building and is non-combustible with excellent fire resistant properties

Dobson's findings emanating from eleven case studies in Zambia showed that earth structures have low embodied energy than buildings made from conventional materials (Hadjri, Osmani and Baiche, 2007). In comparison with other building materials, the production of compressed stabilized soil blocks does not need energy for drying or firing. In addition to energy savings at the production stage, earth buildings require less heating and cooling since the earth walls ensure substantial reduction in heat losses and a general feeling of thermal comfort. Soil also exhibits excellent beneficial climatic performance in most regions due to its thermal capacity, low thermal conductivity and porosity and thus it can moderate extreme outdoor temperatures and maintain a satisfactory internal temperature balance (Adam and Agib, 2001).

According to Zami and Lee (2007), soil is also environmentally appropriate and sustainable .This is because the use of this almost unlimited resource in its natural state involves no pollution and negligible energy consumption, thus further benefiting the environment by saving biomass fuel.

Creation of productive employment is an important aim of national development plans in developing countries. Hence technologies which need more labour per unit of output than other technologies are preferable, providing that labour is used in an efficient and economical way (Adam, 1983). Experience has shown that in general, the small scale production of compressed stabilized earth blocks is much more labour intensive than that of other similar building materials such as fired clay bricks or concrete blocks (Adam, 1983).

Most developing countries can produce tools and equipment required for the production of compressed stabilized soil blocks. Thus the manufacture of compressed stabilized soil blocks could create a great deal of both direct and indirect employment, more so than for other building materials (David, 2014).

According to UNHCR (2009), interlocking stabilized soil block technology is an affordable way of construction because soil is available in large quantities in most regions and in most parts of the world it is easily accessible to low income groups. The bricks are also weather-proof hence there is no need to plaster the building exterior. Due to the block’s interlocking mechanism, little cement is needed between block joints and wall construction goes up quickly allowing for labour savings. Some costs are also reduced as the technology becomes widely spread due to economies of scale. In a prototype school constructed in Sudan using stabilized soil blocks, Adam and Agip (2001) found construction using interlocking soil blocks to be very cost effective by Sudanese standards, with total cost savings per square meter of approximately 40% .

This study sought to evaluate whether the benefits derived from the interlocking stabilized soil blocks had an influence on the adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

2.4.4 Challenges of Interlocking Stabilized Soil Blocks

This section explained how information dissemination and costs associated with production of interlocking stabilized soil blocks influence successful implementation of housing projects.

2.4.4.1 Information Dissemination

Project communication refers to information exchanges or dissemination intended to create understanding amongst project stakeholders (Ruuska, 1996). Information dissemination is a proactive information service designed to educate and inform focused groups of users on social, economic and educational issues.

Fisher and Urich (1999) define information dissemination as the conscious effort to spread new knowledge, policies and practices to target audiences or stakeholders. Project communication requires systematic planning, collection, organization and storage of information for its delivery to the target audience using different media and communication means (Hamsworth and Turpin, 2000).

Project stakeholders who are any group of individuals who can affect or are affected by the project including local communities, regulatory agencies, customers, project team and project sponsor have varying degrees of power and access to information (Freeman and Beale, 1992). In order for project stakeholders to participate effectively in decision making, they need to have access to appropriate information, in an appropriate form, keeping in mind language, culture and constraints in accessing information (World Bank, 1993).

Ramsing (2009) emphasizes the importance of communication on project success and states that lack of up-to- date communication stands as a major cause of failure of many projects. Baker, (2007) states that ineffective communication contributes up to 95% of many project failures while Lester (2007) states that effective communication is one of the most important factors that accounts for the success of any project. Hamsworth and Turpin (2000) underscore the importance of information dissemination for creating awareness, knowledge and prompting action.

Effectiveness of project communication depends on the quality of communication flows. The quality of communication all through the project life cycle can be described as the degree to which appropriate information reaches the intended information receivers in an apt time (Rogers and Agarwala-Rogers, 1976). According to Hamsworth and Turpin (2000) effectiveness of information dissemination can be enhanced through varying the media of communication, customizing the information and encoding the message in a language well understood by the intended recipients. To achieve effective information dissemination, there is need to learn the way of life of those societies that intended projects impact on, so as to derive the appropriate channel and message design which most times are overlooked.

Communication is considered effective when the information disseminated is accurate, timely and relevant (Balke, 2001).

Project communication can be either extra project or intra project (Lievens and Moenaert, 2000). Intra project communication consists of both formal and informal communication undertaken by the project members for the purpose of disseminating information to one or more audiences within the project .This type of communication is mainly done through project team meetings, memos and follow-up reports to ensure that all the staff members are provided with timely, important and relevant information.

Extra project communication is communication between the project and its relevant environment primarily the end users (Lievenes and Moeanert, 2000). Ruuska (1996), states that it is common for projects to experience resistance and negative attitudes as a result of lack of or inadequate information.

To create a positive profile for itself therefore, a project should keep the stakeholders well informed on its goals and operations through timely and relevant information. In the absence of effective communication, stakeholders may perceive successful projects as failures due to inadequate awareness.

Production of interlocking stabilized soil blocks is a process based activity involving a series of systematic steps which have to be followed to achieve a quality end product. There is therefore need for proper knowledge of all the processes in order to achieve quality blocks and structures. This can be achieved through information dissemination especially in training programmes. Specific areas that need to be covered include finding suitable materials, safety briefing, machine operation, block production and curing, machine maintenance, block yard management, block testing and quality control, and building concepts (Hydra Form, 2011). The trainings should be fully supported with permanent reference material. This will ensure there is standardization and consistency in training and in the process of production.

Dissemination of information on low cost building materials and building technologies as an appropriate and or alternative technology in Kenya is done through the use of demonstration projects. In these demonstration projects, the target group is identified and trained in the production and use of alternative building materials and technologies. The aim of the training programmes is to create awareness, knowledge of the technology and to promote adoption.

In order to increase and ensure future use of ISSB technology, especially in urban areas more young professionals need to be trained in its use. In addition, introducing stabilized soil block education into the curricula will encourage further research. Acosta (2000) suggested the need for locally based studies to suit the local building characteristics which will also augment the professionals and developer's knowledge on the need for promoting appropriate building materials and technologies.

There are a variety of groups using interlocking stabilized soil blocks, each building their own experience with the technology. There is a need to develop information sharing mechanisms in order to facilitate further improvements and the proper spread of the technology.

This study sought to evaluate how dissemination of information has affected the adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

2.4.4.2 Cost

Cost is the estimation of the amount of money that will be required to complete the project. Project cost management includes the processes involved in planning, estimating, budgeting, financing and funding, managing and controlling costs so that the project can be completed within the approved budget (PMI, 2013).

Project cost management is primarily concerned with the cost of resources needed to complete project activities. Project cost management should also consider the effect of project decisions on the subsequent recurring cost of using, maintaining and supporting the product, service or result of the project.

The costs associated with a project can affect the success of that project. Success can be measured in terms of the project meeting its budget (Pinto and Slevin, (1998). The cost success criterion could be measured in terms of cost over or under run as a percentage of the initial budget.

The cost associated with appropriate building materials and technologies affects either positively or negatively the adoption of the technology. According to the Kenya National Housing Survey 2012/2013, it is estimated that building materials account for approximately 40% of the construction costs.

This is based on the fact that conventional building materials like cement, paints and metal are produced in some large scale industries and end up being costly due to high costs of production and transport to construction sites for the incorporation into the housing structure.

The cost of producing compressed stabilized earth blocks will vary a great deal from country to country and even from one area to another within the same country (Adam, 1983).Unit production costs will differ in relation to local conditions and may in some situations be even more expensive than conventional materials. Some of the factors that influence cost include availability of soil; that is whether it is available on site or has to be transported to the site. Suitability of the soil for stabilization and thus the type, quality and quantity of stabilizer also influences the cost of block production. Other factors affecting the cost of a block are current wage rates and productivity of the labour force.

High costs of equipment are also a constraining factor that contributes to the overall high costs of production. The machines should be affordable by potential users and easy to transport and maintain. Imported tools and equipment are very expensive and difficult to maintain. Mechanized machines like the ones used by the government also have additional costs of fuel and maintenance. Importing makes the technology inaccessible to the majority low income groups.

High costs are compounded by lack of awareness by both decision makers and the general public about the existence of low cost building materials and technologies. David (2014), states that block presses can be too expensive for small scale individual use.

In a study in Uganda by UNHCR (2009), it was found that the ISSB manual machine is the most cost-effective and accessible way of making soil blocks. Nonetheless, there is potential for further decreasing its cost and facilitating its use. In rural areas with limited access, transportation of the machine was challenging due to its weight mostly necessitating motorized transport.

The appropriate building materials however remain unaffordable by most of the targeted groups. This is because most of the appropriate building materials being promoted so far are cement based, which is not affordable by the majority. In a study in Uganda, UNHCR (2009), it was observed that the most common method of making the blocks is through the mix of cement or lime and murram soil compressed in the machine. However in areas where insufficient amounts of murram are available and cement or lime is expensive, affordability can be a problem.

One of the recommendations is to encourage researchers to come up with a wider range of appropriate building materials from which developers can select the best options to use (UN-HABITAT, 2010). The study states that in Uganda, it is common to plaster building walls with cement which is expensive and unaffordable for low cost housing. More research is needed to provide population with effective, affordable and environmentally friendly techniques to protect walls against wear and tear. Farm residues such as animal dung or plant husks can be used to improve the structural strength of the earth based masonry materials and are considered affordable and durable in some countries (Adam, 1983).

To ensure cost-effectiveness with cement stabilized blocks also, soil selection and testing are fundamental. Where the soils are of a good quality, less cement has to be introduced into the mixture. In addition, the cost of finance is high. This is because alternative building industry is viewed as being too risky. Thus the norm has been reliance on own finances by private sector which are often limited (UN-HABITAT, 2010).

Lack of an enabling environment, through well formulated and well-articulated policies on capital and funding, means that very few financial institutions can be willing and ready to offer capital to potential small scale producers of low cost building materials. The main reason is that low cost building materials and their building technologies are yet to gain general acceptance despite the legal recognition.

It therefore constitutes a financial risk to lend to potential producers of building materials that have not gained wider acceptability and have only recently been permissible under the building regulations in only special scheduled areas and therefore the market still remains limited (Adam, 1983) . This study sought to evaluate how cost has affected adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

2.5 Conceptual Framework

Independent variables Dependent variables

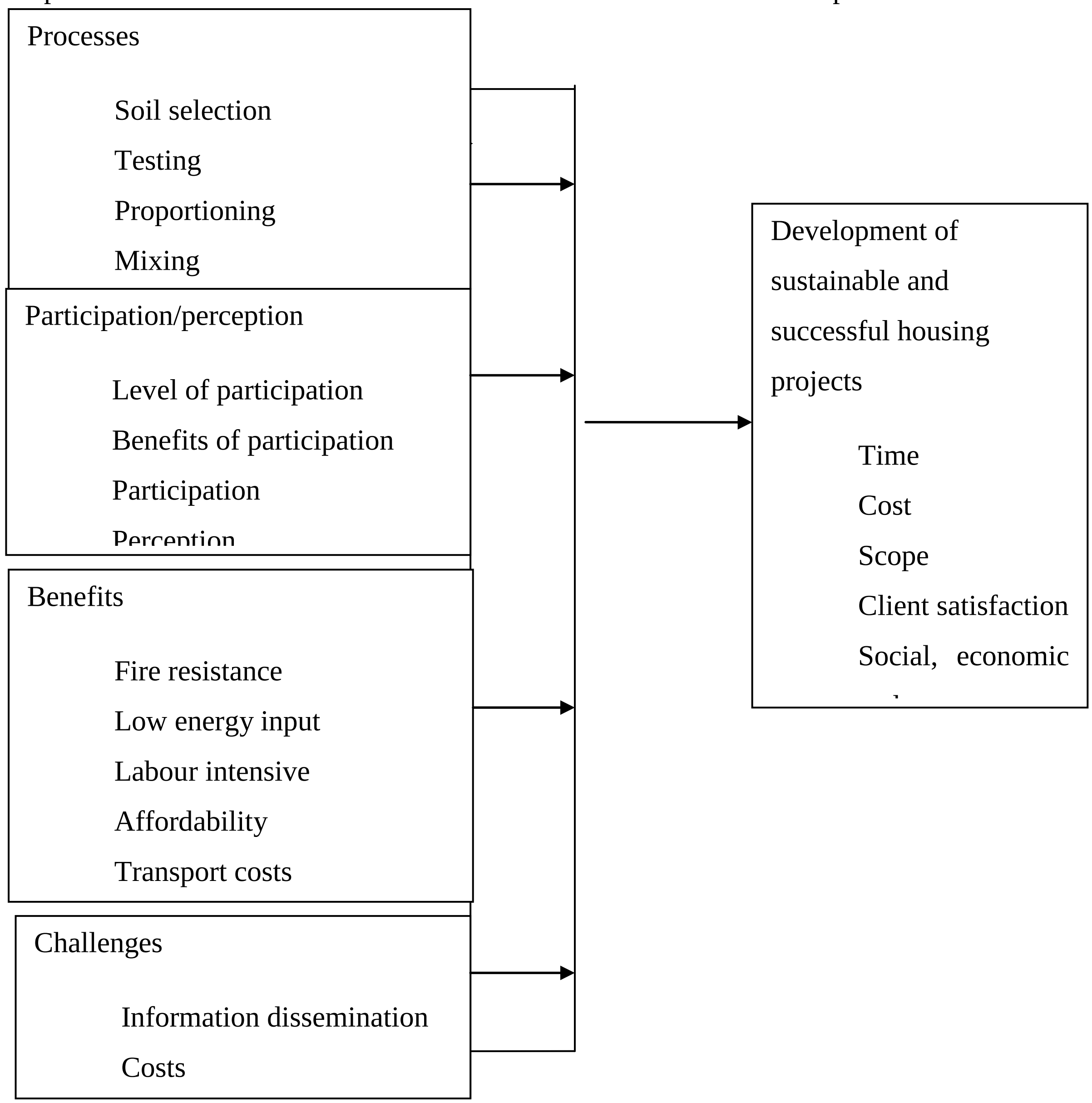

Figure 2.2. A Conceptual Framework for Adoption of Interlocking Technology in Development of Adequate and Sustainable Housing Projects.

2.6 Research Gaps

Gooding and Thomas (1995) carried out a study in nine developing countries in Africa, Asia, and Latin America to determine the potential of cement stabilized building blocks as an urban building material in developing countries.

The study established that though cement stabilized building blocks are currently in common use; there are several technical problems or deficiencies experienced in its use. It also indicated various factors including social stigma, standards, quality and training as some of the factors likely to affect the uptake of the technology. These factors were however not measured to establish whether in fact they affected the use of the blocks (Gooding and Thomas, 1995).

Adam (1983) carried out a study on compressed stabilized soil blocks manufacture in Sudan and used the blocks to construct a school. The study noted that there are some socio-economic constraints that may prevent or delay the wide adoption of the building material especially in low-cost housing programs. The study however did not measure these factors to establish the extent to which they influence the use of the blocks.

UNHCR (2009) while working with interlocking stabilized soil blocks in projects in war-torn Northern Uganda encountered several challenges including community scepticism, community sensitization and standardization. The study did not however measure extent to which these challenges influenced the use of the blocks in construction.

The 2012/2013 Housing Survey in Kenya (KNBS, 2013), established that some professionals do not advise clients to use appropriate building materials and technologies because of the belief that they are not readily acceptable by the market or clients, not supported or enabled by legislation or laws, expensive or unaffordable. Other factors included challenges in maintenance and lack of knowledge of the technology.

Mule (2012) and Sangori (2013) studied the adoption of the interlocking technology by considering factors such as lack of harmonized regulatory framework, poor workmanship, and slow adoption by the built environment professionals, prevailing research gap and inadequate local capacity.

Other factors that were considered in their studies were inadequate funding, inadequate personnel, negative cultural perception on soil products and access to training, equipment and transport costs.

This study sought to evaluate the adoption of the technology in development of sustainable and successful housing projects in Nandi County from a project management and product success perspective by considering factors such as knowledge of scope, community participation, benefits to clients, costs and effectiveness and efficiency of information dissemination.

2.7 Summary of Literature

This chapter reviewed literature on the Innovation Diffusion Theory and the Systems theory which have been used to explain the adoption of interlocking technology. The Innovation Diffusion Theory explains how the relative advantage, communication channels and complexity of an innovation influence its adoption. The theory has been used to explain how the objectives of knowledge, community participation, benefits and costs and information dissemination influence the adoption of interlocking technology.

The systems theory evaluates the success of a project based on inputs, processes, outputs and outcomes. The theory has anchored hypotheses relating to influence of community participation and benefits derived from the interlocking technology on development of adequate and sustainable housing projects.

The chapter also reviewed literature on the various factors that influence adoption of interlocking technology. The literature was divided into the various objectives of this study, that is, knowledge of the processes of production of interlocking soil blocks, community participation, benefits, costs and information dissemination.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a detailed description of the study's research methodology. It covers the research design, target population, sampling techniques and sample size, instruments of data collection, validity and reliability of the instruments, methods of data analysis and ethical considerations.

3.2 Research Design

The study was conducted through a mixed method research design. Mixed method research is a class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study (Onwuegbuzie, 2004). This study adopted quantitative and qualitative techniques in collecting, analyzing and presenting data.

3.3 Target Population

Kothari, (2004) defines population as the total of items about which information is desired while Mugenda and Mugenda (2003) describe population as all the elements that meet the criteria for inclusion in a study. Population is therefore the entire group of individuals, events or objects having a common observable characteristic.

The target population in this study was 81,672(KNBS and SID 2013) households in three sub-counties of Nandi County. These sub-counties are Emgwen, Chesumei and Aldai. The sub-counties were chosen purposively because this is where the government has established appropriate building materials and technology centres in Nandi County. Key informants who include professionals in the built environment and individuals who are involved in promoting the interlocking stabilized soil blocks were also targeted in the study.

3.4 Sample size and Sampling Techniques

Kothari (2004) defines a sample as the selected respondents representing the population. A sample enables one to obtain sufficiently accurate results by studying only a part of the total population. Three sub-counties where the government has established appropriate technology centres were purposively sampled. Simple random sampling was applied to ensure each element in the population had an equal and independent chance of selection in the sample.

The sample size refers to the number of items to be selected from the universe to constitute a sample. Size of sample should neither be excessively large nor too small but should be optimum. For large populations, Yamane (1967) developed a simplified formula for proportions to yield a representative sample for proportions;

$$n=N/1+N\,(e)^{2}$$

Where n is the sample size, N=the population and e is the level of precision. Given a population of 81,672 and assuming an 8% level of precision, the sample for this study was approximately 155 respondents.

The 155 respondents were divided proportionately to the number of households in each sub-county and selected by using excel randomization formula.

Aldai: $\dfrac{28{,}784 \ \mathrm{X}155}{81672}=55$

Emgwen: $\frac{26,879 \times 155}{81672}=51$

Chesumei: $\frac{26009 \times 155}{81672}=49$

3.5 Data and Instruments of Data Collection

The study adopted a semi-structured questionnaire and an interview schedule.

3.5.1 Questionnaires

A semi-structured questionnaire was used to collect data from the respondents. A questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents (Mugenda and Mugenda, 2003). The questionnaires had both open and close-ended questions. The questionnaires were distributed to the respondents and were collected after three days. A letter from the student was also attached to the questionnaires explaining the objectives and relevance of the study and assuring the respondents of anonymity.

The questionnaire gathered data on knowledge of the processes and operations of production, community participation and perception, benefits of the interlocking blocks and the challenges of cost and information dissemination. The questionnaire was on likert type statement anchored on a five point rating scale.

3.5.2 Interviewing

The interview method of data collection involves presentation of oral-verbal stimuli and reply in terms of oral verbal responses (Kothari, 2004).This study adopted a structured interview method where an interview schedule was developed and used to collect data from key informants. An interview schedule consists of a written list of questions, open ended or closed, prepared for use by an interviewer in a person- to- person interaction (Kumar, 2011). The interview schedule gathered data based on the four specific objectives of this study.

3.6 Validity and Reliability of Instruments

3.6.1 Validity and Reliability of the questionnaire

The questionnaire was tested for face validity in terms of logical link between the questions and the objectives of the study. Content validity was also tested to ensure that the items and questions covered the full range of issues being measured. The validity was ensured through seeking the opinions of experts especially the student’s supervisors and lecturers.

The external consistency of the questionnaire was tested using a test/retest procedure in a pilot study of thirty randomly selected households who would not participate in the main study. The questionnaire was tested to ascertain whether the wording was clear, to estimate the average time needed by the respondent to fill it and also to ascertain that the data collected was consistent. The researcher improved on the instrument whenever there seemed to be inconsistency in the outcome to ensure the right data was collected.

The internal consistency of the questionnaire was established using the Cronbach’s Alpha. The research instrument had a Cronbach’s Alpha of 0.75 indicating that it was reliable based on Tavakol and Dennick, (2011) who stated that the acceptable values of Cronbach’s Alpha ranges from 0.7 to 0.9.

3.6.1 Validity and Reliability of the interview schedule

Credibility and reliability in qualitative research is determined by four indicators: credibility, transferability, dependability and 'confirmability' (Trochim and Donnelly, 2007). The credibility of the interview schedule was established by taking the findings of the study to the respondents for confirmation, congruence, validation and approval.

3.7 Data Analysis

Primary data collected was first edited to ensure that it was accurate, consistent with other information and complete. The data was then arranged to facilitate coding and tabulation. Coding involved assigning numerals or other symbols to answers so as to enable the responses to be grouped into a limited number of classes or categories (Kothari, 2004).

Quantitative data collected was analyzed, presented and interpreted with the aid of both descriptive and inferential statistics using variables like the mean, standard deviation, percentages, frequencies, correlation and regression. Secondary data was analyzed manually and categorized systematically. Qualitative data gathered from the interview was analyzed and presented in prose while repetitive answers were grouped into themes and used to complement the quantitative responses.

The study was guided by the following multiple regression model

$Y=\beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4 +e$

Where Y=adequate and sustainable housing development using ISSB

β_0=constant

β_1- β_4=beta coefficient

X_1=knowledge of the processes

X_2=community participation and perception

X_3=benefits

X_4=challenges

e= error of prediction

The multiple regression model was guided by six assumptions of multiple regression. First, it was assumed that there was linear relationship between the dependent and each independent variable and between the dependent and the independent variables collectively. This assumption was tested using a scatter plot. The second assumption was that there was independence of the observations and this was tested using the Durbin-Watson statistic. The third assumption was that the data would show homoscedasticity where variances along the line of best fit in a scatter plot remain similar along the line.

The fourth assumption that guided the regression model was that there would be no multicollienarity in the data, where two or more independent variables are highly correlated with each other. This would lead to a problem of understanding which independent variable contributed to the variance explained in the dependent variable. Multicollinearity was tested through inspection of correlation coefficients. The fifth assumption was that there would be no significant outliers that reduce the predictive accuracy and statistical significance of the results. This was checked using the Cooks distance in SPSS. The sixth assumption was that the residuals are approximately normally distributed and this was checked using a histogram with a superimposed normal curve.

3.8 Ethical Considerations

The principle of voluntary participation was strictly adhered to and respondents were not coerced into participating in the study. Confidentiality of the information given by the respondents was upheld by not mentioning specific names of the people from whom the data was collected. Permission to carry out the research was also obtained from the relevant authorities.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter deals with presentation, analysis and interpretation of data that was obtained on the evaluation of the adoption of the interlocking soil technology and development of adequate and sustainable housing projects in Nandi County, Kenya. A descriptive research design was used in this study.

The study made use of frequencies on single response questions. On multiple response questions, the study used a five point likert scale in collecting and analyzing the data whereby a scale of five points was used in computing the means and standard deviations. These were then presented in tables as appropriate with explanations given in prose. Correlation analysis was done to determine the relationship between the dependent and independent variables.

4.2 Response Rate

The research was conducted on a sample of 155 households drawn from three sub-counties in Nandi County. Out of the total sample, 109 questionnaires were returned duly filled with relevant information that could be entered and analyzed. This represents a response rate of 70% which is an adequate response rate for statistical reporting. According to Mugenda Mugenda (2003), a response rate of 50% is adequate for analysis and reporting, 60% is good while 70% and above is very good.

4.3 Demographic Characteristics

Application of a new technology calls for the understanding of the various demographic characteristics that include age, gender and education level of the respondents. This section presents data on demographic factors in order to explain their influence on adoption of the interlocking stabilized soil block technology.

4.3.1 Respondents per Sub-County

The number of respondents per sub-county was analyzed and the results are as presented in Table 4.1.

Table 4.1 Respondents per Sub-County

		Frequency	**Per cent**
	Emgwen	38	34.9
Valid	Chesumei	38	34.9
	Aldai	33	30.3
	Total	109	100.0

The respondents comprised 38 households (34.9%) from Emgwen Sub-county, 38 households (34.9%) from Chesumei Sub-County and 33 households (30.0%) from Aldai Sub-county. This indicates that all the target Sub-Counties were equally represented in the study.

4.3.2 Gender of Respondents

The distribution of the respondents according to gender is as presented in Table 4.2.

Table 4.2 Gender

Gender	Frequency	Percent
Male	71	65.1
Female	38	34.9
Total	109	100.0

Seventy one respondents (65.1%) were male while thirty eight respondents (34.9%) were female. The differences in number between males and females may give a reflection of a patriarchal society where construction of houses is predominantly a male function and most of the family resources are controlled by the males. However the presence of female respondents who have an understanding of the technology means that it is a gender insensitive technology and females are slowly adopting it.

These findings are in agreement with studies carried out by Mule (2012) while studying the factors affecting the adoption of appropriate building materials and technologies programme in North Eastern Province Kenya, where more men than women were involved in the programme. Doss and Morris (2001) while studying how gender affect adoption of agricultural innovations concluded that generally women tend to adopt improved technologies at a lower rate compared to men.

The gender schema theory suggests that differences between the genders' adoption of new innovations stem from gender role and socialization processes reinforced from birth rather than biological gender per se (Kirchneyer 2002; Lynott and McCandless, 2000). The theory states that adoption of new technologies may also be affected by other non-gender differences that may impact adoption for example control over resources.

4.3.3 Age of Respondents

The distribution of the respondents according to age is presented in Table 4.3

Table 4.3 Age

Age	Frequency	Percent
Below 20	7	6.4
21-35	67	61.5
36-50	28	25.7
Above 50	7	6.4
Total	109	100.0

67.9% of the respondents were below the age of 35 years .Twenty eight respondents (25.7%) were aged 36-50 while 7 respondents (6.4%) were aged above 50 years. This result may imply that the youthful population has easier access to information and new developments and are more flexible in trying out and adopting new technologies. The older population seems to be more conservative and may be more comfortable working with ideas that have been tried and applied over time.

These findings are in agreement with a study on influence of age on adoption of information technologies by Venkatesh and Morris (2000), who found that age influence, exists in technology adoption contexts in terms of usefulness and ease of use of the technology. In the manufacturing sector, age was found to be negatively related to the probability of adopting new or significantly improved technologies. Firms with a higher proportion of younger employees were more likely to adopt new technologies than firms with older workforce (Meyer, 2008). In the agricultural sector, Darko (2014) found that age showed a strong negative association with adoption of agricultural technologies with the older farmers more likely to stick to use of traditional farming methods whereas younger farmers prefer use of new methods of farming. While studying factors influencing adoption of appropriate building technologies, Mule (2012) found that most of the respondents were in their youth with ranges of 30-34 years.

4.3.4 Education Level

Table 4.4 presents the education level of the respondents.

Table 4.4 Education Level

Level of Education	Frequency	Percent
Primary	4	3.7
Secondary	41	37.6
Tertiary	41	37.6
Graduate	18	16.5
Post graduate	5	4.6
Total	109	100.0

Forty one respondents (37.6%) had each attained secondary and tertiary education, while 18 respondents (16.5%) had bachelor's degrees, 5 respondents (4.6%) had post graduate studies while 4 respondents (3.7%) had primary level of education. Cumulatively, 96.3% of the respondents had a minimum of secondary education. This implies that a majority of the respondents could answer the questionnaire well. It also implies that a majority of the respondents had an education sufficient enough to grasp the technology and apply it.

During case studies in Uganda, it was found that technology adoption sometimes fails due to lack of skills and knowledge (UNCHR, 2009), therefore education is paramount for any new technology adoption as it enhances the capacity to grasp the new ideas that are being propagated. Darko (2014) found that a farmer's education level positively correlated with adoption of agricultural technology. Educated farmers tended to prefer modern methods of farming whereas farmers with no education were accustomed to traditional methods of farming.

4.4 Knowledge of the Production Processes

Respondents were asked to indicate their level of knowledge of the processes of production. The response is presented in Table 4.5.

Table 4.5 Knowledge of the Production Processes

ITEM	VP	P	A	W	VW	MEAN	SD
Soil selection	1	4	27	47	30	3.93	0.868
Soil testing	0	9	31	37	32	3.84	0.945
Sieving	0	7	34	34	34	3.87	0.934
Proportioning	6	12	30	28	33	3.64	1.183
Mixing	1	6	28	35	39	3.96	0.962
Molding	3	13	22	43	28	3.73	1.060
Curing	3	7	25	36	38	3.91	1.041

Key:

VP-very poor P-poor A-Average W-Well VW-very well SD-standard deviation

Understanding of the scope of a project is one of the determinants of project success. The first objective of the study was to examine how level of knowledge of the process of production affects the adoption of interlocking soil technology in development of adequate and sustainable housing projects. To achieve this, the study sought to establish the extent to which the respondents understood the operations and processes involved in production.

Respondents demonstrated an average knowledge of the soil selection process, with a mean of 3.93. Soil selection is the first step in production and if one does not understand it then he cannot succeed in production.

Not all soils are suitable for production of the soil blocks and the manufacture of good blocks requires the use of soil containing fine gravel and sand for the body of the block and clay and silt to bind the sand particles together. A person interested in adopting the technology must therefore have a good knowledge of the soil selection process.

Soil testing which aids in determining composition of soils and its suitability for production process returned a mean of 3.84 implying an average knowledge. The process also helps to determine the amount of stabilizers required in production. A good knowledge of soil testing is therefore essential for production of quality blocks which can convince the population that the blocks are suitable for construction and hence boost the integration of the technology.

The respondents gave a mean of 3.87 for sieving indicating a tendency towards good knowledge. This can influence the integration of the technology because sieving helps to remove the soil particles that are too large for use in block production. Sieving is important in that it helps to achieve a good compact and smooth finish that can persuade the population that the block is suitable for use in house construction.

The mean given for proportioning was 3.64 indicating an average knowledge and the least understood among the respondents. Proportioning involves determining the correct amount of water, soil and stabilizer to use in order to produce quality blocks. Where proportioning is not right the block will be weak and will easily disintegrate and this will negatively influence integration of the technology.

The respondents gave a mean of 3.96 for mixing which indicates a somewhat good knowledge. This may be due to the fact that the mixing of the components for the interlocking stabilized soil blocks is almost similar to mixing of sand and cement while constructing using other building materials. Proper mixing of stabilizer and soil is important in integration of the technology as it ensures that the stabilizer is evenly spread resulting in a well bound and strong block which can convince the population that it is a good quality construction material.

The respondents indicated an average knowledge of moulding with a mean of 3.73. A good knowledge of the moulding process is important as it ensures that the manufactured blocks are of uniform size and density with good neat surfaces that will interlock well. Through observation, the respondents seemed to have difficulty with consistently filling the mould with the same amount of mix, fully compressing the mix and proper handling of the wet block. Proper moulding is important in influencing integration of the technology as it ensures a quality and acceptable product.

The respondents indicated a mean of 3.91 for curing an indication of an almost good knowledge of the process. This may be due to the fact that it is a common requirement for all cementatious materials used in construction. By observation, the respondents seemed to have problems with stacking and covering of the blocks and also gentle sprinkling of water on the blocks especially when still wet. Proper curing is essential in ensuring integration of the technology as it ensures that the final product is strong enough and durable to persuade the population to use it for construction.

These findings concur with the findings from the interview schedule which indicated that the level of knowledge of the processes of production was still low. One of the respondents had this to say,

> *Most of residents of the county are not aware of the existence of this technology and even where they are aware, they do not fully understand how it works. They are therefore apprehensive about its adoption and this explains the widespread use of burnt bricks for walling of modern houses and mud for traditional houses.*

Another respondent agreed with the above stated sentiments but expressed optimism on the future of ISSBs

> *The current stringent regulations on environmental conservation especially on wetlands where most of the bricks in this county are baked will force people to adopt more environmentally sustainable alternatives like ISSB.*

In their study in nine countries, Gooding and Thomas (1995) observed that ISSB production is often presented as a simple process while in fact it relies on a significant degree of knowledge coupled with a rigorous pre-production testing. They observed that the respondents had problems with raw material testing, cement optimization, mixing, batching, mould filling, compaction and curing. These problems they stated could be reduced if the producers were better skilled and more informed.

David (2014) also observed that production must be carried out with great care, paying attention to appropriate mix proportions, thorough mixing, and proper use of the block press and curing in order to achieve strong, well-shaped and durable blocks. Such quality blocks are able to trigger persuasion towards adoption and integration of the technology as per the second stage of the Innovation Diffusion Theory (Rodgers, 1995).

Proper knowledge of scope of a project is a necessary ingredient for project success and it is paramount that the users and prospective users of the interlocking soil technology are better skilled in the production process. This can be achieved through sensitization in the appropriate building and technology centres that have been established by the government for purposes of promoting modern building technologies in all constituencies of Kenya.

4.5 Community Participation and Perception

The study sought to establish how community participation and perception of the community influenced adoption of the technology in development of adequate and sustainable housing projects in Nandi County. To achieve this objective, the study sought to establish the respondents' benefits from community participation, level of participation in establishment of ABTM centres and perception of the soil blocks.

4.5.1 Community Participation in Establishment of ABMTS

The respondents were asked to indicate their level of participation in establishment of ABMT centres; the response is as presented in Table 4.7

Table 4.7 Community Participation in Promotion of ISSB

Item	N	R	O	Oft	Al	Mean	SD
Community was involved in information gathering and identification of project	3	6	4	16	51	4.33	1.111
The community was involved in planning	6	8	12	20	34	3.85	1.284
The community was involved in implementation	4	6	9	17	44	4.14	1.188
the community is involved in evaluation	9	19	5	7	40	3.63	1.554

KEY: N-Never **R**-rarely **O**-occasionally **Oft**-often **Al**-always **SD**-standard deviation

Respondents were often (mean 4.33) involved in information gathering and identification of project mainly through provision of land and identification of site where the raw materials are available. 44 respondents agreed that they were often (mean, 4.14) involved in implementation mainly through provisions of labour in digging out the soil, sieving, mixing, moulding, curing and the actual construction. Community participation is important in influencing adoption of the technology as people are able to see firsthand how the blocks are produced and used and can be persuaded to use them.

The respondents felt that they were only occasionally (mean, 3.85) involved in planning and evaluation (mean, 3.63). They believed that these were done in offices away from them. The respondent’s lack of participation in all the stages of project implementation may result in a reluctance to embrace the technology since there is no ownership of the same by the community. This may negatively affect the integration of the technology as it indicates a sense of indifference towards their opinion and may lead up to improper decisions, lack of information, unfulfilled goals and consequently widespread discontent with the project and the technology as attested to by David (2014), in his study. There is therefore, need to improve the level of participation of the community in the promotion of the technology to improve integration.

Figure (4.1) shows an appropriate building and materials technology centre that is largely underutilized probably due to inadequate community participation during its establishment. There is therefore need to encourage participation in all the stages of project development.

Figure 4.1. An Appropriate Building Materials and Technology Centre

While promoting the interlocking stabilized soil blocks in Uganda, (UNHCR, 2009), it was found out that disseminating the technology through community leaders using the concept of the circle of influence and employing local community labour force could help in promoting the technology.

David (2014), while carrying out a study on construction of low cost houses in informal settlements in Nairobi Region, concluded that for a housing project to be truly successful there is need for close collaboration between the community and the support organization and it should involve all project stages. This emphasized the need to involve the stakeholders in all the stages of project development from design through to implementation in order to promote adoption of the technology in the community.

4.5.2 Benefits of Community Participation

The respondents were asked to state the benefits of community participation and the response is presented in Table 4.6.

Table 4.6 Benefits of Community Participation

ITEM	N	R	O	Oft	AL	MEAN	SD
Community ownership of project	3	9	11	15	42	4.05	1.211
Project was catalyst for further development	5	2	11	15	47	4.21	1.166
People acquired new skills	0	0	11	8	61	4.63	0.718
It helped to disseminate information	0	3	5	12	60	4.61	0.771

KEY: **N**-Never **R**-Rarely **O**-occasionally **Oft**-Often **Al**-always **SD**-standard Deviation

The respondents agreed that community participation led to acquisition of new skills (mean 4.63). The skills acquired covered production and use of the soil blocks in the construction of houses. This has helped to boost the adoption and diffusion of the technology though at a slow pace.

60 respondents agreed that community participation helped to disseminate information (mean 4.61). The members of the community that participated in the projects were able to pass information on the technology to other members who were not directly involved. The respondents also agreed that community participation was a catalyst for further development (mean 4.21) and that participation led to community ownership of project (mean 4.05). Through participation members of the community were convinced that the

technology actually works and they are able to either use it on their own projects or advice others to use it.

David (2014) found that community involvement is a pre-requisite for capacity building of members and for successful implementation and sustainability of projects. Importance of community participation was also demonstrated in Uganda where it was concluded that ways should be devised to increase individual and community ownership of projects to promote adoption of the technology (UNHCR, 2009).

The respondents in the interview schedule demonstrated a strong conviction that community participation is important for the success of any undertaking. An interviewee for instance had this to say,

> *Community participation is currently a must if you want to succeed in a public project. That is why community participation is even enshrined in our constitution. Proper community participation is important in promoting ownership and understanding of the project.*

Another respondent agreed with him and added,

> *If you want to succeed, involve the people. I believe if community participation was properly done when this project was introduced, more people would have adopted it.*

4.5.3 Perception of Local Community on ISSB

The respondents were asked to indicate their perception on the interlocking stabilized soil blocks and their response is presented in Table 4.8.

Table 4.8 Perception of Local Community on ISSB

Item	SD	D	U	A	SA	Mean	SD
Soil is a permanent building material	5	15	7	62	20	3.71	1.065
Interlocking stabilized soil block is a low quality building material	13	62	11	23	0	2.40	0.954
Interlocking stabilized soil block is a building material for the low class(low income group)	32	65	8	13	0	2.02	0.923
Interlocking stabilized soil block is an affordable building material	5	16	5	52	31	3.81	1.142
Interlocking stabilized soil block is an environmentally friendly building material	0	12	2	63	32	4.06	0.870

Key: **SD-**strongly disagree **D-**disagree **U-**undecided **A-** agree **SA-**strongly agree **SD**-standard deviation

Respondents agreed that the interlocking stabilized soil block is an environmentally friendly building material (mean 4.06). This perception can help in positively influencing integration of the technology because currently the population is more conscious of their environment and there is a tendency to move towards activities that promote environmental conservation.

62 respondents disagreed that the block is a low quality building material (mean, 2.40) and 65 respondents disagreed that it is a building material for the low income groups (mean, 2.20). This finding contrasts a study in Sudan by Hadjri, Osmani and Baiche, (2007) that indicated that most of the respondents would not consider living in earth houses because they were considered low quality and for the low income. The response in this study is an indication that the population is slowly accepting the technology and is willing to adopt it.

82 respondents agreed that soil is a permanent building material (mean, 3.71). This finding is in contrast with a study by Gooding and Thomas (1995) which concluded that the

interlocking stabilized soil block is disadvantaged by the incorrect perception that it is not a permanent building material. In Sudan (Adam, 1983), it was found that soil walling, where used, is seen as a temporary structure built because no alternative material could be afforded. Perception on permanence negatively affects the integration of the technology as people mainly in the middle class and upper class would not wish to put up temporary structures for their habitation. There is therefore need for more research and education on the permanence of this building material.

The respondents from the interview schedule seemed to hold a lukewarm perception towards the ISSB. One of the respondents expressed her sentiments as follows

> *ISSB is made from soil therefore like our traditional houses the resultant building is temporary and of low quality. It is therefore not likely to be used by households in the middle and high income brackets.*

Another respondent on his part had this to say,

> *ISSB interlock and does not involve the use of mortar in the joints. This makes people to believe that the building cannot withstand strong forces and is therefore not a worthwhile investment.*

While agreeing that there is a lot of negative perception surrounding ISSBs, a respondent had this to say,

> *My experience of over five years working with the interlocking blocks indicates that it is a strong and quality building material especially where your get the right soils.*

Overall, community participation and perception is fundamentally important for project success because it can contribute to effectiveness and efficiency of the project and empowerment of the beneficiaries.

4.6 Benefits of Interlocking Stabilized Soil Blocks

The third objective of this study was to assess how the benefits derived from ISSBs affect integration of the blocks. The respondents were required to state the extent to which they agreed with the stated benefits of interlocking stabilized soil blocks. The response is presented in Table 4.9

Table 4.9 Benefits of ISSBs

Item	SA	A	N	D	SD	MEAN	SD
Soil is fire resistant	38	52	4	8	7	3.97	1.126
There is low energy input in processing ISSB	20	57	12	18	2	3.69	1.016
Production is labour intensive therefore creates employment	37	53	3	12	4	3.98	1.071
It is environmentally appropriate and sustainable	32	65	4	8	0	4.11	0.786
Soil is locally available in large quantities and affordable	46	53	1	8	1	4.24	0.870
Interlocking stabilized soil blocks can be produced on site hence saving on transport costs	61	29	5	10	4	4.22	1.125
ISSB production and construction uses cheap local labour	41	41	4	20	3	3.89	1.181
Interlocking of blocks and non-use of mortar in joints reduces cost of walling	49	43	3	13	1	4.16	1.011
Walling is faster and cheaper since many courses can be done per day	54	42	4	8	1	4.28	0.914
Construction produces neat joints that do not require rendering hence reducing costs of constructions	48	47	1	10	3	4.17	1.023

Key: **SA**-strongly agree **A**-agree **N**-neutral **D**-disagree
SD-strongly disagree **SD**-standard deviation

97 respondents agreed that the interlocking stabilized soil blocks are environmentally appropriate and sustainable (mean, 4.11). This response in agreement with studies carried out in Uganda where interlocking stabilized soil blocks were considered more environmentally friendly as compared to other walling materials in terms of environmental degradation through destruction of wetlands and deforestation (Gooding and Thomas, 1995; UNHCR, 2009).With the current stringent laws on environmental protection, as contained in EMCA Act 1999, this factor is essential in positively influencing the adoption of the technology in promoting development of sustainable housing projects since policy and regulatory frameworks can influence technological adoption(Kemp Schot and Hoogma,1998).

99 respondents agreed that soil is locally available in large quantities hence affordable (mean, 4.24) and 90 respondents agreed that the blocks are produced on site hence saving on transport costs (mean, 4.22). This finding is similar to that of a study carried out in North Eastern Province on factors influencing adoption of the interlocking stabilized soil blocks (Mule, 2012). As found out in case studies in Uganda, the cost of the blocks relative to other construction techniques for example traditional techniques have an influence on the integration of the technology hence the need to make them even more affordable (UNHCR, 2009).

92 respondents agreed that the interlocking of blocks and non-use of mortar in the joints reduces cost of walling (mean, 4.16); walling is faster and cheaper since many courses can be done per day (mean, 4.28) and construction produces neat joints that do not require rendering hence reducing costs of constructions (mean, 4.17). These findings are in similar to findings of previous studies on the benefits of the interlocking blocks (Mule, 2012;

UNHCR, 2009; Gooding and Thomas, 1995). These benefits can persuade the population to adopt and integrate this technology in development of housing projects.

Figure (4.2) shows a building being constructed using the ISSB indicating the interlocking of blocks and the neat joints that do not require rendering.

Figure 4.2. A house under construction using ISSB

The blocks in figure 4.2 are joined to form neat joints that do not require further rendering as indicated in figure 4.3.

Figure 4.3 A wall built using interlocking stabilized soil blocks

The respondents were however neutral on fire resistance of soil (mean, 3.97), low energy input in processing ISSB(mean, 3.69) and that production of ISSB is labour intensive therefore creates employment(mean, 3.98). The respondents were also neutral to the idea that ISSB production and construction uses cheap local labour (mean, 3.89).

This has an effect of negatively affecting adoption of the technology. These findings contrast with other studies which found that soil has excellent fire resistant properties, that soil blocks require low energy input and is labour intensive therefore creates employment (Hadjri, Osmani and Bauche, 2007; Adam, 1983).

These findings are in agreement with the responses from the interview schedule where the respondents stated that ISSBs had some obvious benefits that are not obtained from the use of other building materials. A respondent had this to say,

> *From my experience working with the blocks, there are tremendous savings on costs due to production on site saving on transport costs, non-use of mortar on joints and faster walling hence savings on labour costs.*

Another respondent concurred with him and added

> *Construction with ISSBs also produces neat joints hence there is no need for rendering resulting in cost savings.*

One of the components of the Innovation Diffusion Theory is that the relative advantage of an innovation may influence its adoption and diffusion (Rogers, 1995). The benefits derived from a project and the resultant level of customer satisfaction is a dimension in assessing success of a project. The perceived benefits of ISSBs by the stakeholders relative to other walling materials can therefore be a major contributing factor to the success of the housing projects.

4.7 Challenges in Production and Use of ISSBs

The fourth objective of this study sought to determine how the challenges of information dissemination and costs associated with production and use of ISSBs influence adoption of the interlocking technology

4.7.1 Information Dissemination

The respondents were asked to indicate what functions were accomplished by information dissemination. The response is presented in Table 4.10

Table 4.10 Functions Accomplished by Information Dissemination

Response	Frequency	Percentage	Mean	Standard deviation
None	17	15.6		
Created awareness	46	42.2	1.58	1.091
Brought understanding	34	31.2		
Led to adoption of technology	12	11.0		

17 respondents (15.6%) felt that there had not been effective information dissemination on interlocking stabilized soil blocks in their locality. Ineffective information dissemination has an effect of hindering successful adoption and diffusion of the technology because it means that the population does not have the adequate information they would require in order to adopt the technology. This finding is in agreement with case studies carried out in Uganda which found that ignorance, lack of access to information and education hinder successful implementation of comprehensive and appropriate development projects (UNHCR, 2009).

42.2% of the respondents said the information disseminated created awareness, 31.2% said it brought understanding while 11.0% said it led to adoption of the technology. Effective dissemination should go beyond creating awareness and bringing understanding to action whereby there is change of practice resulting from the adoption of products, materials or approaches offered by a project (Hamsworth and Turpin, 2000). Rogers (1995) in the Innovation Diffusion Theory also states that adoption and diffusion should go beyond awareness and persuasion to the decision to implement.

4.7.2 Characteristics of Information Disseminated

The respondents were asked to indicate level of agreement with the characteristics of the information disseminated. The response is as presented in Table 4.11.

Table 4.11 Characteristics of the Information Disseminated

Item	SD	D	N	A	SA	MEAN	SD
Information was customized and relevant to our needs	1	18	13	64	13	3.64	0.928
The dissemination media was suitable for our needs	1	17	23	54	14	3.58	0.936
Communication was in a language we understand	1	9	9	75	15	3.86	0.787
The information content was of interest and relevant to the community	2	14	7	68	18	3.79	0.934
The information provided was accurate	1	21	21	49	17	3.55	1.004
The information provided was timely	5	22	18	50	14	3.42	1.091

Key: **SD**-strongly disagree **D**-disagree **N**-neutral **A**-agree **SA**-strongly agree **SD**-standard deviation

Asked whether the information was customized and relevant to their needs, the respondents gave a mean of 3.64. This is a neutral response that may imply that steps were not taken to first assess and understand the information needs of the target audience before dissemination, thus negatively affecting the integration of the technology.

The respondents gave a mean of 3.58 when asked if the dissemination media was suitable for their needs. This neutral response implies that the media used were not suitable for the respondents for example the trainings were too short for any meaningful understanding of the concepts and this has an effect of negatively influencing the integration of the technology.

On whether communication was in a language they understood, the respondents gave a mean of 3.86. The result may be due to the technical jargon that may not be easy to understand. Asked whether the information content was of interest and relevant to the community the respondents gave a neutral response with a mean of 3.79. This may be attributed to the economic situation that may not allow the population to invest in a modern house.

The respondents gave a neutral response when asked whether the information provided was accurate (mean 3.55), and a mean of 3.42 on whether information provided was timely. This may imply that the information provided did not satisfy all their expectations towards improved housing.

The findings of this study imply that the information disseminated has not achieved its intended goal of facilitating integration of the technology. More effort is therefore needed to ensure that information is disseminated effectively to the relevant stakeholders by for example preparing pamphlets in the local dialects to promote understanding and using trained personnel in dissemination programmes to ensure that the information given is customized and accurate.

From the interview schedule, the respondents were asked to describe the influence of information dissemination on adoption of the interlocking technology. A respondent for example had this to say,

> *Information on the ISSB has not reached a large number of the households in this county, especially in rural areas which in essence should be the main target of this technology.*

Effective communication is one of the most important factors that account for success of any project. Information dissemination on ISSBs should be effective to enhance success of the project.

4.7.3 Costs Associated with Interlocking Stabilized Soil Blocks.

The respondents were asked to give their views on the costs associated with production and use of interlocking stabilized soil blocks as one of the challenges hindering adoption of the technology in development of adequate and sustainable housing projects. Their response is as presented in Table 4.13

Table 4.13 Costs

Item	SD	D	U	A	SA	MEAN	SD
Machines for production are easily available and the cost of acquiring is affordable	20	42	9	33	5	2.64	1.221
The cost of operation and maintenance of machines is reasonable	17	26	4	55	7	3.08	1.278
Cost of stabilizers like cement is affordable	2	58	9	23	17	2.95	1.205
Finance for construction is easily available and affordable	6	51	12	35	5	2.83	1.085
Design costs are way high above the reach of many	14	45	12	24	14	2.81	1.280
Approval and licensing fees increase the cost of construction	2	18	5	30	54	4.06	1.173

Key: **SD-** strongly disagree **D**: disagree **U:** undecided **A**: agree **SA**: strongly agree **SD**: standard deviation

The respondents disagreed that the machines for production are easily available and the cost of acquiring is affordable (mean, 2.64). The mechanized machines as shown in figure 4.4 are imported at costs that quite high while the manual machine is manually assembled by local companies such as Numeric Machines Ltd and Makiga Engineering. The two government machines available in the county cannot meet the needs of the entire county. These findings are in agreement with those of David (2014), and Mule (2012) who concluded that block presses can be too expensive for small scale individual use, a factor that can negatively affect the integration of the technology.

The plate in figure 4.4 shows a Hydraform motorized block press machine mostly imported from South Africa at costs that may not be affordable to the ordinary citizen.

Figure 4.4 the motorized versus the manual block press machine

The respondents were neutral on the cost of operation and maintenance of the machines being reasonable (mean, 3.08). This can be attributed to cost of fuel for motorized machines and cost of transporting the machines for both the manual and motorized types. This is a challenge that was also experienced in Uganda (UNHCR, 2009) and it may affect adoption of the technology due to the expense that is beyond the reach of the ordinary citizen.

On the cost of stabilizers like cement being affordable, the respondents disagreed (mean, 2.95).This is in agreement with previous studies (UNHCR, 2009 and Gooding and Thomas, 1995), which concluded that the costs of stabilizers pushed up the costs of the soil blocks and recommended exploration of alternatives.

For a family to be adequately housed as per the Universal Declaration of Human Rights, it would require a minimum of three rooms which would be put up using a minimum of three thousand interlocking soil blocks. At an average of one hundred blocks for every bag of cement, a three roomed house would require thirty bags of cement at an average of eight hundred shillings per bag. This translates to twenty four thousand shillings for the stabilizer only and this may be way above the reach of many who are within the minimum wage bracket, thereby negatively affecting adoption of the technology.

The plate in Figure 4.5 depicts a house in an urban area of Nandi County that is constructed using traditional techniques of wood and mud. The units are in a deplorable condition that is not adequate for human habitation and are in urgent need of improvement.

Figure 4.5. A rental house within Kapsabet town

Respondents disagreed that finance for construction is easily available and affordable (mean, 2.83). Interlocking blocks are considered a temporary building material and no financial institution would be willing to lend money for construction using these blocks. This is in agreement with previous studies (Adam and Agib, 2001 and Hadjri, Osmani and Bauche, 2007) where it was found that very few financial institutions are willing and ready to offer capital to potential small scale producers of low cost building materials. The likely reason is that low cost building materials and their technologies are yet to gain general acceptance and constitutes a financial risk. Lack of access to affordable finance will hinder adoption of the technology in that the citizens may not have adequate funds from private sources to finance construction

On whether design costs are way high above reach of many, the respondents disagreed (mean, 2.81). This may be due to the fact that in rural areas people do not contract professionals to design houses. The respondents however agreed that approval and licensing fees increase cost of construction (mean 4.06) especially so in the urban and peri-urban areas where building plans have to be approved by various authorities including National Environment Management Authority, public health officials and public works officers and local authorities.

The respondents from the interview schedule were asked to describe the influence of costs on the adoption of the interlocking technology. A respondent had this to say,

> *The county heavily relies on the machines provided by the government for the interlocking blocks. These machines are mechanized, and therefore the operational costs in terms of fuel, maintenance and towing to the production sites are beyond the reach of the ordinary citizen.*

Another respondent agreed with the sentiments above and had this to add,

> *The fact that cement has to be mixed with soil for block production makes the ISSBs expensive for the low income households.*

The costs incurred in a project relative to its budget influences success of the project in the short term and this can have an effect on uptake of the technology and efforts should be made to address these issues.

4.8 Inferential Statistics

Inferential statistics including correlation analysis regression and chi-square were used to aid in drawing an inference about the population on the basis of sample data.

4.8.1 Correlation Analysis

In this study Karl Pearson' correlation coefficient was used to establish the magnitude, direction and significance of the relationship between knowledge of the processes, community participation and perception, benefits and the challenges of cost and information dissemination and adoption of interlocking stabilized soil blocks. The variables were computed into single variables per factor by obtaining the averages of each factor. The correlation matrix for the parameters under the first objective is presented in Table 4.17.

Table 4.17 Correlation Matrix for Operation and Processes Parameters

		Soil selection	Soil testing	Moulding	Curing	Adoption
Soil selection	Pearson correlation	1				
	Sig.(2-tailed)					
	N	109				
Soil testing	Pearson correlation	.629**	1			
	Sig.(2-tailed)	0.000				
	N	109	109			
Moulding	Pearson correlation	.502**	.633**	1		
	Sig.(2-tailed)	0.000	0.000			
	N	109	109	109		
Curing	Pearson correlation	.597**	.682**	.599**	1	
	Sig.(2-tailed)	0.000	0.000	0.000		
	N	109	109	109	109	
Adoption	Pearson correlation	.764**	.871**	.809**	.833**	1
	Sig.(2-tailed)	0.000	0.000	0.000	0.000	
	N	109	109	109	109	109

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

The correlation matrix indicates that there is a statistically significant correlation at 99% confidence level for all the variables. This implies that the correlation is not a result of sampling error or chance. It also implies that the correlation can be generalized from the sample to the overall population.

The direction of correlation between the variables is positive implying that the value of one variable increases as the value of the other variable increases. A high level of knowledge of the independent variables, that is, soil selection and testing, proportioning, mixing, moulding and curing is correlated with a high level of adoption of the interlocking stabilized soil blocks.

Based on Cohen (1992) scale of measuring the strength of correlation, there is a strong correlation between knowledge of the independent variables and adoption of the ISSB technology. This is indicative of the importance of a good knowledge of the processes and operations in production of ISSB for adoption of the technology. A correlation matrix for the second objective of this study is presented in Table 4.18.

Table 4.18 Correlation Matrix for Benefits of Community Participation

		Ownership	**Catalyst**	**Skills**	**Dissemination**	**Adoption**
Ownership	Pearson correlation	1				
	Sig.(2-tailed)					
	N	80				
Catalyst	Pearson correlation	.674**	1			
	Sig.(2-tailed)	.000				
	N	80	80			
Skills	Pearson correlation	.604**	.610**	1		
	Sig.(2-tailed)	.000	.000			
	N	80	80	80		
Dissemination	Pearson correlation	.577**	.628**	.260*	1	
	Sig.(2-tailed)	.000	.000	.020		
	N	80	80	80	80	
Adoption	Pearson correlation	0.891**	0.900**	0.732**	0.740**	1
	Sig.(2-tailed)	0.000	0.000	0.000	0.000	
	N	80	80	80	80	80

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

The correlation matrix indicates a statistically significant correlation between all the variables implying that it is not a result of sampling error or chance. The direction for correlation between the variables is positive implying that they change in the same direction. This means that the more the community participates in ISSB projects in their area, the more the integration of the technology.

The degree of correlation between benefits of community participation and adoption of the ISSB is strong, ranging from 0.732 to 0.9. This implies that when the community is involved in ISSB projects in their locality, it promotes ownership, acquisition and dissemination of new skills and is a catalyst for further developments. These in turn are strongly correlated to adoption of the technology in development of adequate and sustainable housing projects. This is in agreement with the findings of David (2014), who found that for a housing project to be truly successful, opinions and engagements of beneficiaries in all the project stages is important. The correlation matrix for the parameters of the third objective of this study is as presented in Table 4.19.

Table 4.19 Correlation Matrix for Benefits of ISSBs

		Low walling cost	Afford-Ability	Environmental	Fire resistant	adoption
Low walling cost	Pearson correlation	1				
	Sig.(2-tailed)					
	N	109				
Affordability	Pearson correlation	.473**	1			
	Sig.(2-tailed)	0.000				
	N	109	109			
Environmental appropriateness	Pearson correlation	.340**	.408**	1		
	Sig.(2-tailed)	0.000	0.000			
	N	109	109	109		
Fire resistant	Pearson correlation	.402**	.404**	.380**	1	
	Sig.(2-tailed)	0.000	0.000	0.000		
	N	109	109	109	109	
adoption	Pearson correlation	.752**	.730**	.605**	.738**	1
	Sig.(2-tailed)	0.000	0.000	0.000	0.000	
	N	109	109	109	109	109

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

Table 4.19 on the correlation matrix for benefits of ISSBs indicates that all the correlations among all the variables are statistically significant and the direction of correlation between the variables is positive implying that they increase or decrease in the same direction. This implies that an increase in the benefits of ISSBs is strongly correlated to an increase in the adoption of the technology.

The degree of correlation between the benefits of ISSB and adoption of the technology is strong ranging from 0.605 for environmental appropriateness and 0.752 for low cost of walling. This may be because at the household level, people are more likely to be concerned with the cost of construction as compared to environmental conservation. However, overall, the benefits associated with ISSBs are important factors in adoption of the technology. This is in agreement with the Innovation Diffusion Theory (Rogers, 1995), which states that the relative advantage of an innovation influences its adoption and diffusion.

A correlation matrix for the correlation between information dissemination and adoption of the interlocking soil technology is as presented in Table 4.20. The matrix indicates that the correlation between information dissemination and adoption of the ISSB technology is statistically significant implying that the correlation is not a result of chance or sampling error. The direction of correlation is positive implying that an increase in information dissemination is correlated with an increase in adoption of the interlocking stabilized soil blocks in development of adequate and sustainable housing projects in Nandi County.

The degree of correlation indicates that there is a strong correlation between information dissemination and adoption of ISSBs, ranging from 0.695 to 0.844. This is in agreement with studies by Croxton (2013) and Kemp Schot and Hoogma (1998) which emphasize the importance of dissemination of knowledge and skills in technology adoption and diffusion.

Table 4.20 Correlation Matrix for Information Dissemination

		Customized	Suitable	Language	Interest	adoption
Customized	Pearson correlation	1				
	Sig.(2-tailed)					
	N	109				
Suitable	Pearson correlation	.560**	1			
	Sig.(2-tailed)	.000				
	N	109	109			
Language	Pearson correlation	.553**	.436**	1		
	Sig.(2-tailed)	.000	.000			
	N	109	109	109		
Interest	Pearson correlation	.585**	.522**	.477**	1	
	Sig.(2-tailed)	.000	.000	.000		
	N	109	109	109	109	
adoption	Pearson correlation	0.844**	0.750**	0.695**	0.749**	1
	Sig.(2-tailed)	0.000	0.000	0.000	0.000	
	N	109	109	109	109	109

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

4.8.2 Regression Analysis

Regression analysis is a statistical process for estimating the relationships among variables. With this analysis, one is able to understand how the typical values of the dependent variable change when one of the independent variables in varied, while the other variables are held constant.

For this study, a multiple regression model was applied to identify the impact of knowledge of the processes, community participation and perception, benefits and challenges on adoption of the interlocking technology in development of adequate and sustainable housing.

The study adopted the following regression equation to establish the relationship between variables $Y=\beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4 +e$. Where Y=adequate and sustainable housing development using ISSB, β_0=constant, β_1- β_4=beta coefficient, X1=knowledge of the processes, X_2=community participation and perception, X3=benefits, X4=challenges and e is the error of prediction. Table 4.21 presents a summary of the regression analysis.

Table 4.21 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.921[a]	0.849	0.845	0.04

Dependent variable: Development of adequate and sustainable housing

a: Predictors: (constant), understanding, community participation, benefits and challenges.

The study used the R square (R^2). R square is the coefficient of determination and indicates the percentage of variability in the dependent variable accounted for by the independent variables together. In this study the R^2 indicated how the adoption of interlocking soil block technology in development of adequate and sustainable housing varied with knowledge of the operations and processes, community participation, benefits and the challenges of cost and information dissemination. In this study, knowledge, community participation, ISSB benefits and challenges of cost and information dissemination account for 84.9% of the variation in adoption of interlocking soil technology in development of adequate and sustainable housing in Nandi County. The difference of 15.1% is due to other factors which were not studied and therefore not in the regression model.

4.8.2.1 ANOVA

The ANOVA was generated to help evaluate whether the regression model was statistically significant in explaining the existing association between the dependent variable and the independent variables.

Table 4.22 ANOVA [a] of the Regression

	Sum of squares	Df	Mean square	F	Significance
Regression	12.223	4	48.892	9.44	0.000[b]
Residual	460.49	89	5.174		
Total	472.709	93			

a: Dependent variable: development of adequate and sustainable housing

b: Predictors: (constant), understanding, community participation, benefits, challenges

The study used the ANOVA results to establish the significance of the regression model from which an F-significance value of P less than 0.005 was established ($P=0.000<0.05$). The model is statistically significant in predicting how knowledge of the processes and operations, community participation, benefits and the challenges of cost and information dissemination affect adoption of interlocking technology in development of adequate and sustainable housing projects in Nandi County.

This means that the regression model has a less than 0.05 probability of giving a wrong prediction. This therefore means that the regression model at confidence level of above 95% is significant and hence high reliability of the results.

4.8.2.1 Coefficients of Correlation

The beta coefficient indicates the strength of association between the independent and dependent variable.

The regression equation for this study as deduced from the Table 4.23 would be:

$Y=3.80+0.78X_1+0.46X_2+0.47X_3+0.53X_4$

Where Y=adequate and sustainable housing development, X_1=understanding, X_2=community participation, X_3=benefits, X_4=challenges.

Table 4.23: Coefficient of Correlation

Coefficients [a]

	Un-standardized coefficients B	**Std. Error**	**Standard coefficients**	**t**	**Sig.**
(constant)	3.80	0.451		8.36	0.004
knowledge	0.78	0.121	0.146	6.46	0.003
Community participation	0.46	0.079	0.126	5.86	0.001
Benefits	0.47	0.073	0.045	6.48	0.005
Challenges	0.53	0.073	0.142	7.29	0.004

a: dependent variable: development of adequate and sustainable housing

From the above regression equation, it is evident that when we set the value of the coefficients of knowledge of the operations and processes, community participation, benefits, and the challenges of information dissemination and costs to zero, the adoption of the interlocking soil technology in development of adequate and sustainable housing would be 3.8 due to variations from effects other than these independent variables.

A unit change in knowledge of the production processes while setting the coefficients of other independent variables at zero would lead to a change in the adoption of the interlocking soil block technology in development of adequate and sustainable housing by a factor of 0.78. A unit change in community participation while holding the other variables at zero would lead to adoption by a factor of 0.46.

A unit change in benefits while holding the other variables at zero would lead to adoption of interlocking soil technology in development of adequate and sustainable housing projects by a factor of 0.47, while the cost and information dissemination would lead to adoption by a factor of 0.53 if other variables are held at zero.

This implies that knowledge of the production processes had the highest influence on adoption of interlocking soil technology in development of adequate and sustainable housing projects, followed by cost and information dissemination, benefits and finally community participation.

4.9 Hypothesis Testing

The study sought to establish the relationship between the independent and the dependent variables by conducting a chi-square test.

Testing hypothesis for the first objective:

H_0: Knowledge of the process of production has no significant effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

Table 4.24: Testing Hypothesis for the First Objective

F	e	(f-e)=d	$(d)^2$	$(d)^2/e$
2	21.8	-19.8	392.04	18
8	21.8	-13.8	190.44	8.7
28	21.8	6.2	38.44	1.8
37	21.8	15.2	231.04	10.6
34	21.8	12.2	148.84	6.8
			$\Sigma(d)^2/e$=45.9	

χ^2_C=45.9> χ^2 0.05=9.488 at 4degrees of freedom and 5% level of confidence.

Since the calculated chi-square value of 45.9 is greater than the critical chi-square value at 5% level of confidence, accept the alternative hypothesis, thus knowledge of the process of production has a significant effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

Testing of hypothesis in relation to the second objective

H_0: Participation and perception of the community has no significant influence on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

Table 4.25: Testing of Hypothesis for the Second Objective

F	e	(f-e)=d	$(d)^2$	$(d)^2/e$
6	16	-10	100	6.25
10	16	-6	36	2.25
7	16	-9	81	5.06
15	16	-1	1	0.06
42	16	26	676	42.25
			$\Sigma(d)^2/e$=55.87	

χ^2_C=55.87> χ^2 0.05=9.488 at 4degrees of freedom and 5% level of confidence.

Since the calculated chi-square value of 55.87 is greater than the critical chi-square value at 5% level of confidence, accept the alternative hypothesis, thus participation and perception of the community has a significant effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

Testing of hypothesis in relation to the third objective

H_0: Benefits derived have no significant effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

Table 4.26: Testing of Hypothesis for the Third Objective

F	**E**	**(f-e)=d**	**$(d)^2$**	**$(d)^2$/e**
3	21.8	-18.8	353.4	16.2
11	21.8	-10.8	116.6	5.3
4	21.8	-17.8	316.8	14.5
48	21.8	26.2	686.4	31.5
43	21.8	21.2	449.4	20.6
			$\Sigma(d)^2$/e=88.1	

χ^2_C=88.1> χ^2 0.05=9.488 at 4degrees of freedom and 5% level of confidence.

Since the calculated chi-square value of 88.1 is greater than the critical chi-square value at 5% level of confidence, accept the alternative hypothesis, thus benefits derived have an effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

Testing of the hypothesis in relation to the fourth objective:

H0: Associated challenges have no significant effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

The calculated chi-square value in Table 4.24 is 35.9 which is greater than the critical chi-square value at 5% level of confidence, accept the alternative hypothesis, thus associated challenges of cost and information dissemination have an effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects.

Table 4.27: Testing of Hypothesis for the Fourth Objective

F	**E**	**(f-e)=d**	**$(d)^2$**	**$(d)^2/e$**
10	21.8	-11.8	139.24	6.39
40	21.8	18.2	331.24	15.2
9	21.8	-12.8	163.84	7.51
33	21.8	11.2	125.44	5.75
17	21.8	-4.8	23.04	1.05
			$\Sigma(d)^2/e=35.9$	

$\chi^2_C=35.9> \chi^2$ 0.05=9.488 at 4degrees of freedom and 5% level of confidence.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings, conclusions, recommendations of this study and suggestions for further studies.

5.2 Summary of Findings

This study was carried out to evaluate adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County, Kenya. Four objectives were formulated for the study. The first objective was to examine how the process of production affects the adoption of the interlocking soil technology in development of adequate and sustainable housing projects. The second objective was to assess how the participation and perception by the community influences the adoption of the interlocking soil technology in development of adequate and sustainable housing projects. The third objective was to evaluate how the benefits derived affect the adoption of the interlocking soil technology in development of adequate and sustainable housing projects. The fourth objective was to analyse how the challenges of cost and information dissemination influence the adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

5.2.1. Knowledge of the Production Processes

Successful production of the interlocking stabilized soil blocks requires adequate knowledge of all the operations and processes from soil selection, soil testing, sieving, proportioning, mixing, moulding and curing in readiness of use.

Respondents demonstrated an average knowledge of the soil selection process with a mean of 3.96. Not all soils are suitable for production of the interlocking stabilized soil blocks and the manufacture of good blocks requires the use of soil containing fine gravel and sand for the body of the block and clay and silt to bind the sand particles together. Where soils are not suitable, the block will disintegrate and will not be suitable for construction.

The mean given for soil testing was 3.84 implying an average knowledge. Soil testing assists in determining the composition of the soils and thus its suitability for production. It also helps to determine the amount of stabilizers required in production. Proper knowledge of the soil testing is therefore paramount for production of quality blocks which can convince the population that the blocks are suitable for construction and hence boost the adoption of the technology.

The respondents gave a mean of 3.87 for sieving indicating an average knowledge. This can influence the adoption of the technology because sieving helps to remove the soil particles that are too large for use in block production. This is paramount in order to achieve a good compact and smooth finish that can persuade the population that the block is suitable for use in house construction.

The mean given for proportioning was 3.64 indicating an average knowledge and the least understood among the respondents. Proportioning involves determining the correct amount of water, soil and stabilizer to use in each batch in order to produce quality blocks. Where proportioning is not right the block will be weak and will easily disintegrate and this will negatively influence adoption of the technology.

The respondents gave a mean of 3.96 for mixing which indicates a somewhat good knowledge. This may be due to the fact that the mixing of the components for the interlocking stabilized soil blocks is almost similar to mixing of sand and cement while constructing using other building materials. Proper mixing of stabilizer and soil is important in adoption of the technology as it ensures that the stabilizer is evenly spread resulting in a well bound and strong block which can convince the population that it is a good quality construction material.

The respondents indicated an average knowledge of moulding with a mean of 3.73. A good knowledge of the moulding process is important as it ensures that the manufactured blocks are of uniform size and density with good neat surfaces that will interlock well. Through observation, the respondents seemed to have difficulty with consistently filling the mould with the same amount of mix, fully compressing the mix and proper handling of the wet block. Proper moulding is important in influencing adoption of the technology as it ensures a quality and acceptable product.

The respondents indicated a mean of 3.91 for curing. This indicates an almost good knowledge of the process which may be due to the fact that it is a common requirement for all cementatious materials used in construction. By observation, the respondents seemed to have problems with stacking and covering of the blocks and also gentle sprinkling of water on the blocks especially when still wet. Proper curing is essential in ensuring adoption of the technology as it ensures that the final product is strong enough and durable to persuade the population to use it for construction.

5.2.3 Community Participation and Perception

5.2.3.1 Community participation in establishment of ABMTS

In this study, respondents agreed that they were often (mean 4.33) involved in information gathering and identification of project mainly through provision of land and identification of site where the raw materials are available. Majority of the respondents also agreed that they were often (mean, 4.14) involved in implementation. This was mainly through provisions of labour in digging out the soil, sieving, mixing, moulding, curing and the actual construction. Community participation is important in influencing adoption of the technology as the people are able to see firsthand how the blocks are produced and used and can be persuaded to use them.

The respondents however felt that they were only occasionally (mean, 3.85) involved in planning and evaluation (mean, 3.63), processes they believed were done in offices away from them. Lack of participation in all the stages of project implementation may result in a reluctance to embrace the technology since there is no ownership of the same by the community. There is therefore need to encourage participation in all the stages of project development.

5.2.3.2 Benefits of Community Participation

The respondents agreed that community participation led to acquisition of new skills (mean 4.63). The skills acquired covered the production and use of the soil blocks in the construction of houses and this helped to boost the adoption and diffusion of the technology though at a slow pace.

Respondents agreed that community participation helped to disseminate information (mean 4.61). The members of the community that participated in the projects passed information on the technology to other members who were not directly involved. The implementing agency was also able to get information on community preferences which can influence future policy decisions.

Community participation was a catalyst for further development (mean 4.21) and that participation led to community ownership of project (mean 4.05). Through participation members of the community were convinced that the technology works and they are able to either use it on their own projects or advice others to use it.

5.2.3.3 Perception

Respondents agreed that the interlocking stabilized soil block is an environmentally friendly building material (mean 4.06). This perception can help in positively influencing adoption of the technology because currently the population is more conscious of their environment and there is a tendency to move towards activities that promote environmental conservation.

75 respondents disagreed that the block is a low quality building material (mean, 2.40) and 97 respondents disagreed that ISSB is a building material for the low income groups (mean, 2.20). 82 respondents agreed that ISSB is a permanent building material (mean, 3.71).

5.2.4 Benefits of Interlocking Stabilized Soil Blocks

97 respondents agreed that the interlocking stabilized soil blocks are environmentally appropriate and adequate and sustainable (mean 4.11). 99 respondents agreed that soil is locally available in large quantities hence affordable (mean, 4.24) and 90 agreed that the blocks are produced on site hence saving on transport costs (mean, 4.22).

Interlocking of blocks and non-use of mortar in joints reduces cost of walling (mean, 4.16); walling is faster and cheaper since many courses can be done per day (mean, 4.28) and construction produces neat joints that do not require rendering hence reducing costs of constructions (mean, 4.17). The respondents were however neutral on fire resistance of soil (mean, 3.97), low energy input in processing ISSB (mean, 3.69), production is labour intensive therefore creates employment (mean, 3.98) and that ISSB production and construction uses cheap local labour (mean, 3.89).This has an effect of negatively affecting the adoption of the technology.

5.2.5 Challenges

This section gives a summary of the challenges of information dissemination and cost that were analysed in this study in relation to adoption of interlocking stabilized soil blocks in development of adequate and sustainable housing projects.

5.2.5.1 Information Dissemination

In this study, 17 respondents (15.6%) felt that there had not been effective information dissemination on interlocking stabilized soil blocks in their locality. 46 respondents felt that the information they received only succeeded in creating awareness, 34 respondents said the information disseminated brought understanding while 12 respondents said it led to adoption of the technology.

5.2.5.2. Characteristic of Information Disseminated

The respondents were asked to give their agreement with the characteristics of the information disseminated in order to assess the extent to which information dissemination efforts met the intended goals and objectives.

Asked whether the information was customized and relevant to their needs, the respondents gave a mean of 3.64. Their response may imply that steps were not taken to first assess and understand the information needs of the target audience before dissemination. This has an effect of negatively affecting the adoption of the technology.

The respondents gave a mean of 3.58 when asked if the dissemination media was suitable for their needs. The response implies that the media used were not suitable for the respondents for example the trainings were too short for any meaningful understanding of the concepts and this has an effect of negatively influencing the adoption of the technology.

On whether communication was in a language they understood, the respondents gave a mean of 3.86. The average response may be due to the technical jargon that is difficult to understand. The respondents gave a neutral response on whether the information content was of interest and relevant to the community with a mean of 3.79. On whether the information provided was accurate, the respondents gave a neutral response (mean 3.55), and a mean of 3.42 on whether information provided was timely. This may imply that the information provided did not satisfy all their expectations towards improved housing.

5.2.5.3 Costs

The respondents were asked to give views on costs associated with production and use of interlocking stabilized soil blocks as one of the challenges hindering adoption of the technology in development of adequate and sustainable housing projects. The respondents disagreed that the machines for production are easily available and the cost of acquiring is affordable (mean, 2.64). The mechanized machines are imported at costs that are beyond the reach of many while the manual machine is manually assembled by local companies. It is not economically viable to purchase a machine for individual private use. The two government machines available in the county cannot meet the needs of the entire county.

The respondents were neutral on the cost of operation and maintenance of the machines being reasonable (mean, 3.08). This can be attributed to cost of fuel for the motorized machines and the cost of transporting the machine for both the manual and motorized types. On the cost of stabilizers like cement being affordable, the respondents disagreed (mean, 2.95).

57 respondents disagreed that finance for construction is easily available and affordable (mean, 2.83). On whether design costs are way high above the reach of many, the respondents disagreed (mean, 2.81). This may be due to the fact that in rural areas people do not contract professionals to design houses for them.

The respondents however agreed that approval and licensing fees increase the cost of construction (mean 4.06).This is especially so in the urban and peri-urban areas where building plans have to be approved by various authorities including National Environment Management Authority, public health officials and public works officers.

5.3 Conclusions

The first objective of the study was to establish the relationship between knowledge of the processes of production of interlocking stabilized soil blocks and adoption of the interlocking technology in the development of adequate and sustainable housing projects in Nandi County Kenya. The chi-square test rejected the null hypothesis and accepted the alternative hypothesis. It can therefore be concluded that knowledge of the processes of production is important in promoting adoption of the interlocking technology in development of adequate and sustainable housing projects in Nandi County.

The second objective of the study sought to establish the relationship between community participation and perception and adoption of interlocking technology in development of adequate and sustainable housing projects in Nandi County. From the chi-square test of the hypothesis, the alternative hypothesis was found to be true that community participation and perception has a significant effect on adoption of interlocking technology in development of adequate and sustainable housing projects in Nandi County. It can thus be concluded that community participation is a suitable strategy for promoting the adoption of the interlocking technology in development of adequate and sustainable housing projects in Nandi County.

The third objective sought to establish the effect of the benefits of ISSB on adoption of the interlocking technology in development of adequate and sustainable housing projects in Nandi County. The chi-square test of the null hypothesis led to the acceptance of the alternative hypothesis that the benefits have a significant influence on adoption of interlocking technology in development of adequate and sustainable housing projects in Nandi County. It can be concluded therefore that the benefits derived from use of ISSB play a significant role in influencing adoption of the interlocking technology in development of adequate and sustainable housing projects in Nandi County.

The fourth objective of this study sought to establish the relationship between the challenges of cost and information dissemination on adoption of interlocking technology in development of adequate and sustainable housing projects in Nandi County. The Chi-square test led to acceptance of the alternative hypothesis that costs and information dissemination have a significant effect on adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County. From this finding it can be concluded that costs and effectiveness and efficiency of information dissemination are important factors in adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County.

5.4 Recommendations

On the first objective, this study recommends that the government and other agencies should promote knowledge of the operation and processes of production. This can be achieved through training for instance by engaging resource persons in the constituency ABTM centres which are currently lying idle. These persons will offer training on a continuous basis and offer any other technical support to community members willing to use the technology, hence promote the adoption of the interlocking soil technology in development of adequate and sustainable housing projects.

From the second objective, this study recommends that all actors in the soil block technology should strive for meaningful community participation in all ISSB housing development projects to ensure adoption of the technology.

For the third objective, this study recommends that there should be deliberate attempts to publicize the benefits of interlocking stabilized soil blocks relative to other construction techniques in order to promote adoption.

On the fourth objective, this study recommends that there should be efforts to promote timely, accurate, relevant and customized information in a suitable language and media to promote uptake of the technology. In addition, there is need for information sharing mechanisms among the various groups promoting and using the interlocking stabilized soil blocks in order to facilitate further improvements and further spread of the technology.

On the factor of cost, this study recommends that members of the community could be encouraged to form housing cooperatives which can have machines for use by its members and can also advance affordable financing or credit to put up adequate housing and ease the financial burdens of construction.

5.5 Suggestions for Further Research

This study concentrated in three sub-counties in Nandi County. A comprehensive study could be done to cover a wider region.

This study focused on four variables that could influence adoption of the interlocking technology in development of sustainable housing. A study could be carried out to examine how other variables could influence adoption of the technology.

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APPENDICES

APPENDIX A: QUESTIONNAIRE

LETTER OF INTRODUCTION

Moi University

P.O. Box 3900-30100

ELDORET

Dear respondent,

Re: Research

I am a student at the above named university pursuing a Master of Science Degree in Project Planning and management. As a requirement for this course, the university expects me to submit a research project as a partial fulfilment for the award of the degree.

To fulfil this requirement, I am undertaking a research on evaluation of the adoption of interlocking soil technology in development of adequate and sustainable housing projects in Nandi County, Kenya.

I kindly request you to fill in the questionnaire attached. The information provided will be used with confidentiality and will only be used for academic purposes.

As you participate in this study, do not indicate your name. I highly appreciate your participation towards the success of this study. Thank you in advance for your kind participation.

Yours faithfully

Chang’ach Euginia

SHRD/PGP/04/14

QUESTIONNAIRE

Section A: Background information

1. Gender (tick as appropriate)

   Male [ ] Female [ ]

2. Age

   Below 20 years [ ] 21-35 years [ ] 36-50 years [ ]

   Above 50 years [ ]

3. Level of education
   Primary [ ] Secondary [ ] Tertiary [ ] Graduate [ ] Postgraduate [ ]

4. Sub-county
   i. Emgwen [ ] Chesumei [ ] Aldai [ ]

Section B:

Operation and processes

5. State the extent to which you understand each of the following processes of production of interlocking stabilized soil blocks**.**

	Very well 5	Well 4	Average 3	Poor 2	Very poor 1
Soil selection					
Soil testing					
Sieving					
Proportioning of soil, stabilizer and water					
Mixing					
Moulding					
Curing					

Community participation

6. Do you consider community participation as important in promotion of sustainable housing strategies in your locality? Yes [ ] No [ ]
7. Has there been community participation in the promotion of appropriate building materials and technologies in your locality?
8. Yes [ ] No [ ]
9. If yes go to question number 8; if No, go to question number 12

10. If yes, how would you describe the level of participation?

    [ ] giving information

    [ ] consultation

    [ ] partnership

    [ ] delegated power

    [ ] empowerment

11. What form of community participation was used?

    [ ] Field workers of the project agency

    [ ] Community workers or committees

    [ ] User groups

12. Kindly state the extent to which you agree or disagree with the following statements on benefits of community participation.

Item	Never 1	Rarely 2	Occasionally 3	Often 4	Always 5
Community ownership of project					
The project was a catalyst for further development					
People acquired new skills					
It helped to disseminate information					

13. Please indicate the extent to which you agree or disagree with each of the statements by selecting one category that mostly corresponds with your desired response in relation to the establishment of ABTM centres and promotion of ISSB in your locality.

Item	Never 1	Rarely 2	Occasionally 3	Often 4	Always 5
The community was involved in information gathering and identification of the project					
The community was involved in planning					
The community was involved in implementation					
The community is involved in evaluation					

14. If your answer to number 7 above is **NO**, what are the probable causes for non-participation?

[ ] Lack of education

[ ] Lack of appropriate skills

[ ] Lack of confidence

[ ] Lack of structural ties with existing organizations

[ ] Lack of interest

[ ] Lack of trust

[ ] Lack of experience

[ ] Lack of time and money

Perception

15. Please indicate the extent to which you agree or disagree with each of the statements by selecting one category that mostly corresponds with your desired response.

Item	Strongly agree 5	Agree 4	Undecided 3	Disagree 2	Strongly disagree 1
Soil is a permanent building material					
Interlocking stabilized soil block is a low quality building material					
Interlocking stabilized soil blocks is a building material for the low class(low income group)					
Interlocking stabilized soil block is an affordable building material					
Interlocking stabilized soil block is an environmentally friendly building material					

16. Do you consider the interlocking stabilized soil block as a sustainable solution to the housing problem in your locality?

Yes [ ] No [ ]

17. If yes, what are the possible reasons?

[ ] It is environmentally friendly

[ ] It is affordable

[ ] soil is a culturally acceptable building material

Benefits

18. State the extent to which you agree with the following stated benefits of interlocking stabilized soil blocks

	Strongly agree 5	Agree 4	Neutral 3	Disagree 2	Strongly disagree 1
Soil is fire resistant					
There is low energy input in processing ISSB					
Production is labour intensive therefore creates employment					
It is environmentally appropriate and sustainable					
Soil is locally available in large quantities hence affordable					
Interlocking stabilized soil blocks can be produced on site hence saving on transport costs					
ISSB production and construction uses cheap local labour					
Interlocking of blocks and non-use of mortar in the joints reduces cost of walling					
Walling is faster and cheaper since many courses can be done per day					
Construction produces neat joints that do not require rendering hence reducing costs of constructions					

Information dissemination

19. Has there been effective information dissemination on interlocking stabilized soil blocks in your locality?

    Yes [ ]   No [ ]

20. If yes, what was the source of information?

    [ ] Government agencies

    [ ] Non-governmental organizations

    [ ] Barazas

    [ ] Churches

    [ ] Media

    Electronic [ ]   Print [ ]   social [ ]   [ ] others (please specify)……………………………

21. Which of the following functions has the information dissemination accomplished?

    [ ] Created awareness

    [ ] Brought understanding

    [ ] Led to adoption of the technology

22. State the extent to which you agree with each of the following statements.

Item	Strongly agree 5	Agree 4	Neutral 3	Disagree 2	Strongly disagree1
Information was customized and relevant to our needs					
The dissemination media was suitable for our needs					
Communication was in a language we understand					
The information content was of interest and relevant to the community					
The information provided was accurate					
The information provided was timely					

23. Did you find the knowledge attained relevant to improving your housing situation?

[ ] To a very large extent-(5)

[ ] To a large extent-(4)

[ ] To a sufficient extent (3)

[ ] To a small extent (2)

[ ] To a very small extent (1)

24. Do you think you will have an opportunity to apply the newly acquired knowledge in improving your housing situation?

Yes [ ] No [ ]

25. Please give suggestions on knowledge gaps that you feel need to be addressed in relation to interlocking stabilized soil blocks………………………………………………………………………………………

……………………………………………………………………………………………
……………………………………………………………………………………………

Costs

26. Please indicate the extent to which you agree or disagree with each statement by selecting one category that mostly corresponds with your desired response.

Item	Strongly Agree 5	Agree 4	Undecided 3	Disagree 2	Strongly Disagree 1
Machines for production are available and affordable					
The cost of operation and maintenance of machines is reasonable					
Cost of stabilizers like cement is affordable					
Finance for construction available and affordable					
Design costs are high					
Approval and Licensing fees increase the cost of construction					

APPENDIX B: INTERVIEW SCHEDULE (KEY INFORMANTS)

1. What materials are commonly used by residents of this county in their wall construction needs?
2. What are the main sources of these materials?
3. Are they still abundant or depleted and to what extent?
4. What strategies are being used in the dissemination of ISSB
5. How can the community be involved in housing projects in this county to promote sustainability?
6. From your experience, how would you describe the influence of the following factors on the adoption of the interlocking stabilized soil blocks?
7. Operation and processes
8. Community participation and perception
9. Associated benefits
10. Information dissemination and cost
11. What would you say are the environmental effects of the interlocking stabilized soil blocks?
12. What are the challenges you experience in promotion of the interlocking stabilized soil blocks?
13. What are your recommendations on enhancing of adoption of the ISSB technology for development of adequate and sustainable housing projects in Nandi County?