

# THE USE OF ALTERNATIVE BUILDING MATERIALS IN DEVELOPING COUNTRIES: ADDRESSING CHALLENGES FACED BY STAKEHOLDERS

E. C. Mpakati-Gama\*, S. C. Wamuziri and B. Sloan

School of Engineering and the Built Environment, Edinburgh Napier University, United Kingdom

## ABSTRACT

*The rising concern on inefficient wood consumption associated with shelter development has led to policy and regulatory reforms to address such problems in most countries in recent years. The use of alternative building materials (ABMs) and technology, for example, have been proposed by decision makers as one of the ways of curbing deforestation hence promoting sustainable development. Although the use of alternative materials has enhanced housing stocks where these are appropriately employed, there are several problems faced by developers to embrace the proposed strategies more particular in developing countries. Focusing on the Sub Sahara Africa (SSA), this paper proposes strategies the decision makers would employ to promote the use of ABMs. In this paper, which is based on the extensive literature review of an ongoing academic research to find ways for promoting sustainability in developing countries, it is noted that cost of raw materials, flaw of sustainability definition as well as the lack of information related to the building sector are some of the limitations for building stakeholders to promote the use of ABMs. Therefore, the course of actions proposed is regarded as one of the possible ways for decision makers to take into consideration to improve the current situation in the building sector in SSA and beyond.*

**Keywords:** *Alternative Building Materials, Building Challenges, Building Stakeholders, Developing Countries, Policy Strategies.*

## 1. INTRODUCTION

The increasing demand for wood for housing construction is considered to contribute severely to the adverse environmental effects attributed to the building sector in most countries. Although the effects vary from one country to the other, (Alam and Starr, 2009; Duguma and Hager, 2010) policy strategies and regulatory reforms have been proposed to encounter such problems in most developing countries. In Sub-Saharan Africa (SSA) particularly building developers and designers are encouraged to switch from the use of conventional clay burnt bricks to alternative building materials in order to minimise the inefficient wood consumption particularly for brick making (e.g. GoM, 2004).

The use of alternative building materials (ABM) has been advocated by the United Nations Commission for Human Settlement (UNCHS, 1993) since the early 1990s. Apart from the curbing of deforestation, the use of ABM is also considered as a means of enhancing the housing stock for low-income populations by using local and affordable materials and methods. However, the concept has highly been criticised by previous authors for a number of reasons. For instance, it is considered to have contradictory aims according to Myers (1999). That is, considering that most of the low income communities rely on the existing resources that also need to be protected this appears to be contradictory aims as highlighted by Myers (1999). Furthermore, the structures built of the ABMs are considered as structurally poor in terms of durability due to the lack of technological knowhow during material manufacturing or house construction process (Wells, 1993a; Wells *et al.*, 1998b). Although highly criticised in the early 1990's by several researchers for example, Wells, (1993b), the UNCHS strategies have highly been supported and promoted in a number of countries such as Kenya (Syagga, 1993). Furthermore, the need for the use of ABMs continues to rise with the housing demand in most countries. Consequently, the use of ABMs is gaining more favour as most of the problems highlighted earlier are being addressed through research and development.

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\* Corresponding Author: E-mail- [e.mpakatigama@napier.ac.uk](mailto:e.mpakatigama@napier.ac.uk)

Among the several studies in the literature, Venkatarama (2007a and b) illustrate how the improvement in the shear stress and bonding strength of stabilised soil-cement blocks (SSBs) makes the SSBs suitable ABMs for the Indian context. Similar studies have also been conducted in several other parts (for example in Venezuela (Acosta, 2000) and Mozambique (Kuchena and Usiri, 2009). Consequently, as the improvements enhance the performance of the ABMs and methods this will also contribute to improving both quality and quantity of urban housing although other factor as those highlighted by Keivani and Werna (2001) and Lizarralde (2011) also need to be taken into consideration. Despite the improvements, most of which are technically oriented, building designers, developers and clients are still facing several challenges to embrace the proposed strategies.

This paper is based on an extensive literature review of an on-going academic research to explore ways of promoting sustainable construction in developing countries. Focussing on the SSA, the paper has three major objectives: (a) to establish the contributing factors to changes in building materials in order to augment the decision makers' understanding on the need for promoting of the use of ABMs and technologies; (b) to analyse the major limitations faced by building stakeholders in promoting the proposed ABMs in order to establish ways for addressing them; and (c) to recommend the course of action for the decision makers and other stakeholders to consider in addressing the existing challenges of sustainable construction in developing countries.

## 2. CHANGES IN BUILDING MATERIALS FOR URBAN HOUSING IN DEVELOPING COUNTRIES

### 2.1. OVERVIEW

The building sector has undergone a radical change in the type of building materials and methods used for urban dwellings over the past few decades in most countries. Alternative building materials are increasingly being employed to replace the conventional and traditional building materials. In some parts, though not widely common, earth based materials are modified with plant residues or animal dung to improve the durability and the architectural aesthetics. Depending on the local resources available and the level of affordability of the residents, industrialised ABMs such as cement and lime are also being widely employed. In most Sub Sahara Africa (SSA) precisely, earth, wattle and grass are being substituted by the conventional materials such as burnt bricks and metal sheets for walls and roofs respectively. Table 1 lists examples of materials classified for the purpose of this study. However, these will vary widely from one country to the other alongside with the factors contributing to the changes.

Table 1: Building Materials Classification  
(Sources: NSO,1998, GoM, 2004 and Venkatarama Reddy, 2007)

| Material classification      | Masonry materials   | Roofing materials                     |
|------------------------------|---|---------------------------------------|
| <b>Traditional</b>           | Daub, mud blocks, rammed earth  | Wattle and grass                      |
| <b>Conventional</b>          | Burnt bricks, asbestos, cement blocks,  | Metal sheets (galvanised iron sheets) |
| <b>Alternative materials</b> | Cement rammed earth, stabilised soil-cement blocks, waste recycled materials etc. | Cement roofing tiles                  |

### 2.2. PRECEDING STUDIES ON CONTRIBUTING FACTORS TO CHANGES IN BUILDING MATERIALS

According to the existing literature, the scarcity of the traditional resources, international organisations' involvement, durability of the materials as well as policy and regulatory reforms are some of the main contributing factors to the changes in the building material types in most developing countries. In terms of scarcity of materials, Wells *et al.* (1998b) for instance, found that the increased distance from sources of traditional building materials such as poles fuelled the use of conventional materials for urban housing

development in Dar es Salaam, Tanzania. Similar findings are also demonstrated in studies conducted in other parts of the SSA such as Mali (Wells *et al.*, 1998a), Ethiopia (Duguma and Hager, 2010). However, in other parts this has been due to the government initiated programmes. For instance in Ethiopia, the government's idea to ban the use of endangered wood species sourced from forest reserves since the 1990s has contributed to the scarcity of wood for housing construction hence affecting the quality of wood currently used for housing construction. In Egypt on the contrary, it was observed that the scarcity of good soil for red brick manufacturing was due to the construction of Aswan dam leading to the loss of the traditional raw material brought about from the Nile river hence contributing to the change in the type of building materials to cement, lime and gypsum based materials (Farag, 2004). Therefore, as suggested by Duguma and Hager (2010) the use of ABMs would solve such problems in respective countries.

Although some materials are always available, they are evaded due to their low durability and poor aesthetics hence contributing to the on-going changes. Earth for example, which is being promoted in other developed countries parts due to its low embodied energy, is regarded as a materials suitable for low-income societies who can hardly afford other options on the market. In Ghana for instance, laterite is regarded as a '*rural-ish*' material and not suitable for modern housing construction (UN-HABITAT, 2011a). Consequently, these traditional, affordable and resource efficient materials, which are shirked for urban housing construction, are losing popularity despite the several attempts being made to promote them (Hadjri *et al.*, 2007).

The changes are also exacerbated by the increasing knowledge on technical aspects as well as the health and safety issues related to various locally used materials. For example, due to the earth's poor structural strength against earthquakes, the Malawi Bureau of Standards (UN-HABITAT 2010), as it is also the case in Zambia (Hadjri *et al.*, 2007) do not recommend earth as suitable material for urban structures' development. Consequently, if such materials are to be used, this is based on the local assemblies' discretion when scrutinising the plans submitted for planning approval (Hadjri *et al.*, 2007). Furthermore, the widening of knowledge, as a consequence of globalisation has also contributed to the exploitation of foreign designs as well as building materials. As observed in Ghana, the use of imported materials by both local and foreign developers is contributing to the rapid change in the types of materials used for urban areas (UN-HABITAT, 2011a). Interestingly, the increase in knowledge also enables the developers to evaluate the best sources from where materials can be obtained hence improving the quality of materials even further (Ibid 2011a). Apparently, some imported building materials are purchased at a reasonable price compared to the locally manufactured counterparts. Therefore the changes towards imported materials will be the norm in countries like Ghana as long as the economic climate mostly based on the previous regulatory reforms continues to be favourable.

As noted previously, the role of the reforms in changes of building materials could be in twofold: that is, market liberalisation or policy and regulatory review. As noted by Wells and Wall (2003) in a study conducted in Tanzania and Kenya, market reforms enabled the small entrepreneurs to manufacture and supply building materials in urban areas. In this industry, which was originally dominated by large companies, the stone and timber artisans were able to produce the materials locally hence following the liberation of markets. The market liberalisation therefore, has led to price increase following the removal of subsidies for purchasing such items according to Wells (2003) hence encourage developers to use alternative modern materials. Beside the promotion of the small scale manufacturing of materials, the market liberation also has promoted the public and private partnerships in material supply as observed by Mlinga and Wells (2002) in another study conducted in Tanzania in 1999/2000. On the other hand, the policy reforms have led to the review of the old legislations and formulation of new policy strategies to encourage building developers to use resource efficient building materials. This is considered as one of the ways of increasing quantity of affordable housing for the low-income populations while minimising the use of scarce resources particularly where wood is used as fuel for brick making. However, follow-up studies are needed in this area to validate the changes with regard to the market and regulatory reforms.

Finally, the changes in building materials are also due to the international development organisations' concern on resource use as discussed below. Embraced by the international Non-Governmental and Community Based Organisations (NGOs, CBOs), the strategies have also contributed to the changes in building material types in most countries particularly the ABMs.

### 2.3. THE CALL TO USE OF ALTERNATIVE BUILDING MATERIALS

Since the past few decades, there has been a rising concern over the inefficient use of resources for building construction in most countries leading to the need for the use ABMs. In the Sub-Saharan Africa (SSA) in particular, the increasing demand for wood for housing construction is considered to contribute so severely to the adverse environmental effects attributed to the building sector. Apart from land degradation (Alam and Starr, 2009), the excessive use of wood and forest resources is considered to contribute to the effects of climate change although very little is so far known on the extent of the contribution. However, a number of efforts are being made to promote the use of ABMs.

The United Nations Commission on Human Settlements' report for instance, emphasised the need to promote 'appropriate technology' in the construction industry in developing countries (UNCHS, 1993) as one of the ways of promoting sustainable construction. The strategies aim to employ simple building blocks manufacturing 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, regulatory and policy strategies are in place as one of the ways of curbing deforestation as well as the effects of climate change. Section five of the Malawi National Environmental Policy (NEP) (1996), which was formulated based on the 1994 National Environmental Action Plan (NEAP) and the 1996 Environmental Management Act, highlights the policy objectives, principles and strategies for various sectors to adhere to in reducing fuel wood consumption and promote the use of renewable energy (GoM, 2004). Section 5.6 precisely, emphasises on minimising the use of petroleum fuels, in order to promote the renewable and energy saving technologies, to reduce the emission of greenhouse gases and minimise the dependency on fuel wood (GoM, 2004). Focussing on the building sector, Section 5.7 aims to promote *the "development of industries that are based on domestic raw materials and use of technology that is appropriate for the local environment"* (section 5.7.4, GoM, 2004). *It also encourages the "use of cement blocks in order to decrease use of burnt bricks to curb deforestation"* (section 5.7.10, GoM, 2004). In other words, the NEP urges the building designers and developers to switch from the conventional brick making to the use of options such as the stabilised cement blocks, concrete solid or hollow blocks and earth (adobe). Therefore, in order to meet the decision makers' set strategies, developers are required to comply with the recommended materials despite the problems associated with them.



Figure 1: Example of Alternative Building Material and the Related Structures: Stabilised Soil-Cement Blocks for Mass Housing Projects in Malawi (Photos by EC Mpakati Gama, May 2011)

Interestingly, the concept of ABMs commonly termed as appropriate technology, has highly been criticised by previous authors. It is not surprising though because according to Bhalla (1979), introduction of concepts in a society can be perceived in a number of ways. These include *"rejection of the concept, acceptance of the idea in principle, active involvement in knowledge and the willingness to apply"*. Myers (1999) for instance, considers the proposals made to have contradictory aims. That is, while the use ABMs aims to promote locally (natural) available resources and to enhance the inefficient consumption of the natural resources, it also aims to protect the excessive use of such resources on which most of the low income communities rely in most developing countries. Consequently, the balance to protect the resources and also utilise them for is not easy to achieve by many. In addition to that, Wells (1993a) also denotes that due to the use of manufactured raw materials in the production of most of the ABMs, this tends to

reduce affordability of the materials by most of the intended groups. Consequently, the outcomes are more beneficial to the wider economy than the individual developers as previously noted by Wells (1993a) in a study conducted to assess the economic implications of the use of alternative technologies in Kenya and Senegal. Furthermore, the lack of durability due to their poor performance exacerbated by lack of technical expertise also contributed to the critics associated with the ABMs based on the studies conducted previously by Wells *et al.* (1998b) among others.

Despite the critics, alternative building materials for sustainable construction appear to enhance the building stocks where these are appropriately employed although the literature is almost silent on the quantities due to variation of materials being used. The use of ABMs is also considered as a way of curbing the environmental impacts attributed to the building sector although there are few empirical studies demonstrating the extent of environmental attributes associated with the building sector particularly in the SSA as previously elaborated by Mpakati-Gama *et al.* (2011). As discussed earlier on, several improvements have been made in materials such as the SSBs as presented in several studies such those conducted in India (Venkatarama Reddy (2007a and 2007b), Mozambique (Kuchena and Usiri, 2009) and Venezuela (Acosta, 2000) among others. However, there still several problems beyond structural failure associated with the use of ABM in most developing countries.

### **3. CHALLENGES FACED BY BUILDING DEVELOPERS TO EMBRACE ABM**

Although there are several challenges highlighted in the literature with regard to the use of ABMs, a few of these are discussed here. However, attempts have been made to focus on the economic, technological and institutional factors affecting the building stakeholders in most developing countries.

One of the major hindrances to the use of alternative building materials is the rising cost of ABM or the raw materials for producing them. Taking cement as an example, which is commonly used for the production of ABMs, its costs are mainly associated with a number of factors. However, they vary from one country to the other hence cannot be generalised. In Malawi for instance, cement costs are associated with the high manufacturing costs due to the use of imported raw materials (U.S. Geological Survey, 2011). Transportation of raw materials as well as the finished product also contributes to the rising costs. While the two main cement companies continue to find ways to promote the production of locally found raw materials to reduce the production costs, hence promote affordability, cement prices continue to be relatively high due to low market competition in the country. This is also exacerbated by fuel scarcity affecting both production and transportation of cement in the country (UN-HABITAT, 2010) as it is also the case in other developing countries such as Nepal (UNHABITAT, 2011b). On the contrary, in Tunisia, where the manufacturing companies are able to produce adequate raw materials as well as cement to meet the national requirements, inflation is a major contributing factor to the rising costs of cement (UN-HABITAT, 2011c). Beside these factors, there are other hidden costs associated with the equipment used for material production as well as the maintenance costs in most countries (Syagga, 1993). Although some costs are reduced as the technology becomes widely spread and also taking the economies of scale in consideration, the ABMs remain unaffordable by most of the targeted groups. Hitherto, the use of ABMs, particularly those involving manufactured raw materials is regarded as one of the best options due to lack of other best suitable and affordable alternatives in most SSA countries. However, affordability remains one of the major challenges beyond the developers' control.

Besides cost, the lack of technical knowhow for the manufacturing and use of the new technologies also limits the probability of their usage by building professionals and developers. This is usually contributed by the lack of information dissemination in the use of such materials. In most SSA countries, where the small entrepreneurs and informal sectors dominate in housing development, most developers are not fully knowledgeable of the specifications of the ABM leading to poor performance of the finished products (UN-HABITAT, 2010, 2011a). On the contrary, where information exists, most of it is based on the imported technology. Consequently, where these are not compatible with the local construction climatic and physical conditions let alone building specifications, poor performance of the ABMs will always result as previously noted by Bhalla (1979). Some researchers such as Acosta (2000) suggested the need for locally based studies to suit the local building characteristics which will also augment the professionals and developers' understanding on the need for promoting ABMs.

Policy implementation failure is another major challenge faced by the building designers and stakeholders. As highlighted in previous studies (Mpakati-Gama *et al.*, 2011) policies, regulations and economic measures are commonly used as conventional tools for environmental monitoring in most SSA countries. However, these measures suffer severe limitations hence they are considered as not appropriate for promoting sustainable construction (Halliday, 2008). The major limitations of the frameworks, most of which are interrelated, include the lack of measurable targets, the poor structuring to suit local conditions and the use of flawed data on which the strategies are based. Poor structuring of the policy strategies also provides loopholes for misinterpretation of the formulated policies hence encouraging the community's use of inappropriate alternative measures as commented in the Malawi National Environmental Action Plan (GoM, 1994). Interestingly, Ebohon and Rwelamila (2001) commented that poorly structured strategies are sometimes a result of the superimposed proposals most of which are influenced by other interested parties. This therefore, results in disintegration between the proposed policies and the local agenda. Although frequent restructuring could be one of the ways to improve the performance of such policies, Halliday (2008) highlights that such improvements are not always effective even in developed countries such as the UK. However, other authors suggest that the combination of the local and foreign policies, could encounter such problems (Urge-Vorsatz *et al.*, 2007; Liso *et al.*, 2007). Nevertheless, this will also depend on several other factors affecting the building sector as a whole in the country in question. Moreover, the policy related challenges affecting developers and designers' capability to embrace the use of ABMs include the lack of institutional capacity for the implementation of the policy strategies as observed in countries like Ghana and Malawi (Matope, 2000; UN-HABITAT, 2011a). This, therefore result in the lack of law enforcement where the regulations and policies are in place. On the contrary, the decision makers use their own discretion on what to give their priority to especially where enforcement of the policies leads to the draining government resources as highlighted by Tisdell (2005) and Shen (2006). That is, decision makers may deliberately overlook some proposals made especially where the financial implications or political interference outweigh the need for environmental conservation as denoted by Myers (1999) in a study conducted in Tanzania. In short, where regulations are in place but not respected or where the use of outdated National Building Regulations or even where they do not exist, the pose challenges to building stakeholders to promote the use of ABMs in most countries.

In addition to the flawed regulatory and policy frameworks, the lack of adequate information on environmental effects leads to flaw of motivation for developers to promote the use of ABMs. So far, there are a few studies conducted in most SSA countries on the extent of contribution the construction industry makes particularly with respect to deforestation. In Malawi for example, regulatory and policy strategies are in place for the building sectors to comply with as one of the ways of curbing deforestation as well as the effects of climate change. Thus although the NEP urges the building designers and developers to switch from the conventional brick making to the use of options such as the stabilised cement blocks, concrete solid or hollow blocks and earth (adobe) it appears that there is not adequate information on which the proposals are based. For instance, apart from the preliminary study by Zingano (2005), little has been done to investigate the extent of the building industries' contribution to deforestation in terms of wood quantity, the type of wood utilised, and where the wood is sourced in order to justify the need for the use of ABM. On the other hand, the proposed alternatives such as those using cement are also associated with environmental effects which need to be evaluated. Therefore, by only focussing on one environmental aspect, this only leads to the shift from one environmental problem to the other as discussed in previous studies (e.g. Mpakati-Gama, *et al.*, 2011). Consequently, the absence of such guiding principles leads to inconsistency of laws used by the local councils in encouraging developers to embrace the use of ABMs. As a result, the building stakeholders are often in a dilemma on what standards to follow (UN-HABITAT, 2011a) more especially with the recent poorly defined concept of sustainability.

As the notion of sustainability continues to be an important factor for consideration in carrying out building development works in the 21<sup>st</sup> century, the concept also appears to be a hindrance to the promotion of the sustainable construction which includes the use of ABMs. The flawed definition of sustainability is one of the major contributing factors. The literature contains critics of the term which is often used to qualify other nouns making other more complex terms not easy to define. Du Plessis (2007), for example considers the term 'sustainable construction', is based on words that already complex to define. Therefore, it is even more difficult to understand the new phrase if it is not properly defined.



Although often embraced by decision makers when promoting the use of ABMs, the concept is ambiguous to the building designers and developers as it requires a thorough clarification within a specific context. Secondly, the contradicting aims and expected results of sustainability lead to poor understanding of the developers to embrace ABMs. For instance, the sustainable construction aims to promote the use of local materials which are considered as affordable by most individuals for housing development. Yet most of such materials are also considered to have very significant damage to the environment according to previous authors such as Myers (1999). Considering that there is a lack of measurable targets of sustainability at both the global and local settings this also contributes to the hindrances for the building stakeholders to embrace the proposed ABM in deferent countries.

In summary, although there are well established regulations and policies established in some countries, the presence of these and other challenges based on individual countries, it is not uncommon for developers to revert to the use of conventional materials. Therefore, some projects are abandoned before completion yet some of those completed, do not deliver the intended outcomes due to the challenges faced at design stage or at construction stage as the proposed use of ABMs are not favoured by many. Although several examples exist, most of them are not recorded in the literature hence there is need for further inquiry in this area based on individual country practices. However, a few recommendations made here provide the basis for further enquiry to promote the use of ABMs in developing countries, particularly the SSA.

#### **4. RECOMMENDED COURSE OF ACTION TO PROMOTE THE USE OF ABMS**

In previous sections, the major contributing factors leading to the rising need for the use of ABMs and the challenges faced by developers in embracing ABMs in developing countries have been discussed based on the existing literature. This section highlights policy implications recommended for decision makers and the building stakeholders to take into consideration as some of the ways for addressing sustainable construction by promoting the use of ABMs.

Considering that most of the ABMs being promoted so far are cement based, though not affordable by the majority, one of the recommendations is to encourage researchers to come up with a wider range of ABMs from which developers can select the best options to use. Apart from earth, which neither meet the developers' aesthetical requirements nor the building specifications in most countries (UN-HABITAT, 2010; Hadjri *et al.*, 2007; UN-HABITAT, 2011a), there are several other opportunities to develop a variety of affordable ABMs. For instance, farm residues such as animal dung or plant husks (e.g. rice husks, groundnut shell and rice wheat straw) which are used to improve the structural strength of the earth based masonry materials, are considered as affordable and durable in other developing countries such as India (Pappu *et al.*, 2007) and a few parts of the SSA (Wells, 1995). However, this requires a sustainable supply of raw materials which could be a problem in most SSA countries where agricultural annual outputs vary significantly due to the effects of climate change. Nevertheless, other options highlighted in the literature include the use of solid and industrial waste as demonstrated by Pappu *et al.* (2007) and Singh (2007) among other researchers. Basically, further research is needed to utilise locally available resources which will not be able to meet the appropriate standards but are also sustainable. Therefore, these will not only provide better skills in promoting use of indigenous materials but also minimise the potential secondary environmental aspects.

Thus, the second recommendation is to urge the researchers to compile locally based environmental aspects of various materials for objective selection of ABMs to avoid shifting from one environmental impact to the other. As the different alternatives exist, further empirical research will also be needed to ensure the most suitable and affordable alternative ways are being promoted. Furthermore, the studies would need to include the indicators for sustainability based on a wider range of parameters as suggested by Singh (2007). For future prediction of sustainability indicators, further research would be ideal to evaluate environmental issues over the life span of the building materials in question. Moreover, health, aesthetical and safety issues as well as the economic aspects of ABM also need to be identified, addressed and revisited from time to time to encourage the developers' involvement in their usage. By involving the building stakeholders, at differs stages of the ABMs development process, it is expected that they will be more knowledgeable of the basis for their selection of materials at design and construction stages as appropriate. Therefore, with such information in place, appropriate policy strategies can be put in place

although frequent revisions need to be encouraged relative to changes in local and global development challenges. It should be noted though that, it requires various stakeholders to contribute to these proposals although the building professionals need to take a leading role to get them established while policy makers need to promote the implementation.

Finally, monitoring and evaluation of projects previously undertaken is also required to ensure that appropriate standards are not only recommended but also used accordingly. However, project based assessments need to be prioritised in order to ensure appropriate materials and technologies are used as suggested by previous authors (e.g. Acosta, 2000). The learning institutions which will also act as a way of knowledge dissemination related to the use of alternative building materials to new professionals would contribute effectively in such developments. Accordingly, reference manuals can be developed and compiled by the building researchers alongside with the public and private sectors in the building industry. In short, it is a requirement for different sectors to work together to enhance the availability of such information vital for policy makers to determine the proper direction on how to tackle the environmental related issues attributed by the built environment whilst promoting the building stakeholders' participation. It is pitiable though that few empirical studies exist in this area due to inadequate financial support for evaluating the proposed projects. This therefore leads to low motivation for building professionals to pursue further application of ABMs for future projects. In contrast, several recommendations have been made by previous researchers yet only a few are addressed by decision makers as well as the international communities in supporting the efforts to promote further research and development for ABMs.

## 5. CONCLUSIONS

The rising concern on inefficient use of natural resources has led to policy and regulatory reforms to address the problems in recent years. In most developing countries, further changes in the type of building materials are being made not only to address the environmental related issues but also to meet the rising shelter need. Although it is not easy to predict the direction of the type of materials for future housing development, several efforts are required by to encourage the building stakeholders to employ the ABMs. It is therefore, expected that the use of simple manufacturing technology for building blocks production will not only reduce the building costs but also curb the environmental effects associated with similar materials produced using high technological processes. This work, which is based on an on-going academic research to find ways for promoting environmental sustainability in the building industry in Sub Sahara Africa, exhibits some of the challenges faced by building stakeholders in their efforts to embrace the use of ABMs.

Although the inefficient use of wood fuel is inevitable in most SSA countries a few studies demonstrate the associated environmental effects. One of the reasons is that such projects do not only require studies at a wider scale but also have financial implications that require political intervention hence avoided by decision makers. Interestingly, despite the little evidence on the construction industry's contribution to adverse environmental impacts, a number of government driven strategies as discussed earlier are put in place as possible ways to minimise them. Consequently, the ABMs are considered to contribute to the reduction of wood fuel consumption attributed to the construction industry if fervently employed. However, apart from the policy strategies proposed in various countries to enhance the use of alternative building materials (ABMs) and technology, decision makers need to address the other several problems faced by the building stakeholders in embracing the proposed strategies.

Based on the extensive pertinent literature of the study being undertaken, it is noted that only if the policy makers are able to intervene on the high costs of raw materials required for making the BMs, it is not easy for the developers to switch from the use of conventional materials to the proposals made. In addition, the misleading concept of sustainability and the flaw of knowledge with regard to building related environmental effects require further clarification through research and development to augment the building stakeholders' knowledge and understanding on the need to promote the use of ABMs. Otherwise, the promotion of sustainable construction through policy and regulatory frameworks appears to be rhetoric in most developing countries.



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