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Evaluation of Adoption of Interlocking Soil Technology in Development of Adequate and Sustainable Housing Projects in Nandi County, Kenya.

Chang'ach Euginia[1]; Prof. Peter Omboto[2]; Prof. Leonard Mulongo[3]

[1] Student, Department of Entrepreneurial and Project Studies, Moi University, Kenya
[2] Lecturer, Department of Entrepreneurial and Project Studies, Moi University, Kenya
[3] Lecturer, Department of Development Studies, Moi University, Kenya.

Abstract:
Project success incorporates both project management success and product success. The basic criteria for evaluating project success are scope, time, cost, and client satisfaction with the final product or service. The use of interlocking stabilized soil block technology in housing projects has been promoted in Kenya as a means to address poverty, sustainable housing and housing affordability challenges facing many Kenyans. 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 in development of adequate and sustainable housing projects in Nandi County. The variables analyzed for this study were; understanding of the processes of production, community participation, benefits of the technology and the challenges of cost and information dissemination. The study was guided by the Innovation Diffusion and Systems theories. The study adopted a descriptive survey design. 155 households were sampled out of the 81,672 households in the target population. Quantitative data was collected using questionnaires. Data was analyzed using descriptive and inferential statistics. The study established that the interlocking technology is not widely practiced. There is an average understanding of the processes of production, community participation is not widely embraced, information dissemination is not effective and efficient and the costs were not affordable. The study recommends that action should be taken to promote better understanding of the processes of production, enhance community participation and addressing the challenges of cost and information dissemination

Key words: Adoption, interlocking soil technology, adequate and sustainable housing.

1.1. Introduction and background

Since the early times man has made relentless efforts to obtain shelter. The struggle for this basic need 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. 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 to invest in shelter.

Improvement of housing for the Kenyan population continues to be a major concern to the government. 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 the elements of privacy, space and housing conditions.

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 wall materials of a dwelling unit are also indicative of the extent to which they protect occupants from the elements and other environmental hazards. Housing conditions have implications for provision of other services such as connections to water supply, electricity and waste disposal. They also determine the safety, health and well being of occupants. 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. According to the Housing Policy of 2004, the urban housing needs are 150,000 units per year while the estimated production is only 20,000-30,000 annually giving a shortfall of over 120,000 units. This shortfall 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).

This 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 (Republic of Kenya, 2004).

In terms of space and privacy, the Kenya Integrated Household and Budget Survey of 2006 reported that 59 % of people in urban areas of Kenya are accommodated in one roomed houses as per table 1 below:

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)

In addition, only 39.5 % of the Kenyan population has used stone and brick/block for walling as compared to Nandi County which has only 14.1 % as tabulated below:-

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 the 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.

On the other hand, Kenya is endowed with abundant natural resources that can meet the demand for basic building materials (Republic of Kenya, 2004).

To mainstream this strategy, the government in 2006 introduced the Appropriate Building Materials and Technology (ABMT) project focusing mainly on the interlocking stabilized soil blocks (ISSB). It aimed at addressing the high building material costs which account for approximately 40% of the construction costs (KNBS, 2013) by facilitating the provision of improved and affordable housing in both urban and rural areas. ABMT 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 seeks to evaluate adoption of the interlocking soil technology in development of adequate and sustainable housing in Nandi County.

1.2 Statement of the Problem

Sustainable housing development must aim at economic, social and environmental sustainability from project planning to implementation phases and at the same time result in housing that is affordable, accessible and environmentally less damaging (Pakir, H.K. and Tabassi A.A., 2012). The United Nations committee on economic, social and cultural rights stated that the right to adequate housing should be seen as a right to live somewhere in security, peace and dignity. Adequate housing must provide more than four walls and a roof. It should guarantee adequate privacy, physical safety, physical accessibility and adequate security, security of tenure, structural stability and durability. An adequate house should also at a minimum have two habitable rooms.

Adequate housing should also provide adequate lighting, heating and ventilation. It should guarantee adequate basic infrastructure such as water supply, sanitation and waste management facilities, suitable environmental quality and health related factors, that is, 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.

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(Republic of Kenya, 2004).

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. 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% (KNBS, 2018). 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 (KNBS and SID, 2013).

The unprecedented proliferation of slums and other informal settlements is the physical manifestation in cities of a chronic lack of adequate and affordable housing.

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.

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 appropriate building materials and technology centres in each constituency (Government of Kenya, 2007). This study will evaluate the adoption of interlocking soil technology in development of sustainable housing in Nandi County

1.3 Research Objective

The objective of this study was to evaluate the adoption of the interlocking soil technology in development of adequate and sustainable housing projects in Nandi County. The specific objectives were to examine the influence of the level of understanding of the process of production of ISSB on adoption of interlocking soil technology in development of adequate and sustainable housing projects; to assess the extent to which

participation and perception by the community influences adoption of interlocking soil technology in development of adequate and sustainable housing projects; to evaluate the effect of the benefits of ISSB on adoption of interlocking soil technology in development of adequate and sustainable housing projects and to analyse the influence of the challenges associated with ISSB on adoption of interlocking soil technology for development of adequate and sustainable housing projects in Nandi County, Kenya.

1.4 Significance of the study

It is anticipated that the study will inform policy decisions on the adoption of the interlocking soil blocks technology under the Appropriate Building Materials and technology (ABMT) programme as provided by the Kenya Vision 2030. The study will also shed light on the effectiveness of dissemination of information on interlocking stabilized soil blocks to the potential users in order for them to make informed decisions about the technology.

The study will also contribute to the body of knowledge in the subject of ISSBs in improving the shelter situation and can be used as a reference material.

2.0 Literature Review

2.1 Theoretical Review

In this study, the Innovation Diffusion Theory and the Systems Theory were considered, illuminating the objectives and variables of this study.

2.1.1The Innovation Diffusion Theory

The Innovation Diffusion theory by Rodgers (1995) provides a broad foundation to understand the factors that influence the choices that an individual makes about an innovation. The theory describes five stages that individuals go through during an evaluation of an innovation; these are awareness, persuasion, decision, implementation and confirmation.

Rodgers (1995) also gives four major components which interact to describe how individual adoptions combine to represent diffusion. These are the innovation itself, (relative advantage, compatibility, complexity, trial-ability and observe-ability of an innovation), communication channels, social systems and time.

This theory has relevance to this study in that the study 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 understanding, community perception and participation, benefits, costs and information dissemination to development of adequate and sustainable housing projects.

2.1.2 Systems Theory

The systems 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 is a system comprising of inputs, processes, outputs, outcome, feedback and the environment. This theory was therefore 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 perception and the benefits derived from the interlocking technology on development of adequate and sustainable housing projects.

3.1 Methodology

The study adopted the descriptive research design. Kumar (2011), states that descriptive research attempts to describe systematically a situation, problem, service or programme or to provide information or describe attitudes towards an issue. This design was appropriate for this study as it helped to describe the relationship between the dependent and independent variables.

The target population for this study was 81,672 households in Emgwen, Aldai and Chesumei constituencies of Nandi County (KNBS and SID, 2013). The sub-counties were chosen purposively since the government

has established appropriate building materials and technology centers in these sub-counties and it is imperative that the residents have some knowledge on the interlocking stabilized soil blocks (ISSB).

Yamane's (1967) formula, $n=N\ 1+N(e)^2$ at 8% level of precision was used to determine the sample size which was 155 respondents, which were divided proportionately between the three sub-counties. Simple random sampling was then used to select the respondents.

A semi-structured questionnaire was administered to the sampled respondents. The questionnaire gathered data on understanding of the processes and operations of production, community perception and participation, benefits and the challenges of cost and information dissemination. The questionnaire was on likert type statements anchored on five point rating scale.

The questionnaires were administered to all the 155 respondents but responses were only obtained from 109 respondents. 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.

Content validity of the research instrument was ensured through seeking opinions of experts, specifically the lecturers and supervisors. External consistency of the research instrument was tested using a test/retest procedure in a pilot study. The internal consistency 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.

Data was analyzed using both descriptive and inferential statistics. Descriptive statistics helped to describe the main characteristics of the variable of interest in the study. Mean scores, standard deviations, percentages and frequencies were generated to aid in analysis and interpretation. Regression analysis was done to determine the relationships among the variables. The analyzed data was presented in form of tables.

4.1 Data Analysis
4.1.1 Descriptive statistics

Table 4.1 Understanding 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

The first objective of the study was to examine how the level of understanding of the process of production affects the adoption of interlocking soil technology in development of adequate and sustainable housing. To achieve this, the study sought to establish the extent to which the respondents understood the operations and processes involved in production of ISSBs.

Majority of the respondents in this study seemed to have challenges with production of the blocks and demonstrated an average understanding of most of the processes as indicated in Table 4.1. These findings are similar to findings of Gooding and Thomas (1995) who observed that ISSB production is often presented as a simple process while in fact it relies on a significant degree of understanding 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 underscored the importance of proper understanding of the production process by observing 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.

Table 4.2 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

The second objective of the study was to find out the influence of community participation on adoption of the interlocking soil technology in development of adequate and sustainable housing. 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. This 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). They believed that these were done in offices away from them. Their 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. 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 emphasizes the need to involve the stakeholders in all the stages of project development from design through to implementation in order to promote success of the project

Table 4.3 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

The third objective of the study was to assess how the benefits derived from ISSBs affect adoption of the interlocking soil technology in development of adequate and sustainable housing. A majority of the

respondents agreed that the interlocking stabilized soil blocks are environmentally appropriate and sustainable (mean, 4.11).

This is in agreement with studies carried out elsewhere 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, this factor is essential in positively influencing the adoption of the technology in promoting sustainable housing development since policy and regulatory frameworks can influence technological adoption(Kemp Schot and Hoogma,1998).

Most of the respondents agreed that soil is locally available in large quantities hence affordable (mean, 4.24) and the blocks are produced on site hence saving on transport costs (mean, 4.22). This is in agreement with studies carried out in North Eastern Province of Kenya 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).

The respondents also 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). This is in agreement with previous studies (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.

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 the 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).

The fourth objective of the study sought to determine how the challenges associated with production and use of ISSBs influence its adoption. The study sought to establish how the challenges of dissemination of information and costs influenced the adoption of the technology. The respondents were asked to give their level of agreement with the characteristics of the information disseminated in order to assess the extent to which information dissemination efforts in terms of customization, media suitability, language, accuracy, timeliness and relevance to the intended audience were meeting the intended goals and objectives.

Table 4.4 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. This has an effect of 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 is a neutral response that 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. This is an average response that tends toward a good understanding. The result may be due to the technical jargon that may not be easy to understand.

Majority of 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). This may be attributed to the economic situation that may not allow the population to invest in a modern house.

Most of the respondents gave a neutral response on 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.

Table 4.5 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 were also 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. The respondents disagreed that the machines for production are easily available and the cost of acquiring is affordable (mean, 2.64). These findings are in agreement with the findings of David (2014), and Mule (2012) who concluded that block presses can be too expensive for small scale individual use. This is a factor that can negatively affect the integration of the technology.

The respondents gave a neutral response 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. This is a challenge that was also experienced in Uganda (UNHCR, 2009). This 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). 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 require 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. Research on alternative stabilizers replacing cement in the mixture will help to reduce the cost to a level that is affordable.

Most of the 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 main reason is that low cost building materials and their technologies are yet to gain general acceptance and constitutes a financial risk.

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. Licenses from the local authorities also have to be applied for and paid. These are factors that may slow down not just construction using ISSBs but construction activities in general.

4.1.2 Regression Analysis

For this study, a multiple regression model was applied to identify the impact of understanding 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=understanding of the processes, X_2=community participation and perception, X3=benefits, X4=challenges and e is the error of prediction. Table 4.6 presents the summary of the regression analysis.

Table 4.6 Model Summary

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

	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			

	Un-standardized coefficients **B**	Std. Error	Standard coefficients	t	Sig.
(constant)	3.80	0.451		8.36	0.004
Understanding	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

Dependent variable: Development of adequate and sustainable housing

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

The model summary indicates that the coefficient of determination R^2 was 0.849 implying that 84.9% of the total variation in adoption of the interlocking technology was accounted for by the four predictors, that is, understanding, community participation, ISSB benefits and challenges of cost and information dissemination. The difference between the model coefficient of determination and its adjusted R^2 was 0.004 suggesting that if the model was derived from the population rather than a sample, it would account for approximately 0.4% less variance in outcome.

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). This means that the variation attributed to the predictors is very unlikely to have happened purely by chance.

The beta value for the variable of understanding of the processes was 0.78 and the corresponding p value was 0.003. The positive beta value means that the more understanding of the processes of production of interlocking soil blocks, the more the adoption of the technology would increase. The p-value of less than 0.05 implies that there is a significant relationship between understanding and adoption of the technology.

The beta value for the variable community participation was 0.46 with a p-value of 0.001. This implies that the more community participation is used, the more there is adoption of the interlocking technology in development of adequate and sustainable housing. The relationship between the variables is also significant. The beta value for benefits was 0.47 with a p-value of 0.005 and the beta value for cost and information dissemination was 0.53 with a p-value of 0.004 implying that the relationships between the variables were all significant and positive.

5.1 Summary and Conclusions

The first objective of the study was to establish the relationship between understanding of the processes of production of interlocking stabilized soil blocks and adoption of the interlocking technology in the development of adequate and sustainable housing in Nandi County Kenya. The regression analysis returned a p-value of 0.003 which is less than 0.05 indicating that the relationship between the two variables is significant. It can therefore be concluded that understanding of the processes of production is important in promoting adoption of the interlocking technology in development of adequate and sustainable housing 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 in Nandi County. From the regression analysis community participation had a p-value of 0.001 which is less than 0.05, indicating a significant relationship between the variables. 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 developments 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 in Nandi County. From the regression analysis this variable had a p-value of 0.005 which indicates a significant relationship between the two variables. 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 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 in Nandi County. The regression analysis gave a p-value of 0.004 which is less than 0.05 confirming 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 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.

References

[1] Adam E.A. (1983). Traditional and improved methods of low-cost housing in the Sudan, *International Journal for Development Technology, Vol. 1,* 109-120.

[2] Bertalanffy, L.V. (1956). General System Theory. *General Systems,1*,1-10

[3] David .K. (2014). *Construction of low cost houses in informal settlements- A case study of the Nairobi region*. Master of Science thesis in structural engineering and building technology. Chalmers University of Technology. Unpublished thesis

[4] Gooding, D.E. and Thomas, T.H. (1995). *The potential of cement stabilized building blocks as an urban building material in developing countries*. Working Paper No. 44.Development Technology Unit, University of Warwick. Coventry, England.
[5] Hadjri, K.; Osmani, M. M.; Baiche, B. and Chifunda, C. (2007). Attitudes towards earth building for Zambian housing provision. *Proceedings of the Institution of Civil Engineers: Engineering Sustainability, 160(3).* PP. 141-149. Thomas Telford Publishing.
[6] Kenya National Bureau of Statistics (2006), *Kenya Integrated Household Budget Survey, 2006.* Nairobi. Government Printers.
[7] Kenya National Bureau of Statistics (2013), *Kenya National Housing Survey, 2013.* Nairobi. Government Printers.
[8] Kenya National Bureau of Statistics and Society for International Development, (2013). *Exploring Kenya's inequality, pulling apart or pooling together*. Nairobi.
[9] Kemp, R.; Schot, J. and Hoogma R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technology analysis and strategic management vol.10 (2) pp 175-179*
[10] Kumar Ranjit. (2011). *Research methodology. (3rd ed.). A step by step guide for beginners*. Sage Publications. London.
[11] Mugenda O.M. &Mugenda A.G. (2003). *Research methods: Quantitative and qualitative approaches*. Nairobi. ACTS Press.
[12] Mule B.M. (2012). *Factors affecting the adoption of appropriate building materials and technologies (ABM&Ts) programmed in North Eastern Province of Kenya.* Unpublished MA in Project Planning and Management. University of Nairobi.
[13] Pakir H.K, Tabassi A.A, Ramli M, Abubakar H.A and Roufechael K.M (2012). Sustainable housing development and leadership, *Australian Journal of Basic and Applied Sciences,* 6(12):385-395
[14] Republic of Kenya. (2007). *Kenya Vision 2030*. Nairobi. Government Printers.
[15] Republic of Kenya. (2004).*Sessional Paper No. 3 on National Housing Policy for Kenya*. Nairobi .Government Printers.
[16] Republic of Kenya. (2010). *The Constitution*. Nairobi. Government Printers
[17] Rogers, E. (1995). Diffusion of Innovations. (4 th ed.). New York: Free Press.
[18] Tavakol, M and Dennick, R. (2011). Making Sense of Cronbach's Alpha, *International Journal of Medical Education.* No.2. pp53-55
[19] UNHCR. (2009). *Interlocking stabilized soil blocks: Appropriate earth technologies in Uganda*, Nairobi, UNON Publishing Services Section.