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THE ROLE OF INDIGENOUS CONSTRUCTION TECHNOLOGY IN SUSTAINABLE CONSTRUCTION PRACTICES

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ABSTRACT
Developing countries grapple with a myriad of socio-economic problems such as poverty, unemployment and poor housing conditions, among others. Past programmes to provide housing, for instance, have not achieved the desired results, as they are unsustainable. The South African government's policy of providing housing using conventional construction techniques, for example, cannot be sustained due to dwindling financial resources. On the other hand, for centuries houses and other physical facilities in rural and peri-urban areas have been constructed using indigenous construction technology. This technology utilises locally available materials and takes cognisance of the prevailing climatic conditions and imbues cultural values.

Despite its significance, this technology has not attracted much interest as it has been branded primitive, backward and unhygienic. Consequently, many governments in Africa have yet to come up with programmes and policies that can entrench indigenous construction technology in the main stream construction practices, particularly for low-cost housing provision. This is an inordinate omission in the development and promotion of sustainable construction initiatives. In addition, advances in the development of alternative technology do not have indigenous construction technology practices and its attendant aesthetic and cultural expressions incorporated.

This paper highlights the need for recognition and incorporation of indigenous construction technology in the development of sustainable construction initiatives and its contribution to socio-economic development of poor communities. A framework for improving and promoting this mode of construction and its linkage with sustainable construction techniques is discussed.

KEYWORDS
Indigenous Construction Technology, Socio-economic Development, Sustainable Construction

1. INTRODUCTION

Construction activities have preoccupied mankind since time immemorial. Construction facilities have been built for protection against the vagaries of weather and to house both social and commercial activities. Additionally, construction has been used as an expression of a people's cultural identity. However, construction practices around the world have undergone transformation due to the influences caused by migration and through conquest and other

forms of human domination. These have been the main drivers of transfer of technology from region to region throughout human history (Wallbank et al, 1987). For instance, the advances made in construction technology in the western world have spread to other parts of the world through the influence of western civilisation. Western construction practice is now the benchmark of conventional construction technology(CCT). Unfortunately, in developing countries CCT is way above the economic reach of the majority of people.

A rapid population increase in most developing countries and the consequent rural-urban migration coupled with weak economies has meant that practices that advocate for CCT cannot be sustained to match the increasing needs of housing. This has given rise to the emergence of slums, especially in urban centres, that are in squalid condition and lack basic housing standards. It is not until recently that attention has been drawn to indigenous construction technology (ICT), that has hitherto been branded primitive, backward and unhygienic (CIB, 1999).

1.1 Indigenous Construction Technology

The characteristic dwelling of the African Savannah is a grass thatched round hut with walls of wattle and mud (a framework of vertical poles, tied together with horizontal branches and plastered inside and outside with mud). A framework of poles on which bundles of grass are tied supports the roof. There are many variations to this around the world depending on factors such as the local materials available, climate and culture as stated elsewhere.

Broadly speaking, therefore ICT is characterised by the use of local materials found within the immediate vicinity using knowledge that has been handed over from generation to generation. This technology which is labour intensive and ensures continuity, is ecologically sound, culturally sensitive and is within the economic reach of the local inhabitants (Kennedy, 2001). The common materials in use, inevitably, are earth, stone, grass and local timbers. Desert communities have also used animal skins for construction.

In addition to the type of materials available, ICT has been influenced by the prevailing environmental factors, the migration of people, religion and culture. All these have played their part in forming local architectural traditions and it is this complex mixture of influences which explains the variety of local construction practices throughout Africa and the rest of the world (Rapoport, 1969; Spence and Cook, 1983).

2. SUSTAINABLE CONSTRUCTION INITIATIVES

The renewed interest in ICT has been sparked by the worldwide campaign for sustainable development (SD) There have been various attempts to define sustainable development such as those of the Brundtland report, (1987) and Smith and Warr (1991).The underlying factor is that the quest for development, which inevitably has to involve exploitation of the earth's resources, undermines the ability of the earth to support life human or otherwise in perpetuity. Thus these resources must be used prudently in order to sustain life on earth. The earlier concerns of SD concentrated on the biophysical aspects that include natural resources and the environment. It has since been broadened to include socio-economic issues in recognition of the fact that no meaningful sustainable development can be achieved in the midst of social economic problems especially in developing countries (Todd and Geissler 1999; Hill and Bowen 1997; du Plessis 1999).

The SD agenda cannot ignore the construction industry because it directly affects the problems of the environment in many ways, such as the use of natural resources, consumption of energy, generation of waste, contribution to pollution and contamination of micro-environments. Owing to these effects and its role as a major contributor to socio-economic development, the importance of the construction industry in SD through sustainable construction (SC) has generated a lot of interest in the recent past. The main thrust being seeking to apply SD practices in the construction industry's activities (Hill and Bowen, 1997). The Brundtland Report in fact stresses that while pursuing SD initiatives; priority should be given to the world's poor. To pursue SC with inordinate omission of ICT locks out over a third of the world's population who are poor and still rely on ICT for their construction needs. The continued application of CCT will not in the foreseeable future offer sustainability solutions to their construction needs.

2.1 Sustainable Construction Characteristics

Hill and Bowen (1997) have identified the ”pillars” of SC that include the social, economic, biophysical and technical aspects of construction. The key features of social sustainability include improving the quality of life through poverty alleviation; concern for safety and promotion of training and capacity building. The economic sustainability involves instituting measures that ensure financial affordability of the constructed facilities by the intended beneficiaries and creation of employment opportunities. The prudent extraction and use of natural resources, re-use and minimisation of waste are essential elements of biophysical sustainability. The construction of reliable, functional and maintainable structures is one of the efforts that can achieve technical sustainability. The importance of these pillars and the emphasis placed on them differs from region to region.

2.2 The ICT in SC Practices

ICT has always embodied SC practices though from a casual consideration such practices and beliefs may not have been deemed to be contributing to SD. Indeed as acknowledged by the Brundtland report, (1987), traditional cultures have practiced sustainable resource use for centuries. For example, throughout Africa rural communities have set aside lands that are considered to be sacred, where cultural norms do not allow cutting of trees or settlement in those areas. Metaphorically, the significance of this may have nothing to do with sacredness, but more to do with a natural instinct to limit destruction of nature. The Masai of East Africa are perhaps the only community that has lived harmoniously with wild animals side by side. It is taboo in Masai culture to eat game animals, as this would necessitate hunting and killing of wild animals. That has ensured a natural balance within the ecosystem in which they live. Thus within the traditional African cultures there are traits of SC that remain largely untapped and unknown to the world.

Spearheading SC interest is Agenda 21, which has introduced several programme areas that impact directly on the construction industry, one of which is to promote SC activities. The Habitat II agenda covers the broader issues of human settlement. The one that has a direct bearing on ICT specifically states that the construction industry should promote locally available, appropriate, affordable, safe, efficient and environmentally sound construction methods and technologies. This call has been interpreted by various societies in different ways. The northern societies have dwelt more on the biophysical and technical aspects of sustainability- the green building issues.

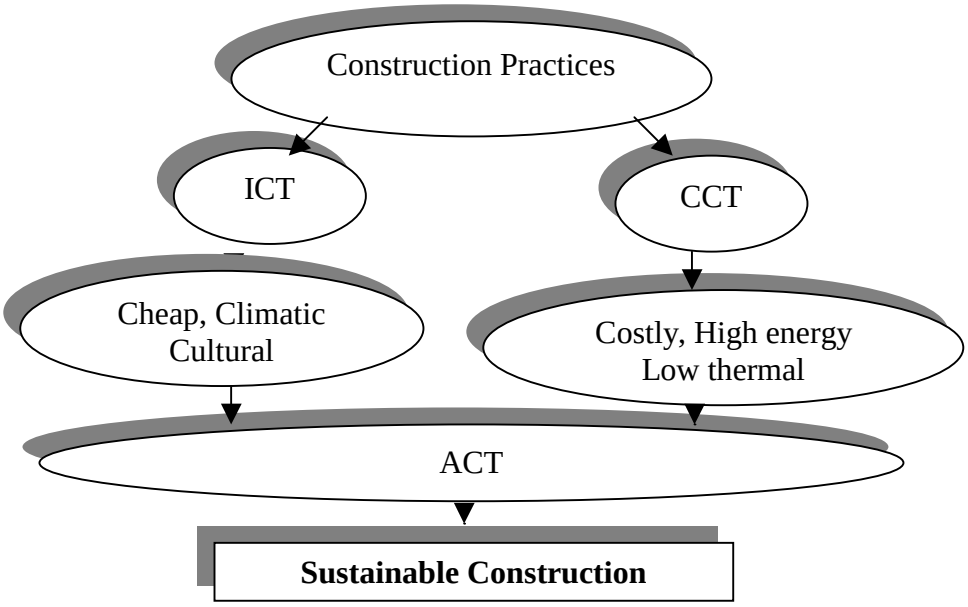

Figure 1: The Interface between ICT and CCT in SC Practices

To them, this is an issue that is foremost on their SC agenda. The societies in the south interpret it more along the lines of socio- economic sustainability. For example in South Africa, social equity is higher on the agenda than environmental concerns, and therefore more emphasis is given to the impact of construction on social and economic sustainability. For instance, in the White Paper on creating an enabling environment for reconstruction and development in the construction industry, there is a stress of the embodiment of socio- economic sustainability in what it terms as a holistic sustainability in the construction industry (DPW, 1999). As part of the process it is hoped that the activities of the ICT will be addressed.

3. LINKAGES BETWEEN ICT AND SC

Contrary to the widely held belief that ICT follows no rule or pattern of practice as observed by Rapoport (1969), the traditional building forms manifest a complex interaction of many factors. Climatic factors affect human comfort due to the effect of climatic elements. The building has to control these elements through its various parts which may be considered as environmental control devices.

Across Africa with its varied climatic conditions, the influence of climate can conspicuously be seen in the nature of the built forms. For instance, construction in arid climates tends to be temporary in nature with flat roofs, while those in humid areas are more permanent with pitched roofs. For example, the Masai, who lead a nomadic life and prefer living in the drier areas use found materials such as twigs, mud, cow dung and cow hides in their construction. When they migrate they carry only artifacts and leave the rest of the structure to decay (Rukwaro, et al, 2001). This is in contrast to the communities who occupy the humid areas, and who lead a sedentary life style and respond to the expected higher precipitation by construction of grass thatched pitched roofs.

Likewise the choice of the site in the traditional context follows a certain ritual. The site is chosen after studying the land, hills, hollows, rocks and creeks and the influence of myths, religion, and way of life overrides other factors (Rapoport, 1969). It is only after this that factors such as protection from both artificial and natural risks such as landslides, proximity to the sources of livelihood such as water, agricultural land, forests and grassing lands would then be considered Therefore the attitude towards nature and site is an important aspect of the creation of house form.

However, Rapoport argues that the social and cultural factors play a more primary role in house form as they are expressed and symbolised in it. The house form is used to extend and prolong the life of the ideal values, attitudes and images not of an individual but of the traditional society as a whole. Thus a house is not only a physical object with functional attributes; it also reflects a traditional society's worldview, ethics and codes of behaviour. For instance these attributes are well demonstrated in Masai settlements which are a mirror of the core values of their social life, with kinship, mythology and social ties playing an important role. The key features that relate to this are clan lineage, the size of the household and the importance of cattle as a source of livelihood. For example, the homestead of a married man would have a cattle kraal, and dwelling units separated by sons, wives, and daughters. The sons units would be located at the main entrance , next to the kraal and the central location of the kraal symbolises the importance of cattle in their lives (Rukwaro et al, 2001).

In addition, art and sculpture play their respective roles where harmony with the natural environment is created through the use of local materials. Stone will probably be the dominant material in rocky areas, which creates ruggedness that blends with the surrounding. The use of mud with the soft texture of the mud plaster and the varying shades of earth pigments to harmonise with the more gentle landscapes (Anderson and Sovre, 1995; Watson and Bertaud, 1976). This avoids drastic interference with the natural environment in which the structures are located.

The insulating capacity of the materials (mud walls and thatched roofs) is important in maintaining a stable indoor climate. Their ability to absorb and accumulate heat during the day and emit it during the night stabilises the indoor temperature thus limiting the necessity to heat and ventilate artificially. The wealth of aesthetic qualities highlights a conscious and valid cultural expression that is unmatched by CCT (Anderson and Sovre, 1995; Watson and Bertaud, 1976).

Construction in rural areas has always been participatory in which all members of the family, neighbours, and friends help in a collective way. Even when specialised skills need to be brought in from outside the payment will most likely be in kind. This enables everyone to have a stake in the process that appears to be a cooperative

construction practice. The notion of cooperative building not only helps overcome complex tasks but also has positive social implications (Wells 1993). Figure 1 shows the interface of ICT with SC and the position of Alternative Construction Technology (ACT) as providing this important linkage.

4. ICT'S CONTRIBUTION TO SUSTAINABLE DEVELOPMENT

Development as viewed in the context of the developing world has always tried to emulate the development indicators of the developed economies such as industrialisation, urbanisation and quality of life. Social and economic development is at the centre stage of most developing countries' development agendas. It has been accepted that developing countries should pursue the social development agenda in a sustainable way to emphasise social progress which recognises the needs of everyone by maintenance of the high and stable levels of economic growth and employment whilst protecting and enhancing the environment and using natural resources prudently (Hill and Bowen, 1997). However, the quest to emulate the social development success of the west will inevitably compromise environmental concerns at a time when the world now agrees that development should be pursued while paying attention to environmental conservation.

Some of the ICT practices, as discussed are within the tenets of what SC aspires to achieve. CCT could borrow from some of these practices in the development of SC best practices. Focuses on ICT can with limited effort contribute to the development of SC and at the same time achieve other benefits. For instance, in wall and roof construction, ICT achieves 'green' building effects without further effort or improvement. Therefore as sustainable development broadens to include SC, researchers need to acknowledge the importance of ICT in SD endeavours. Moreover, a key concept of SD is to recognise the essential needs of the world's poor and their concerns about uneven development (Smith and Warr, 1991). Figure 2 shows that SC will meaningfully contribute to SD if a two pronged approach that embraces ICT is pursued

4.1 Housing

Housing remains one of the major challenges in both rural and urban areas of developing countries. Already a vast number of houses and other social facilities in rural and peri-urban areas are constructed using ICT.

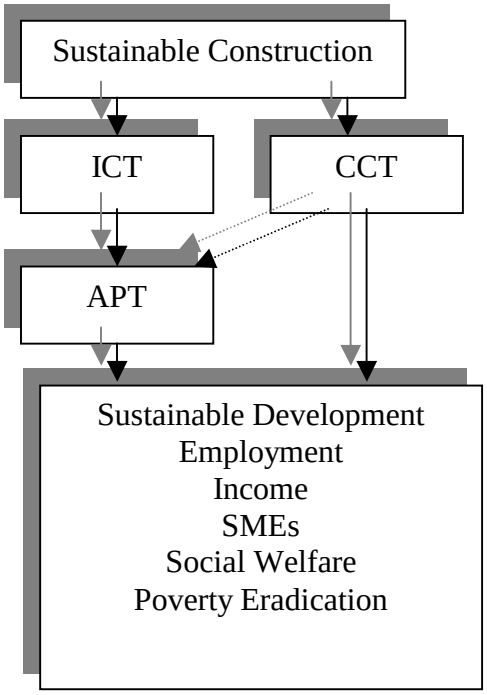

Figure 2: The Role of ICT in Sustainable Development

It is rarely recognised that informal settlements built using ICT represent, for instance, a level of SC that many formal buildings will never be able to achieve. Unfortunately, these structures are not recognised formally as housing because they do not meet the rigid standards set by the building codes. The efforts to provide housing therefore have tended to use CCT. It has been realised that the quest for providing housing to the poor using CCT is unsustainable due to the dwindling resources (Pyne, 1984). For instance the ambitious programme of providing one million houses to the poor in South Africa has already hit the rocks before it takes off (Tomlison, 1996). The rural communities sometimes regard CCT as alien. It would make a lot of sense to provide housing using local materials and methods with which the people are familiar but with some improvement.

4.2 Employment Creation

With high unemployment levels in developing countries, the choice and use of local building materials which do not require sophisticated machinery for their production and the methods of construction can maximise job opportunities, particularly for unskilled and semi skilled labour. Employment opportunities created in this way have the added advantage of enabling preservation of culture, traditional values and heritage, in addition to the promotion of micro-enterprises, development of human resources and contribution to the upliftment of the community and hence alleviation of poverty (Wells, 1993; Jaselskis and Talukhaba 1998).

4.3 Socio-economic Development

The promotion of ICT will add to the development of cottage industries that are desirable in developing countries. The use of ICT materials is expected not only to lower the cost of construction but also to reduce the import content of construction projects (Wells, 1993). Thus ICT achieves savings in foreign exchange, and could generate significant amounts of income in rural areas. The multiplier effect will add to the general transformation of the rural economy.

5. THE FRAMEWORK FOR IMPROVING AND PROMOTING ICT

Though appropriate in their original context, ICT could benefit from scientific and engineering study to establish properties and set standards. The ICT as much as it is cheap, has some level of relative inefficiency in it, is poor in quality and its methods environmental protection could benefit from some improvement. For instance, despite its cheapness, easy to mould, applicability at small scale and the good thermal properties, soil has the disadvantage of lack of dimensional stability (Spence and Cook, 1983). However, this disadvantage can be to a large extent overcome by selection of suitable soils and modifying the soil through mechanical treatment or addition of stabilizers to produce soil blocks of good comparative strength. This is the principle upon which stabilised earth, adobe and cob are based (Kennedy, 2001). Stabilization is achieved using cement, lime, gypsum, pozzolan and bitumen, some of which is found naturally in rural areas. Similarly, composite materials that are made from two or more materials in combination to improve strength, toughness and stiffness are other ways of improving the properties of indigenous materials. That way, materials with low strength or stiffness or some other disadvantage can be upgraded into useful construction materials. For example the combination of straw and mud and the production of fibre reinforced cement tiles (FRC) (Spence and Cook, 1983; Wells, 1993). Agricultural residues such as rice and wheat straw and sawdust have been used to make building boards.

The making of bricks can benefit from more energy efficient processes despite the growing problems of fuel availability, in some areas and sometimes conflicts with agricultural use of the land needed for clay pits. Cut stone is a high cost facing and ornamental material in most areas, but near the quarries may be economically used in conjunction with other materials. Uncut stone and quarry wastes are often economical building materials.

The quality of thatch can be improved by treatment to protect against rot and insect attack. From the environmental point of view, and to ensure that there will be continued supply of timber for building there is need to utilize the trees in the forest with greater efficiency. Saw mill waste need to be utilised in the manufacture of particle and fiberboard.

The proposed improvement techniques of ICT are cheap to establish, small in scale and suitable for small rural communities. They are also relatively simple to produce and require only a small amount of capital investment. Already in a number of countries, NGOs and other organisations are producing materials such as stabilised soil

blocks and fibre concrete roofing tiles for their own use in schools, health and community buildings as part ACT (Mitchell and Bevan, 1992; Wells 1993). However, these efforts seem to be uncoordinated and do not take into account the needs of the rural communities, culturally, aesthetically and economically

5.1Intervention Approaches

The rich heritage of construction practices possessed by the traditional communities makes use of the natural materials from their immediate environment, reusing what they can and leaving demolition waste to biodegrade, offers lessons to SC proponents. It is therefore necessary to learn from these lessons and adopt them to ACT for more inclusive SC practices. This will be facilitated by creating awareness through continued education at all levels, targeting public educators and policy formulators in addition to transference of knowledge from the research institutions to the beneficiaries. Procurement systems and regulations should provide an environment that is tolerant to the practices that promote SC with incorporation of ICT.

6. CONCLUSION

SC programmes cannot and should not ignore ICT. To achieve SD especially in Africa where the issues of environmental sustainability are of secondary importance, will require that ICT be brought in the mainstream SC practices especially in the provision of low cost housing. Therefore, SC must embrace ICT as it develops otherwise an important link would be missed. The multiplier effect towards the socio-economic sustainability is of immense value, especially to the world's poorest.

7. REFERENCES

Amis P. and Lloyd P, (1990), *Housing Africa's Urban poor*, Manchester University press

Anderson H. and Sovre M, (1995), *Traditional rural dwelling of Lesotho*, AB Stjartryck, Stockholm

Baurdeau, L (1999), Sustainable development and the future of construction, A comparison of visions from various countries, *Building research and information*, Vol. 27 no. 6 PP 355-367

CIB (1999), *Agenda 21 on Sustainable Construction*, CIB Report Publication 237

Department of Public Works (DPW)(1999), White Paper, *Creating an enabling environment for reconstruction, Growth and development in the construction industry*, SA Government printer, Pretoria

Du Plessis C, (1999), Sustainable development demands dialogue between developed and developing world, *Building Research and information*, Vol.27, No.s 4/5 July- October, pp321-331

Hill RC and Bowen PA (1997), Sustainable Construction: Principles and framework for attainment, *Construction economics and management*, Vol. 15, pp223-239

Jaselskis E. Talukhaba AA (1998), Bidding considerations in developing countries, with a case study of Kenya, *Construction Engineering and Management*, Vol. No, pp.

Kennedy, J.F (2001), *The art of Natural building, design, construction, technology*, www.networkearth.org

Mitchell M and Bevan A, (1992), *Culture, Cash and Housing: Community and tradition in low-income building*, VSOT/IT publication, London

Pyne, G, (1984), *Low income housing development in the third world, the role of site and services and settlement upgrading*, John Wiley and Sons, New York.

Rapoport A. (1969) *House form and cultur*e, Prentice hall Inc. Englewood Cliffs New York

Rukwaro et al (2001), Architecture of Societies in transition- the case of the Masai of Kenya, *Habitat international*, Vol.25, pp. 81-98.

Smith P.M and Warr, K (1991) *Global environment issues*, Hodder and Stoughton, London

Spence, RJS and Cook, DJ (1983), *Building materials in Developing countries*, John Wiley and Sons, Chichester.

Todd, A and Geissler, S, (1999), Regional and Cultural issues in environmental performance assessment for buildings, *Building Research and information*, Vol.27, nos. 4/5 July- October, pp247-256

Tomlison M, (1996), *From rejection to resignation*: Beneficiaries views on the housing subsidy scheme, Research report no. 49, Centre for policy studies Johannesburg.

Wallbank, T.W, (1987) *History of life, the world and its people*, Scot, Foresman and co. Illinois

Watson D, Bertaud A, (1976), Indigenous Architecture as the basis of House design in Developing Countries: A case study evaluation of Traditional Housing in Bhutan, *Habit*at International, Vo.1 no.3/4, pp 207-217

Wells J, (1993), Appropriate Building Technologies, An appraisal based on case studies of building projects in Senegal and Kenya, *Construction Economics and Manage*ment, Vol. 11, pp203-316

World Commission on Environment and Development (WCED) Brundtland Report, (1987), *Our Common Future*, Oxford University Press, Oxford.