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Towards Enhanced Adoption of Innovative Building Technologies in Construction Industry

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Abstract:

Innovative building technologies (IBT) are often exhibited as a panacea for mitigating housing delivery shortfalls in the light of the ever-growing construction costs. However, adoption of these technologies in Kenya's construction industry is slow and this diminishes the probable impact of IBTs in addressing housing supply challenges. This study aims to formulate a framework that can be used to enhance adoption of IBT in construction projects. To achieve this, the study describes the existing legal and institutional framework influencing adoption Innovative Building Technologies, the promotional strategies for the IBT and the drawbacks to adoption of IBT. A review of related literature shows that there are critical handicaps to adoption of IBT in some legislation. The review also appreciates that there is continued introduction of IBTs in Kenya and there is considerable effort by the Government to promote their adoption. The research relies on interviews to gather information from industry players broadly classified into IBT policy makers and disseminators and the IBT technology providers. The policy formulators include the government agencies with mandate on IBT promotion or regulation and providers include the private entities that produce and promote use of IBT. The researcher sought to assess the drawbacks in institutional and legal framework that derail adoption of IBT from the perspective of the two categories of industry players. From the data analysis, it is concluded that the building laws should be tailored to regulate performance of materials rather than rigidly focusing on the material composition. On institutional arrangement, there is need for wider corroboration between IBT producers and Institutions charged with policy formulation and dissemination. This will help to ease bias against IBT in the construction industry and to bring about perfect information on IBTs in the market including in training institutions.

Keywords: Adoption, Building Technologies

1. Introduction

The provision of adequate and affordable housing remains a challenge to most countries, particularly those in the developing world. Diverse strategies are pursued by various governments worldwide in order to address the problem; key among them is alternative building materials and technologies. It is understood that most of the buildings constructed using conventional building materials like natural stone, steel and mortar are unaffordable to a majority of people in the developing world, thus necessitating the development and adoption of alternative, relatively cheap, decent and durable on site produced materials (HABRI, 2003). It comes as no surprise that in the 1997 Kyoto Agreement, many countries agreed to reduce the use of reinforcing rods to 80%, aluminum down to 90%, and cement down to 80% by the year 2050 (Atkinson, 2007). If this promise is to be kept, it is imperative that Innovative Building Technologies have to be used in significantly high scale.

Attempts have been made to quantify the cost saving impact of Innovative Building Technologies (IBT) by looking at the constituent cost of construction output. It is a widely acknowledged concept that a great deal of housing construction costs is directly linked to building materials. The strategic plan of the Ministry of Housing in Kenya cites the Building Materials & Technology Promotion Council (BMTPC) of India which postulates that building materials account for approximately 60% of the total building costs. Housing and Building Research Institute (HABRI) accentuates the above sentiment and states that the building materials cost can sometimes account for as much as 75% of the cost of a low-cost house. The benefits of Innovative Building Technologies however go beyond cost savings. They have been lauded for environmental protection, employment generation and energy conservation (BMPTC, HUDCO, 2011).

The UN-Habitat 2009 stresses on the need for continued worldwide investment and innovation particularly in appropriate technologies in order to meet the need for adequate housing (UN-HABITAT, 2009). In any case, many African countries are endowed with abundant natural resources that can meet their need for building materials production. Despite this they rely heavily on imported building material and technologies (Selman, 2001). This means that the spread of those technologies has not been as rapid or as

extensive as the urgent housing situation requires (UN-HABITAT, 1987). This builds a case for intervention to ensure that Innovative Building Technologies are embraced to boost provision of houses in construction industry.

On the policy platform at the local level, the problem of housing and the need for appropriate technologies has received considerable attention. The Sessional Paper Number 3 of 2004 on housing policy for Kenya recognizes the problem of urban housing as characterized by an acute shortage in the number of dwellings, overcrowding in the existing housing stock as well as the existence of sub-standard human settlements such as extensive slums and squatter settlements (G.O.K, 2004). The acute shortage in housing supply has pushed the cost of housing beyond the reach of majority of low income earners. The Sessional paper further observes that the majority of the people in urban areas do not own homes as the level of owner-occupancy has been declining. The Government of Kenya attributes this to; high cost of building and construction materials; inappropriate building and construction technologies; limited research on low cost building materials and construction technologies among other contributory factors (G.O.K, 2010). This formal acknowledgement creates an impetus for concerted efforts by both state and non-state agencies to devote resources in production and promotion of appropriate technologies.

The other Government intervention in Innovative Building Technologies can be seen in terms of investments where the government spends millions of dollars in order to introduce new, lower-cost materials into the market. The National Housing Corporation, the implementation arm of the State department for Housing, have put up a factory to produce a polystyrene walling panel. Several other initiatives have been undertaken by the government in the area of research and dissemination of information on low cost building materials and technologies.

However, the paradox on the housing delivery side remains; that the majority of populations remain steeped in traditional construction methods. Despite the high demand for housing especially in the city and the affordability challenges, adoption of IBT is rather subdued. While acknowledging that the use of alternative materials and technologies is promising in Kenya and across most of the world, Noppen (2012), observes that most developers in Kenya stick to stone and cement, and there is not widespread use of any alternative building material. The look and feel of the home is attached to status, and unlike new medical devices or agricultural inputs, when someone purchases a home, they want to put their savings into a reliable structure that looks and feels like the homes of their middle-class counterparts. Besides the social aspects, the existing legal framework has received some bit of criticism. The current Building Code has for instance been branded as material based and contains many inappropriate and outdated provisions (Musungu, 2010). This has potential to discourage adoption of Innovative Building Technologies.

2. Research Methodology

2.1. Introduction

This section outlines the activities that were executed to achieve the objectives of the study. The description covers the research area, research strategy, study population, sample and sampling procedures, data collection approaches and techniques and data analysis.

2.2. Study Area

Innovative Building Technologies application in Kenya has spread to most parts of the Republic of Kenya. As such awareness and knowledge based information exist at both the National and grassroots level with Nairobi City County dominating in terms of information knowledge and access. This study was therefore designed to cover the IBT key informants and technology providers in Nairobi and other Counties in Kenya

2.3. Research Strategy

This study adopted both qualitative and quantitative strategies in the data collection processes. This was particularly important because besides opinions, the study purposed to measure the significance of various factors that influence adoption of innovative materials in order to lay emphasis on effective strategies that can enhance innovative material adoption. The quantitative aspects were addressed by rating of individual parameters that are central to adoption of innovative building materials to gauge their significance. On the other hand, qualitative strategies were instrumental in formulation and reporting on the descriptive statistics.

2.4. Study Population

The study population was divided into two clusters with one cluster comprising of IBT policy makers and disseminators and the other cluster comprising of IBT technology providers

The IBT policy makers and disseminators included the Government Ministry with responsibility of policy making and promotion of innovative building technologies, that is, the Directorate of Housing in the Ministry of Land, Housing & Urban Development. The Ministry also performs the dissemination function mainly through government officials at county level who provides advisory to the county governments on the use of IBT as well as undertaking capacity building to local communities in the uptake of such technologies. The second cluster was derived from Innovative Building Technology Providers who were mainly private organizations. Such organizations are recognized by the Government Ministry in charge of Housing to be dealing in innovative building technologies.

2.5. Sampling and Sample Size

A cluster sample frame in the study was obtained from the state Department of Housing and Urban Development (Directorate of Housing) at the headquarters in Nairobi where the innovative building technology promotion function is domiciled. It involved

obtaining a list and contacts details of the technical staff championing the implementation of innovative technologies countrywide and the technology provider companies in the Ministry's database.

The two clusters selected were subjected to census survey as summarized in Table 1 below

Key Informant Category	Identified Target Population as per Ministry database	Actual Sample Size
Respondents from Government (IBT policy makers and disseminators)	47	47
Respondents from Private Sector (IBT providers).	18	18
Total	82	82

Table 1: Composition of the Sample Size

2.5.1. Types of Data and Sources

The data collection included both Primary and Secondary data sources. The primary data was obtained from the field on IBT adoption in terms of the technologies that are in use and the impact of the existing regulatory and institutional frameworks on the adoption of the technologies in Kenya. This involved the use of structured and open-ended questionnaires. Secondary data used during the study was sourced from State department for Housing on documented projects using IBT and locations, technical capacity, and challenges within the study area. In addition, other secondary information pertaining to adoption of IBT were obtained from relevant Libraries with information on previous research project reports with relevance to the study as well as from companies dealing with IBT.

2.5.2. Data Analysis

The data collected during this study underwent several quality and validity processes including; verification of completeness, coding, data entry, cleaning and processing. The data entry process was conducted using SPSS platform from where the entry, processing and analysis was done. Other processes involved importing the processed data to MS Excel and MS Word for report writing.

3. Results

3.1. Policies and Regulations that Relate to the Adoption of Innovative Building Technologies in Kenya

The respondents were asked to indicate whether they were aware of existing policy and regulations documents as relates to adoption of innovative building technologies. The results of the study revealed that all respondents were aware of both the Building Code and the Constitution of Kenya (2010). Awareness of other policy and regulations like the Kenya Vision 2030, National Construction Authority Act, Public Health Act and Physical Planning Act National Housing Policy (2004) was fairly high at the range of 79 to 90%. The respondents were least aware of the Urban Areas and Cities Act at 47.7%. The high awareness is attributable to respondents from government who are fairly informed on policies and regulations affecting IBT adoption. Table 2 below shows the respondents' awareness of policy and regulation documents relating to adoption of innovative building technologies.

SN	Regulation/Policy	Aware		Not Aware	
		N	%	N	%
1.	Building Code	44	100.00%		0.00%
2.	Constitution of Kenya (2010)	44	100.00%		0.00%
3.	Housing Policy	39	88.64%	5	11.36%
4.	Kenya Vision 2030	39	88.64%	5	11.36%
5.	National Construction Authority Act	39	88.64%	5	11.36%
6.	Public Health Act	37	84.09%	7	15.91%
7.	Physical Planning Act	37	84.09%	7	15.91%
8.	National Housing Policy (2004)	35	79.55%	9	20.45%
9.	Urban Areas and Cities Act	21	47.73%	23	52.27%
	Average		85.86%		14.14%

Table 2: Respondents' awareness of Policy and Regulations in IBT

3.1.1. Provisions affecting IBT adoption in Policies and Regulations

The respondents were asked to highlight provisions in the existing policy and regulatory frameworks that relates to adoption of innovative building technologies. The following were the highlighted provisions:

- a) Provisions in the Building Code
- Provisions relating to wall thickness.
 - Provisions relating to reinforced concrete construction.
 - Prescription in terms of material standards and specifications to be used in construction.
 - Acknowledgement of use of innovative building technologies.

- b) The Constitution of Kenya
- Provisions of Article 43(1) (b) on housing as a basic right for all Kenyans.
- c) Kenya Vision 2030
- It supports the use of innovative building technologies.
 - The provisions relating to establishment of Appropriate Building Materials and Technology Centres in every constituency across the country.
 - Housing and urbanization are recognized as among Vision 2030's social pillars.
 - Vision 2030's flagship projects set up Kenya Industrial Research and Development Institute to foster appropriate technology including in construction.
- d) National Construction Authority Act
- Provision on registration of contractors and function relating to research in building technologies.
- e) Public Health Act
- Provision of safety and approval guidelines.
 - Provision on water absorbency in walling materials.
- f) Physical Planning Act
- Provision for safety and approval guidelines.
- g) National Housing Policy (2004)
- Promotion of research and development on appropriate building technologies.
 - Provision on utilization of appropriate building technology in construction of houses.
 - Provision on Environmental Impact Assessment.

3.1.2. Impact of the Policies/Regulations on Adoption of Innovative Building Technologies

The respondents were asked to indicate the extent to which the policies/regulations adversely affected the use of innovative building technologies in construction projects. The results of the study revealed that the Urban Areas and Cities Act had no adverse effect on the use of innovative building technologies in construction projects represented by a mean of 5. This was within the zone of very low extent on the Likert scale. The National Housing Policy (2004) was also found to have impact to a very low extent on the use of IBT in construction projects represented by a mean of 4.57. The Building Code and National Construction Authority Act were found to have adverse effect to a high extent on the adoption of building technologies in construction projects represented by means of 2.77 and 3.20 respectively. Table 3 shows the effects of the policies/regulations on use of IBT in construction projects.

SN	Regulation/Policy	N	Mean
		Statistic	Statistic
1	Urban Areas and Cities Act (2011)	44	5.00
2	National Housing Policy (2004)	44	4.57
3	Kenya Vision 2030	44	3.97
4	The Public Health Act	44	3.94
5	The Physical Planning Act	44	3.63
6	The Constitution of Kenya	44	3.49
7	National Construction Authority Act	44	3.20
8	Building Code	44	2.77

Table 3: Rating of adversity or enablement of Policy/Regulations on use of IBT in Construction Projects

3.1.3. Weaknesses in the Policies and Regulations

The respondents were further asked to highlight the weaknesses which, in their view, are inherent in the policy and regulatory framework towards the adoption of innovative building technologies. Twenty weaknesses were identified and explained as follows:

- a) There are no clear provisions in the policies and regulatory frameworks on the promotion of the technologies by the government. This leaves promotional initiatives to the whims of the Government of the day and as such, there is bound to be inconsistency in approach and goal.
- b) The policies have not provided for a framework for support of the technologies. This again leaves the options for support open to discretion and at risk of subjectivity.
- c) The regulations seem not to be unified towards a tangible goal such as provision of shelter to all. This is more so because the laws are intended to address other objectives and no attention has been given to promotion of the IBT in the laws.
- d) The regulatory framework is limiting in terms of prescribing standards which limit use of innovative building technologies.

- e) There are no provisions in existing policies and regulations that advise or guide the use IBT or rather, it seems there is no recognition of IBTs and to some, this could be interpreted to mean that that they are prohibited.
- f) There is weak implementation process for various policies and regulatory frameworks.
- g) Some regulations e.g. the Physical Planning Act allows for the approval of conventional building materials at the expense of IBT.
- h) There are no provisions to guide transportation and shifting of housing materials.
- i) Enforcement of the provisions is not clear.
- j) The Building Code is prohibitive on the use of IBT.
- k) There are poor policy implementation strategies.
- l) There are inadequate promotion guidelines of the technologies.
- m) There is no funding policy and most institutions depend on the government.
- n) There is low priority in application of IBT in the Public Health Act and Physical Planning Act.
- o) Lack of standardization of prefabricated housing.
- p) Approval of building plans on the basis of conventional technologies as provided for in the Physical Planning Act slows down the adoption of IBT.
- q) There is lack of policy coordination support.
- r) There is lack of comprehensive regulatory framework guiding housing development.
- s) Lack of comprehensive Housing Act to guide the use of innovate building technologies.
- t) Approval process governed by Urban Areas and Cities Act is quite prohibitive on the use of innovative technologies.

The weaknesses as identified by respondents are largely general and based on opinion of respondent rather than direct provisions in the policy or regulations in themselves. This implies that in order to address weaknesses, focus may not necessarily be geared towards the existing provisions but rather on coordination or interaction of these policies and regulations as well as the environment within which they operate.

3.1.4. Institutions Involved in Promotion of Innovative Building Technologies in Kenya

3.1.4.1. Areas of Involvement of the Institutions in the Adoption of IBT

The respondents were provided with a list of institutions involved in the adoption of IBT where they were required to indicate from four choices, the areas of involvement of the organizations. The choices included research, development, regulation and promotion. Results of the study revealed that for the State Department for Housing and Urban Development, 34.1% of the respondents associated it with promotion of innovative building technologies, 27.3% of the respondents associated it with regulation, 13.6% associated it with research and 25% associated it with development of innovative building technologies. Table 4 below shows the areas of involvement to which the respondents associated the State Department for Housing and Urban Development.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
State Department for Housing and Urban Development	Research	11	25.0%
	Development	6	13.6%
	Regulation	12	27.3%
	Promotion	15	34.1%
Total		44	100.0%

Table 4: Areas of involvement the State Department for Housing and Urban Development

As for the Kenya Bureau of Standards, 93.1% of the respondents associated it with the role regulation in the IBT adoption process while 6.1% of respondents associated it with promotion of the innovative building technologies. Table 5 below shows the areas of involvement with IBT the respondents associated Kenya Bureau of Standards with.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
Kenya Bureau of Standards	Regulation	41	93.1%
	Promotion	3	6.9%
Total		44	100.0%

Table 5: The areas of involvement Kenya Bureau of Standards

With regards to the Kenya Building Research Centre, 63.6% of respondents associated it with the role of research of innovative building technologies, 22.7% associated it with development of the technologies while 13.6% associated it with promotion of the technologies. Table 6 below shows the areas of involvement in IBT the respondents associated Kenya Building Research Centre with.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
Kenya Building Research Centre	Research	28	63.6%
	Development	10	22.7%
	Promotion	6	13.6%
Total		44	100.0%

Table 6: The areas of involvement; Kenya Building Research Centre

As for the National Housing Corporation, 38.6% of the respondents associate it with the role of promoting IBT, 34.1% associated it with development of the technologies, and 20.5% associated it with research while 6.8% associated it with regulation of the innovative building technologies. Table 7 below shows the areas of involvement the respondents associated National Housing Corporation with.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
National Housing Corporation	Research	9	20.5%
	Development	15	34.1%
	Regulation	3	6.8%
	Promotion	17	38.6%
Total		44	100.0%

Table 7: The areas of involvement the respondents associated National Housing Corporation

68.2% of the respondents associated the University of Nairobi with the role of research of innovative building technologies. 18.2% associated the university with development while 13.6% associated it with the role of promoting the technologies. The table below shows the areas of involvement in IBT the respondents associated the University of Nairobi.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
University of Nairobi	Research	30	68.2%
	Development	8	18.2%
	Promotion	6	13.6%
Total		44	100.0%

Table 8: Areas of involvement in IBT of the University of Nairobi

Jomo Kenyatta University of Agriculture and Technology was largely associated with research of IBT by 68.2% of the respondents followed by the role of development of the technologies at 22.7% and regulation and promotion at 4.5% each. The table below shows the roles respondents associated JKUAT with in the adoption of IBT.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
Jomo Kenyatta University of Agriculture and Technology	Research	30	68.2%
	Development	10	22.7%
	Regulation	2	4.5%
	Promotion	2	4.5%
Total		44	100.0%

Table 9: Areas of Involvement of JKUAT in IBT.

54.5% of the respondents associate the Kenya Institute of Research and Development Institute (KIRDI) with the role of research of innovative building technologies. This was followed by development of the technologies at 22.7%, promotion at 20.5% while regulation at 2.3%. Table 10 below shows the areas of involvement of KIRDI with IBT.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
Kenya Industrial Research and Development Institute	Research	24	54.5%
	Development	10	22.7%
	Regulation	1	2.3%
	Promotion	9	20.5%
Total		44	100.0%

Table 10: Areas of involvement with IBT by KIRDI

The Kenya Industrial Property Institute (KIPI) was largely associated with regulation of the innovative building technologies at 34.1% followed by research development and promotion. Table 11 below shows the areas of involvement with IBT by KIPI.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
Kenya Industrial Property Institute	Research	10	22.7%
	Development	7	15.9%
	Regulation	15	34.1%
	Promotion	5	11.4%
	No response	7	15.9%
Total		44	100.0%

Table 11: Areas of involvement by KIPI in innovative building technologies

As for the UN Habitat, 29.5% of the respondents associated it with the promotion of the technologies followed by research at 27.3%, development at 20.5% and regulation at 9.1%. Table 12 below the areas of involvement the respondents associated UN Habitat with IBT.

Name of the Institution	Area of Involvement	Responses	
		N	Percent
UN Habitat	Research	12	27.3%
	Development	9	20.5%
	Regulation	4	9.1%
	Promotion	13	29.5%
	No response	6	13.6%
Total		44	100.0%

Table 12: Areas of involvement the respondents associated UN Habitat with IBT

The National Construction Authority was largely associated with regulation of IBT followed by promotion and research. The Table 13 below shows the areas of involvement with IBT the respondents associated National Construction Authority

Name of the Institution	Area of Involvement	Responses	
		N	Percent
National Construction Authority	Research	3	6.8%
	Regulation	28	63.6%
	Promotion	7	15.9%
	No response	6	13.6%
Total		44	100.0%

Table 13: Areas of involvement with IBT the respondents associated National Construction Authority

As for the National Commission of Science, Technology and Innovation (NACOSTI), majority of respondents associated it with research of the innovative building technologies, followed by development Table 14 below shows the areas of involvement with IBT the respondents associated NACOSTI.

Name of the Institution	Area of Involvement	N	Percent
National Commission of Science, Technology and Innovation	Research	28	63.6%
	Development	4	9.1%
	Promotion	2	4.5%
	No response	10	22.7%
Total		44	100.0

Table 14: Areas of involvement with IBT the respondents associated NACOSTI

The results reveal that most organizations are involved in research and development of innovative building technologies. For these technologies to be widely adopted it is necessary that significant attention be devoted to Promotion of the technologies.

3.2. Effectiveness of the Institutions in influencing adoption of Innovative Building Technologies

The respondents were asked to gauge the effectiveness of the institution in influencing the adoption of innovative building technologies. The results of the study revealed that majority of the respondents were in agreement that the State Department for Housing and Urban Development was effective in influencing the adoption of innovative building technologies with a mean of 4.46 followed by National Housing Corporation with a mean of 4.09 and Kenya Industrial Research and Development Institute with a mean of 3.89. The least influential institution was found to be the Kenya Industrial Property Institute with a mean of 3.4, followed by National Commission of Science, Technology and Innovation with a mean of 3.47 and National Construction Authority with a mean of 3.49. Table 15 below shows the effectiveness of the institutions in influencing adoption of innovative building technologies.

SN		N	Mean
		Statistic	Statistic
1	State Department for Housing and Urban Development	44	4.46
2	National Housing Corporation	43	4.09
3	Kenya Industrial Research and Development Institute	44	3.89
4	Jomo Kenyatta University of Agriculture and Technology	44	3.80
5	University of Nairobi	44	3.77
6	UN Habitat	44	3.66
7	Kenya Bureau of Standards	44	3.66
8	Kenya Building Research Centre	44	3.63
9	Technical University of Kenya	44	3.57
10	National Construction Authority	44	3.49
11	National Commission of Science, Technology and Innovation	43	3.47
12	Kenya Industrial Property Institute	44	3.40

Table 15: Institutions effectiveness in influencing the adoption of Innovative Building Technologies

3.3. Weaknesses of the Institutions

The respondents were asked to highlight weaknesses of the institutions which in their view hinder the effective adoption of innovative building technologies in Kenya. The following were the highlighted weaknesses:

1. Lack of goodwill, uncoordinated approach and conflicting regulations that hinder their operations.
2. Other than NHC, which has invested in EPS panels, other institutions have not demonstrated enough awareness and commitment to the existing building technologies. They have not interrogated the merits and demerits of modern construction methods.
3. The institutions experience budgetary constraints.
4. Government agencies are primarily focused on partnerships that bring huge investment capital to government thus ignoring small projects that are appropriate for application of innovative building technologies.
5. The promotion of the technologies done by these organizations is not extensive.
6. Coordination and integration of roles of these institutions lack clarity.
7. The institutions are centralized and their lack of presence in major parts of the country hinders widespread technology adoption.
8. Lack of strong research linkage.
9. The institutions have low capacity in terms of human resource, tools and equipment.
10. Low funding of research and development of innovative building technologies by the institutions.
11. There is low publicity on the activities performed by the institution.
12. There is no teaching of the technologies in universities.
13. Poor coordination among existing institutions relating to innovative technology promotion and adoption.
14. The research institutions like university are not aggressively conducting research on innovative building technologies to assist achieve low cost housing.
15. There is no coordination between the research and incubation of the technologies.
16. Low technical skills in the innovative building.
17. The transition between researched technologies and incubation of workable technology is poor

3.3.1. Ways to address Weaknesses in Policy, Regulations and Institutions

The respondents were asked to suggest ways on how the weaknesses in policy, regulations and institutions can be addressed. From their expertise, the following were their suggestions:

3.3.2. Suggestions on how to address weaknesses in Policy

The following were the suggestions put forward on how to address weaknesses in policies in order of priority:

1. There should be a strong innovative building technologies promotion policy and private public partnership framework.
2. Integrate innovative construction holistically with other sectors.
3. There should be a policy that guides awareness and acceptance of technologies.
4. The Government should use modern, time and cost saving technologies as a mandatory input in its own projects.
5. The government should give tax incentive to developers and contractors who embrace innovative building technologies.
6. Address use of innovative building technologies in the National Housing Policy, industrialization policy.
7. Consolidate the existing policies to formulate an all-encompassing housing policy which is aligned to the constitution.
8. Consolidating policy frameworks to facilitate promotion and adoption of innovative building technologies.
9. Develop and enforce policy related to the building design and development.
10. Develop clear policy on sustainability of the programmes advanced by the institutions involved in the innovative building technologies.
11. Develop policy to guide on the standard of the prefabricated housing materials.
12. Develop policy to handle the human resource capacity and skills which should include training programmes.
13. Disseminate the policy provisions that relate to technology.
14. Housing policy should support research and allow adequate funding to innovative building technology.
15. Implement the housing policy of 2004.
16. Involve the public in policy formulation.

3.3.3. Suggestions on how to Address Weaknesses in Regulations

The following were the suggestions on how to address the weaknesses in regulations:

1. The regulations should be reviewed to accord as much importance to innovative building technology as is accorded conventional construction methods.
2. There should be consolidation of housing sector regulations and provide comprehensive guidelines on the use of innovative building technologies in Kenya.
3. Develop a framework to regulate the staff skills and establishment of the government institutions dealing in innovative building technology.
4. Develop regulations to guide participation of SMEs in uptake of innovative building technologies.
5. Enact legislative framework to guide the housing sector development and allow for mass application of IBT in Kenya.
6. Enact regulations to guide material application.
7. Enactment of pending laws especially Housing Bill to guide the sector.
8. Have regulations specifically on research, incubation and development of innovative technologies.
9. Mainstream alternative technologies/materials so as to be acceptable for use in urban areas by revising outdated regulations.
10. Public participation to be conducted on providing legislative framework to speed up their enactment process.
11. Recognize use of innovative building technologies by the Housing Act and Industrialization Act.
12. Regulatory frameworks should enacted that encourage use of location-specific appropriate building and innovative technologies.
13. The guidelines for adoption of both local and foreign based innovative building technologies adoption in Kenya should be developed.

3.3.4. Suggestions on how to Address Weaknesses in Institutions

The following were the suggestions on how to address the weaknesses in institutions:

1. Have a coordination body to guide the adoption of the technologies to different parts of the country.
2. Mainstream the promising, homegrown innovative building technology in education and professional practice.
3. Have a body that coordinates and disseminates research in innovative building technologies.
4. The ABMT centres should be adequately staffed with skilled manpower and equipment.
5. There should be collaborations frameworks between the institutions dealing in building and construction from research to promotion.
6. There should be creation and operationalization of ABT and technology institutes in Kenya.
7. Empower KIRDI, Numerical Machining Complex and Ministry in-charge of Housing to upscale innovative building technologies adoption process.
8. Equip the institutions with enough equipment for use in their involvement in innovative building technologies.
9. Establish an institution with bias in the development and promotion of innovative building technologies.
10. Institute proper management structures for the institutions involved in promoting innovative building technologies.
11. Let institutions specialize in specific technologies so that duplication of products may not arise.
12. Ministry responsible for housing should put in place strong operational systems at the appropriate building technologies centres existing country wide
13. Provide funding to institutions dealing with promotion of innovative building technologies to increase their application.
14. Research on the innovative building technologies should be coordinated by gov't agency with the gov't taking the lead.

15. The ministry should have a department to handle the use and adoption of prefabricated housing.
16. Turn the institutions into an enterprise centres to generate more funds.
17. Undertake effective coordination of promotion of innovative building technologies by a centralized and more encompassing gov't institutions-Ministry in charge of housing
18. Various institutions involved in promotion of innovative building materials should forge close working partnership and collaborative approaches.
19. County government should encourage wide use of innovative building technologies within their jurisdictions.
20. More funding should be channeled to the research institutions to enhance more adaptable technologies.

3.3.5. Suggestions on Strategies to Promote Innovative Building Technologies in Kenya

The respondents were asked to suggest ways in which to up-scale the adoption of innovative building technologies in Kenya. The suggestions were grouped in various strategies including Financing, Promotion, regulations and incentives and training and various approaches were identified in each of these strategies as expounded here below.

3.4. Financing

1. Adequate funding to innovative building technology development and promotion of ideal technology incubation through reverse engineering process.
2. Creation of revolving fund to support the adoption process of innovations building technologies.
3. Banks to strengthen their financial capacity and redesign their financing process to support developers and end users. It is of concern that lending institutions consider unconventional technologies risky and tend to attach high premium in lending such projects.
4. National treasury to allocate more funds to support production of innovative building technologies up to grass root levels.

3.5. Regulations and Incentives

1. Governments to define specific tax regulation framework with the necessary tax incentive for developers, buyers and other professionals
2. Provide incentives to motivate participation of more private sector players in innovative building technology adoption.
3. Provision of equipment like the hydraform machine used in making stabilized soil blocks to local communities for production.
4. Ban importation materials that compete with those locally available.
5. Formulating low cost housing policy, support initiatives towards technology incubation

3.6. Training and Information Dissemination

1. Professionals to strengthen their knowledge and trainings in such way to create specialists for ABTs sector in order to be able to provide accurate advices on the technical feasibility of the proposed Alternative Building Technologies;
2. Communication with the population and potential buyers to reassure them about the quality and the benefits of using these new technologies in the housing programs.
3. Develop clear funding policy and to turn the institutions into incubation centres to generate more funds.
4. The involvement and active participation of 'Target Groups'. Through the concept of 'Self-help', by way of production and use of alternative technologies.
5. Develop competency framework for institutions dealing in innovation and technology.
6. Provide information on innovative building technologies at the Government Service Centre outlets to increase knowledge levels of the general public.
7. Creation of works demonstration units to enable more people to learn about existence of various innovative building technologies.
8. Establishment of innovative building technology adoption centres.
9. Suppliers of technologies should support developers and contractors in applying the technology.

3.7. Institutional Arrangements

1. Ensure strong collaboration between the public and private sector in the process of adoption of innovative building technologies.
2. Improve the management system of the institutions involved in promotion of innovative building technology.
3. Promoting development of business enterprises model with various SMEs at grass root levels in the republic.
4. The two levels of governments should use affirmative action to do their construction (offices, schools) using IBT so as to give confidence to public as to the use of the technologies.
5. Decentralize approach to ensure technologies are appropriate to specific areas.
6. Enhance collaborative research and promotion of researched innovative building technologies for use by locals.

4. Discussion of the Results

4.1. Outline of Provisions in Existing Policies and Regulations for the Adoption of Innovative Building Technologies in Kenya

Provisions for IBT in policy documents including the Housing policy, the Constitution and Vision 2030 generally have no bias against adoption of IBTs though they fall short of devoting adequate attention to their promotion. The Acts of parliament on the other hand are generally biased against IBTs. The general feeling is that the Acts of parliament were made with intent to attain high construction standards with no regard to cost efficiency.

There are no clear provisions in the policies and regulatory frameworks on the promotion of the technologies by the government. On the other hand, the Acts of parliament and Building Code are prohibitive on the use of IBT as they focus attention to restricting the materials based on their physical attributes rather than their performance. Their adverse effect on IBT adoption is further amplified by a rigid administrative framework as the approval process favor conventional materials.

4.2. Effectiveness of the Institutions Involved in the Promotion of Innovative Building Technologies in Kenya

The weaknesses exhibited by various institutions involved in the promotion of innovative building technologies include:- lack of goodwill, uncoordinated approach and conflicting regulations that hinder their operations; most institutions have not demonstrated enough awareness and less commitment to the existing innovative building technologies; budgetary constraints experienced by institutions; government agencies are primarily focused on partnerships that bring huge investment capital to government thus ignoring small projects that are appropriate for application of innovative building technologies low publicity on the activities performed by the institution; and poor coordination among existing institutions relating to innovative technology promotion and adoption.

4.3. Framework for Enhancing Adoption of IBT in Kenya

The study concludes that the legal and institutional framework for adoption of IBT is weak. Promotional initiatives are undertaken by various institutions in uncoordinated manner and without any clear objective. In view of this, the following pillars should guide a review of the laws and institutions involved in IBT

1. Consolidation of building laws to bring about consistency and coherence in regulation of choice the building material.
2. Coordination between various institutions involved in IBT production, policy and dissemination
3. Legal principles that focuses on the performance of the material rather than composition or physical properties of the material like stone thickness.
4. Review of training institution and programmes to give attention to innovative building technologies

4.4. Recommendations

4.4.1. Policy, Regulations Provisions and Incentives

The findings on Policy and regulations revealed adverse effect of statutes including building code by for instance focusing on material properties rather than material performance. There is also no deliberate attention to IBT promotion in building statutes objective. The housing policy however makes wide recognition of IBT but for this to have meaningful impact, there is need to cascade the policy into building regulations.

The study therefore makes the following recommendations as pertains to policy and regulations.

1. Review of Statutes to lay emphasis on material performance rather that physical properties
2. Consolidation of building laws to bring about consistency and coherence in regulation of choice the building material.
3. Coordination between various institutions involved in IBT production, policy and dissemination
4. Implementation / actualization of policy provisions through law reviews and enactment, setting up and strengthening institutions
5. Governments to define specific tax regulation framework with the necessary tax incentive for developers, buyers and other professionals
6. Provide incentives to motivate participation of more private sector players in innovative building technology adoption.
7. Provision of capital intensive IBT equipment like the hydraform machine used in making stabilized soil blocks to local communities for production.
8. Offer support initiatives towards technology incubatione.g subsidies and tax relief.

4.4.2. Institutional Framework

On the existing institutional framework, the study established generally that;

1. There is lack of goodwill, uncoordinated approach and conflicting regulations that hinder success of institutions involved in promotion.
2. Other than the National Housing Corporation, which has invested in EPS panels, other institutions have not made heavy investments towards innovative building technologies. The institutions experience budgetary constraints.
3. Government agencies are primarily focused on partnerships that bring huge investment capital to government thus ignoring small projects that are appropriate for application of innovative building technologies.
4. The promotion of the technologies done by these organizations is not extensive.

5. Coordination and integration of roles of these institutions lack clarity.
6. The institutions are centralized and their lack of presence in major parts of the country hinders widespread technology adoption.
7. There is no strong research linkage.

The following recommendations for enhancing institutional capacity for promotion of Innovative Building Technologies are made;

1. Collaboration between the public and private sector in the process of adoption of innovative building technologies so as to harness the synergies in promotion of IBT. .
2. Affirmative action to construction of public buildings using IBT so as to give confidence to public as to the use of the technologies.
3. Decentralization approach to ensure technologies are promoted in appropriate localities
4. Training of Professionals in built environment sector so as to strengthen knowledge and create specialists for ABTs sector in order to be able to provide specialist advices on the technical feasibility of proposed Innovative Building Technologies
5. Develop clear funding policy for IBT and to transform the promoting institutions into incubation centers
6. The involvement and active participation of 'Target Groups'. Through the concept of 'Self-help', by way of production and use of alternative technologies.
7. Develop competency framework for institutions dealing in innovation and technology.
8. Information dissemination on innovative building technologies at major government service departments e.g. at the Huduma Centres outlets to increase knowledge levels of the general public.
9. Establishment of innovative building technology adoption centres and demonstration units for continuous training and showcasing existing and emerging Innovative Building Technologies.
10. Technology providers and end user linkages so as to support developers and contractors in applying technologies.
11. Adequate funding to innovative building technology development and promotion of ideal technology incubation through reverse engineering process.
12. Financing institutions need to be encouraged to redesign their financing process to support developers and end users of Innovative Building Technologies. It is of concern that lending institutions consider unconventional technologies risky and tend to attach high premium in lending such projects.

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