Sustainable Construction In Africa

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1. Introduction

Sustainable construction has not received sufficient attention in Africa even though it is an important aspect of sustainable development. This paper draws on common problems facing African countries in terms of sustainable construction. The conflict between theory and practice is highlighted as is the misconception of sustainable construction in Africa relative to the level of development in different countries viz a viz the trend of the global ideology, advanced technology, standards and methods of operation.

The critical issue surrounding construction activities of any kind in African countries is that construction systems have long been modelled on the experience of the developed world as argued by Taylor et al (1994). He contends that it has been assumed historically that norms and systems arising from a particular set of experiences in the developed world can be readily adopted by developing countries. He argues that this type of thinking typified the stage of economic growth, whereby the economic emergencies of nations were hypothesized to be consistently and universally similar, thus ignoring national circumstances, value systems or current priorities. This has been proved inappropriate where principles of the developed world have been applied in Africa without modification. The interpretation of the meaning and definition of sustainable development and construction is therefore revisited. Whether the general presupposition in practice is accomplished is questionable when applying the meaning in the African context given the diversity of problems facing Africa as a developing continent. It is further questioned whether sustainable construction can stand alone without an understanding of the broader issues of development. The paper argues that sustainable construction has to take place by understanding of the political, economic, social and developmental issues of a place, and that sustainable construction then becomes an integral part of sustainable development.

On a practical note the issues of conflict and war, and pandemics that have implications for sustainable construction, have become another angle of the debate around sustainability. This perhaps lends a different view to sustainable construction in Africa as a region of the world mostly affected by war, HIV/AIDS, malaria and pandemics.

Government policies in areas of housing, economics, environment and spatial planning are discussed as factors affecting sustainable development and construction and in many cases having direct implications on the construction industry and related developmental issues. These policies are concerned with alleviation of poverty, employment creation, capacity building, quality of environment, etc., but whether methods adopted to enact these policies enhance the objective of sustainable construction is debatable. This situation is compounded by the lending policies of the International Monetary Fund (IMF) and the World Bank, coupled with structural adjustment, which have had considerable impact on the construction industry. The policies advocate for reduction in public spending and restructuring of the public sector and privatisation of assets. The process has created unemployment in certain sectors with the construction sector, among other sectors, needing to absorb some of this labour force. There has also been a shift in some countries from construction to maintenance of buildings.

With regard to construction management and maintenance, the procurement systems used should not only focus on macroeconomic issues but should also embrace policies geared towards developmental needs. There is a need to adopt a more logical approach to the most appropriate method of procurement from the proliferation of different systems available (Masterman, 1992). A suitable and adaptive procurement system specific to the location, project and community is crucial. The construction industry with regard to procurement, forms of contracting and management of construction projects takes different forms in empowering communities. Cultural traditional methods can be incorporated into conventional and non-conventional methods. This would

lead to the role of community participation and development of capacity. It has been argued by Rodwin (1987) that the construction industry is unique in its ability to facilitate development by providing directly for human needs, stimulating investment and generating employment. This can be made possible if the nature of the building industry and its role in the national economy is well understood.

Another area of focus in any discussion on sustainable construction is the impact of construction activities on the built environment. Due to the fact that most projects focus on the economic angle, they tend to negate the aspect of quality of environment, preservation of green, water, etc. In addition, other pertinent issues include infrastructure and services provision, energy and water as constant requirements for the success of the construction sector. The intensive consumption of these by the construction industry and their perpetual shortage form part of the discussion of this paper as do waste disposal on construction sites, disposal of by-products of construction materials as well as unused building materials which become an environmental concern. Despite the global environmental campaign and individual country legislation on environmental protection, few African countries have made remarkable strides in this regard. The dilemma is how to ensure that these areas receive adequate response in the region.

The issues raised above call for sustainable construction that responds to the complexities and diversities of context within the region while embracing broader developmental concerns.

2. Development process, economic and policy issues

Sustainable construction has been understood by many nations as the way the building industry responds to achieve sustainable development. Lanthing (1995) further qualifies sustainable construction as a special case of sustainable development targeting the specific group of construction industry. This group is to develop, plan design, build, alter or maintain the built environment including the building materials manufacturers and suppliers. There are several definitions which need to be revisited to ascertain the development realm in which sustainable construction fits into Africa and evaluated against the situation prevailing in the continent today. As put forward by Hill (1994), the list of definitions for the concept of sustainability expanded as more disciplines entered the terminological debate.

Economists called for 'sustainable economy', agriculturalists for sustainable 'harvest' and sociologists for sustainable 'societies' but consensus on the definition of the term sustainability could not be achieved. The 1991 update of the World Conservation Union stated that the term 'sustainable development' had been criticized as ambiguous and open to a range of interpretations, many of which were contradictory. Hill suggests that this was because the term had been used interchangeably with 'sustainable growth'. Hill states that sustainable growth was a contradiction in terms because nothing physical can grow indefinitely. "Caring for the Earth" defined sustainable development as 'development which improves the quality of human life while living within the carrying capacity of supporting ecosystems (IUCN/UNEP, 1991). Any one definition of sustainability can however, not adequately cover the various facets of sustainable construction. The construction industry cannot exist alone without impacting and being impacted upon by economic, social, environmental, technical and policy issues.

It would be important to review the different definitions put forward for sustainable development to determine whether the ideologies contained in these views have been adequately achieved, or indeed if they are even applicable to the African region. For example, the Brundtland Report, WCED (1987) defines sustainable development as " development that meets the needs of the present without compromising that ability of future generations to meet their own needs." This may have worked in the developed world but in the developing world and especially Africa, economic development has been paralysed by poverty, war and an exhausting debt burden which leaves the future generation with a mammoth debt repayment problem, and disempowers it to respond to its present and future needs.

The International Council for Local Environmental Initiatives-ICLEI (1996) on its part defines sustainable development as "development that delivers basic environmental, social and economic services to all residences of a community without threatening the viability of natural, built and social systems upon which the delivery of those systems depends". Government policy implementation in areas such as housing and other social amenities

have largely disregarded the natural and built environment on construction sites. The socio-cultural dynamics that exist have also been systematically destroyed in project implementation.

The Amsterdam Treaty's (1997) definition of sustainable development may meet favour within the African region because it embraces the concept of integrated development within a contextual realm. This definition sees sustainable development as " determined to promote economic and social progress for their peoples, taking into account the principle of sustainable development and within the context of the accomplishment of the internal market and of reinforced cohesion and environment protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progress in other fields". Development theorists, professionals, practitioners and policy makers have long advocated this approach as a notion of development that is all-encompassing in its approach to issues of sustainability. Sustainable construction then becomes the vehicle through which the construction industry responds to achieve sustainable development as part of an integrated whole. Sustainable construction is then driven from the development realm in which it is situated.

2.1 Housing

Political changes in Africa from colonial to post-colonial times have also meant changes in government policies in areas such as housing and other development spheres that have had an impact on sustainable construction.

Due to urbanisation and population growth with the resultant acute shortage of housing, many governments have provided housing among other national needs. The Nigerian federal government's housing policy was geared towards delivery of low cost housing on a large scale, with the various states having similar policies, and delivering core housing and walk-up flats. The government also developed satellite towns, and government employee high-rise apartments. The implementation of these projects contributed greatly to the construction industry.

There was however a shortfall in manpower to deliver at the time. Unscrupulous contractors emerged that had no understanding of construction procedures, and whose workmanship was poor. It has emerged that this housing approach was not sustainable over time due to the absence of a post-implementation strategy, as an integral part of the procurement and management system. Latter policies are now directed at addressing these shortfalls.

Gidado (1996) cites the 1995 National budget a being tagged the 'budget of renewal' in which the construction industry is expected to play an important role. Among other activities, over 600 roads will be constructed or rehabilitated. One million housing units will be built and infrastructure put in place for the development of solid minerals and for industrial development, construction of large and small earth dams, water bores, etc. The outcome of this renewal drive where implementation has taken place has had mixed outcomes. While some of the objectives of the 'budget of renewal' have been met, the areas of post-implementation with regard to maintenance remain largely unaddressed.

The South African housing policy is perhaps more complex than the Nigerian one due to its location within a broader context of reconstruction and development, and its need to embrace the critical issue of equality regardless of race, ethnic grouping and gender. The complexity is one of determining how to redistribute wealth and create new wealth and how to attract investment which yields creation of employment and economic development within the construction industry among other sectors. In terms of sustainable construction, the policy advocates for an enlarged skills base as well as an equitable partnership between the large and small contracting sector which will enable the sustained upliftment, integration and growth of the less formal sector within the mainstream construction industry (Housing White Paper, 1994).

A sustainable housing delivery programme in South Africa has to be located within the supporter paradigm as history has proved that both traditional private and public sector programmes have failed to provide shelter in adequate volumes at prices the poor can afford (Adebayo and Adebayo, 2000).

The South African housing policy, as with other housing policies around Africa and as championed by the World Bank and the United Nations Centre for Human Settlements –UNCHS (Habitat), is formulated around the enabling approach theme, where the state acts as supporter rather than the provider of housing. In the South

African scenario, for example, this assistance is in the form of a capital subsidy to secure a site, basic services and a starter house. The government anticipated providing one million houses in five years (Housing White Paper, 1994). This, coupled with the resultant demand for infrastructure facilities and services that go with housing such as schools, clinics and community facilities and services has caused tremendous growth in the construction industry.

Questions of how sustainable this growth is, have however been raised. On the one hand, construction in the housing sector has been criticized for poor quality of product as well as the built environment created, with a number of reasons to explain this shortfall, among them the relative newness of the housing delivery mode, use of emerging contractors with relatively limited experience in the construction sector, and the general lack of rigor associated with implementation of low-cost housing projects. On the other hand, beneficiaries of such housing have been unable to achieve consolidation on account of low incomes, and lack of access to economic opportunities and credit. In the area of skills transfer, the scale at which women have benefited in this respect has been limited, given the magnitude of housing construction that has taken place. These factors, which collectively challenge the sustainability of the construction growth triggered by the housing sector, have proved to be a reality, not just in South Africa but also in Kenya, Tanzania, Mozambique and Zambia among others. Finally, one cannot ignore the role that the economic and political climates play in sustainable construction in both the private and public sectors.

2.2 Transportation Networks

The notion of compact cities and integrated development has become a critical issue in African cities. Linkages between cities and their rural hinterlands are also critical to the functioning of both. Given past segregation planning systems and the modern movement monofunctional zoning system across colonial cities of Africa, there has been a definite need to address the disjointed and fragmented resultant character. This has been addressed by implementation of programmes of revitalization, redevelopment, transportation networks and infrastructure. The problem facing some of these programmes is lack of management and forward planning for their carrying capacities resulting in deterioration and decay of the built environment.

Transport is a critical part of mobility within the city and the built environment in both developed and developing countries. People living in developed countries have a wider choice of transportation allowing them flexibility with regard to places of living, work and industrial locations. More importantly, transportation in many ways provides a vital lubricant to trade and permits the advantages of geographical specialization in production to be more fully exploited (Bunister and Burton, 1995). This is linked to the construction industry in terms of the activities involved, either by mobility to site or access to building materials industries.

In Africa, the transportation crisis is widespread. Banister and Burton argue that the transportation crisis is not so much one of the quantity of the existing transport systems - many countries have extensive rail and road networks - but rather the quality of the infrastructure. While this may be the case in the developed world, quantity of transport systems in Africa is far from adequate. The continent therefore has to grapple with problems of both quantity and quality. In addition, the mode of transport which remains largely road transport with a more limited rail transport system, poses accompanying problems of noise pollution and air pollution as well as high energy consumption.

However, transportation systems (if well-managed) have an added value with respect to development, in that they contribute to the creation of local transboundary and global networks that necessitate the construction of stations, stops and airports which directly contribute to construction industry activities. For example, in South Africa alone there is major airport refurbishment taking place in major cities. The Nigerian airports are also presently undergoing a similar process, as are a few other African main destinations.

The development strategy of industrialisation of which the construction sector is a large part, focuses most of its activities in urban centres, causing labour in the rural areas to migrate for employment. Gordon (1992) is of the opinion that industry has succeeded neither in achieving economic development for most countries, nor even in providing employment for all the hopeful job seekers. It has been found that a small increase in the number of jobs available may stimulate migration to such an extent that unemployment actually increases as a result. In

addition, providing employment for labour abundant economies of Africa is particularly difficult when capital-intensive, highly mechanized industrialisation strategies are pursued especially in the large-scale construction sector. The employment and labour hurdles surrounding the construction sector then bring to question the issue of sustainability.

2.3 The Tourism Industry

Tourism is an area of development that has been identified as having the potential to contribute to the economy in many African countries. Based on this potential as well as actual economic growth where tourism has been pursued in the continent, it has been integrated in the overall concept of development. Given the extensive construction activities associated with this sector, it is clear that the debate around sustainability will have to arise.

To understand the construction industry in relation to tourism, one needs to understand the models and types of tourism developed in most African cities. The economy plays a major role in determining the nature of tourism and architecture and consequently impacts on construction typology (Adebayo, 2000). For example, most foreign investment in tourism is coupled with foreign architectural concepts and imagery and the destination becomes a replication of Western architecture. The appropriateness of such structures in Africa, the aesthetic quality of the architecture and the implication on the given environment in a specific context are questionable in terms of their responsiveness to the African environment.

Investment in the tourism industry is meant to encourage a self-sustaining economy and sustainable development (Adebayo, 2000). Because of the economic power held by foreign investors, the international tourist industry imposes on peripheral destinations, a pattern of development which exacerbates dependency on developed countries (Pearce, 1991). This trend can be observed in many African tourist destinations and places especially in their architectural expression, imagery, usage of materials and construction procurement systems.

The image and perceptions of both tourists and the host society largely determine the diverse built environments created for tourism while in fact, the built environment in tourism should relate to the architecture of a place and the interrelationship with the habitat space, time and socio-cultural aspects either in the cities or peripheral environments. The built environment therefore functions physically as a specific system. Mills (1983) states that an architect of today involved in tourism projects must consider architecture as a journey involving and linking the past, present and future of his particular site. These types of tourism buildings should aim towards a production of architecture that relates to both time and place. This has given rise to different types of thinking in tourism architecture and construction. The old parts of African cities, especially the coastal cities of East Africa for example, are seen as exotic places, both culturally and socially, and are aesthetically accepted by tourists, giving rise to conservation and maintenance. The emergent construction activities are based on the principles of sustainable construction in terms of usage of materials, environmental friendliness and procurement systems geared towards embracing community methods of construction and their inherent identity of technology and management.

The synthesis of tradition and modernity is another approach to architecture and building techniques in tourism. This type of tourism architecture has led to the development of resort type of hotels in Africa. This type of building approach is intended to re-use the traditional architectural vocabulary, imagery and form which is defined through construction techniques and materials. The emphasis is not only placed on the aesthetic quality, but rather on pragmatic architectural solutions to indigenous methods and construction processes. These methods are region-specific and embrace the type of indigenous architecture and society within a given context that has established a long tradition in terms of image, technology, appropriate traditional materials and functions. The architects and construction team involved in tourism-related design have the task of blending together both traditional and modern polarities. These polarities exist in a language within which architects have to operate (Kahn, 1991). This architectural process brings forth a construction process where people, community, culture, nature and materials become an integral part of sustainable construction.

2.4 Mining and mineral related industry

The mining and mineral related industrial sector cannot but form part of any discussion on sustainable construction. Certain aspects of such developments have direct and indirect impacts on the environment. Nyang'oro (1992) cites the case of Nigeria in which he observes that oil revenues generated by the mining and selling of oil have naturally increased the capabilities of the Nigerian state, making it possible to finance much-needed development projects. On the other hand, the same processes have generated growing regional inequalities, impoverishment, underemployment and degradation of the Nigerian environment. This analysis holds true for other mineral and mining activities across the continent in Zambia, Angola, Congo, Kenya, Libya, Morocco, Algeria, Ghana and others. In specific reference to the oil industry, Hutchful (1985) further notes that the pollution from pipeline leaks, blowouts, drilling fluids and refinery effluent as well as land alienation and widespread disruption of the natural terrain from construction of oil-related industrial infrastructure and installations have been inevitable accompaniments of oil-related development.

In the general area of the mineral industry, there are few programmes of rehabilitation, and nor are there effective regulations to protect the environment. There can therefore only be limited sustainable construction in this regard.

3. Procurement Systems in Practice

There are many construction contract procurement systems in use in countries around the world but in African countries these are mostly replicas of those used by their former colonizers. This is manifested in education, professional training and legislation. Nigeria's construction industry for example, currently uses most of the procurement systems used in the United Kingdom including the traditional contracting, the design and build, construction management, management contracting and project or programme management systems (Gidado, 1996). The same is true for other Anglophone, Francophone and Portuguese African countries.

Most major projects are financed by African governments through their public sector finance with the government and its departments often the client. On completion of such projects, facilities management and maintenance of the resultant buildings remain within the government departments. Major problems arise in the way the government representatives participate in projects with various different levels of understanding of management skills and contracting methods either by using in-house systems or appointing a project manager as consultant acting on behalf of the client. Evaluation of the experiences of various African countries in public sector participation has shown that participation often hinders progress and performance due to bureaucratic procedures and corruption which make development unsustainable.

Another general problem is that of incompletion of projects of all kinds. In Nigeria for example, several housing projects were not completed during the Shagari's regime of the 1980s due to lack of good contractors, managerial skills, corruption and conflict of interest. Similar scenarios exist in Kenya. In South Africa lack of completion can be linked to a lack of experience and capacity of the small, medium and micro-enterprises (SMMEs), and poor tendering procedures. There is also the general problem in Africa of non-payment of the design and construction team, due to frequently changing political situations arising from conflict and war in places like Angola, Congo, Somalia, Sierra Leone among others, and unsustainable economic systems.

Among the various procurement systems possible, most governments in Africa seem to favour turn-key projects, design and build, and build, operate and transfer (B.O.T) for larger projects. Among the problems associated with these procurement systems is the tendency for only large companies to be able to participate effectively in these types of projects, with proof of finance, large capacities and proof of long standing experience in similar projects. Often, foreign companies win such project bids. While sustainability may be achieved through the high quality of work associated with such projects, small indigenous firms run the risk of unemployment and lack of access to these types of projects. It is unlikely that governments will desist from using these procurement systems. An approach or procurement policy that seeks to integrate small indigenous design, construction and finance firms should therefore be a focus of such projects.

Beyond the issue of appropriateness of the procurement systems commonly favoured by African governments is another dimension of procurement, namely the appropriateness of the use of traditional construction procurement systems. Problems have arisen in the application of this form of procurement system. In the case of Botswana, a study by Rwelamila (2000) shows that public building projects do not conform to the principle of the traditional construction procurement systems, as design is normally complete at the time of selecting the contractor. The architect appointed by the client is inadequately experienced to cope with the co-ordination of the design team and to administer the interface between design and building components, and the form of project contract used is normally negotiated in order to ensure equitable distribution of risk. The outcome of Botswana's evaluation suggests that the traditional construction procurement system is basically used as a default system. Rwelamila further argues that the procurement systems management structure and its respective contract arrangements are used merely because the clients and project consultants do not seem to consider the issue of selecting an appropriate procurement system. In this instance, the failure to use an appropriate system poses the risk of failure to achieve construction sustainability.

To develop appropriate procurement systems suited for specific requirements and locations and given the changing circumstances of the political situation across Africa, construction industry procedures in terms of procurement systems need to be restructured for sustainable construction, especially in the public sector where most African countries' development takes place.

As argued in the Namibian White Paper on Labour Based Work Policy (1999), government should set an example of best practice and several other governments also need to review their operational methods and procurement systems. The South African democratic government on its part believes that the public sector should review practices used during the apartheid period and procurement policies and strategies that achieve socio-economic development put in place according to the objectives of the Reconstruction and Development Programme (ANC, 1994) which aims at an inclusive, non-racial, gender balanced approach to development. The principles should lead to development of procurement and construction strategies that facilitate economic empowerment of marginalized groups through development of skills and entrepreneurship of small and medium scale contractors. Watermeyer (1998) sees small, medium scale and micro-enterprises (SMMEs) in South Africa as the vehicle whereby the lowest income people in the society gain access to economic opportunities. A substantial proportion of these opportunities occur in the construction sector. Sustainable construction in this respect can however only be achieved where major constraints facing SMME's viz access to market, credit, skills and supportive institutional arrangements are removed. An effective mechanism that has been used by the public sector in the removal of these constraints is targeted procurement systems to specific marginalized individuals and communities.

Taylor and Norval (1994) see this 'as a developmental oriented approach and argue that such an approach to procurement which considers community empowerment, participation in design, job creation via the developmental process and economically and environmentally sustainable procurement process, supported by institutional reform to ensure socio-economic parameters are achieved in the procurement process'. However, the targeted procurement systems in their application in community contracting are still faced with problems of delays, conflict in communities, and acquired skills on construction sites are once-off with no guarantee of future employment for the newly skilled people. These need to be surmounted if sustainable construction is to be achieved

4. Construction and the Environment

Site design and response of construction to the natural environment remains a common problem in Africa. By not allowing a proper investigation of the site, the natural environment ceases to be an integral part of design and construction implementation and is thereby compromised.

As argued by Schaefer (1994), the architects, developers, builders and owners often overlook the site as one of the significant elements of sustainable development and construction. He further argues that development proceeds in a heroic mode - that nature is to be conquered, the rugged individual mastering and subduing the land for economic gain.

In many urban areas of Africa and especially in the cities, construction of buildings generally, but especially residential buildings has been carried out to occupy the entire site. The natural green system has been destroyed and compaction has taken place to a level that prevents air movement even after construction is completed. The existing natural environment has in many cases been destroyed beyond repair. In South Africa for example, new housing, especially in the state low-cost projects, has turned areas of natural vegetation to desert, with construction activity causing removal of all the trees on site rather than integrating them into the built environment. A comparison of this scenario with informal settlements in Durban and other South African cities reveals that trees are well -preserved in areas where there is no intervention of new construction.

In addressing the complex problem of construction and the environment, efforts towards sustainable design are fundamentally an attempt to put into place practice that restores the balance between the natural and built environment. It is a search for an ecological model that views both realms as fundamentally interconnected. It should be recognised that mankind is locked into a highly dynamic relationship with the natural world and that the two are acutely interdependent. If this relationship is forgotten, certainly mankind and his integration into the environment has failed to effectively utilize it to build and shape the land in a manner that is harmonious, symbiotic and sustainable (Schaefer, 1994).

Site planning as an approach is well understood by the professional as a way in which to achieve balance between the built and natural environment. The work of Lynch (1975) gives a comprehensive approach to site planning, to identify the critical and important aspects of the site to be integrated in the project. Norberg-Schultz (1984) also argues that the point of departure of design on site and construction should understand the existing characteristics of the site as Genius loci which also includes climatic conditions, orientation, hydrology, geology, ecology, etc. It is not uncommon in today's construction to see sinking, cracking of walls and unbearable indoor temperatures coupled with faulty foundations, construction material choice yielding unhealthy environments and high maintenance costs and compromising the notion of sustainable construction.

Waste on construction sites is equally important in most African countries, with dumping taking place in landfills and sometimes with other hazardous material, and in other instances left on the site, often in the case of smaller construction sites. Dams or unseen river courses and hollows also usually attract dumping. Dumping sites, if left unchecked, become a breeding ground for mosquitoes and vermin. The building materials manufacturing industries in some urban areas are also not exempt from problems of waste disposal, with disposal taking place in water or rivers, pits, landfills, etc. These are all contributory factors to environmental degradation. The recycling of construction and waste management in the construction industry are areas that require strengthening. Perhaps the failure in this area lies in the synthesis of theory and practice.

The other environmental malady of African cities is to be found in residential areas. Land is a costly commodity and a basis of many an economic activity on which survival rests. The use of land, especially where there is lack of stringent application of environmental standards and regulations, tends to disregard the quality of the built and natural environment in pursuit of maximum economic gain. Sustainability in such instances is questionable.

Further, massive deforestation in Africa can be attributed to the building material industry. Timber for construction and related industries is often harvested, sometimes from indigenous forests and not necessarily replaced. While forestry and timber harvesting is an important economic activity, it can only continue to be so if deliberate steps to replace the harvested trees are taken. The other dimension related to the timber industry is the tendency of sawmills to be located in towns as part of urban industry, with noise, and air pollution from dust and smell, and the unsightly appearance of industrial waste contributing to environmental problems. Griffith (1994) also draws attention to the environmental effects of construction activities resulting in a number of comfort disturbances to individuals living and working in the areas surrounding construction projects. This is manifested through noise of construction operations and equipment, dust from construction process and traffic, hazardous contamination, for example toxic waste and other visual disturbances from signs and advertising boards, as environmental problems associated with construction sites.

4.1 Traditional Architecture

The concept of sustainable development within the environmental movement is understood by the early tradition in human civilization. This is recognized in the importance of utilizing the resources provided by nature on a sustainable basis, and indigenous people who have practical experience of the fact that humans are dependent on the earth's life support system and traditional cultures, have practiced sustainable resource use for millennia (Hill et al as cited in van den Post, 1994).

With regard to construction, traditional communities have always used the natural materials in their immediate environments for construction, and the resultant buildings have been well integrated in the natural environment. Rudofsky (1994) states that nature is being tamed by modern design implementation but that traditional architecture welcomes, embraces and integrates as a continuum aspect of nature. Norberg-Schultz (1984) supports the same argument that traditional buildings relate to the existing characteristics of the site. This characteristic of architectural elements is supported by the choice of materials of construction that respond to the environment. Traditional building materials have the added advantage of being cheap and easily accessible. There has been wide use of such materials across Africa. Mud wall construction for houses is one such example. There is also still evidence of stonewall construction in greater Zimbabwe. Wood is not only used for roof trusses and doors but also to erect buildings. In swampy areas of the delta region of Nigeria, the Cameroon riverbanks and Senegal among others, timber has been used for piling to suspend buildings above water, as well as for frames, walling and ceiling. Such materials have proved to be climatically friendly as demonstrated in studies by Fathy (1973), Guioni (1976), Schwelferger (1982) and Prussin (1986).

Environmental response to construction sustainability has been enacted for decades in the frequent adaptation of buildings and invariable re-use of earlier material or materials close at hand, or drawn from abandoned or collapsing buildings. Such buildings were simple and in today's interpretation may not have exhibited high building quality, but were often robust and basic if not necessarily well-suited to their purpose (Wyatt, 1994). In terms of dealing with building waste in the more recent past, thatched timber frame and stone buildings with timber roofs would have resulted in a local natural solution whereby when they collapsed, nature would decay and return such material to the earth. Where sound to reasonably sound timber and stone survived, it would have been re-used, or even adapted to suit a new 'design'. Even when fired materials were first introduced, many of the early bricks when left, would also be returned to the earth through the natural agency of weathering (Wyatt, 1994). While this form of natural degradation may still be possible in rural areas across Africa where use of rudimentary building materials and technologies is still rampant, one has to question its workability in the urban setting where the sheer might of construction volume and construction waste, and use of materials that do not lend themselves to natural degradation, is the norm. Nature's re-use and degradation technology needs to be incorporated where possible into modern-day construction processes. Where this is impossible, sustainable construction requires new and innovative methods of waste disposal and re-use.

4.2 Energy

Energy efficiency in construction and production of building materials is an important area of sustainable construction in developing countries. Its efficiency is not only in the usage of direct energy, but also in the amount of fuel used in obtaining the raw materials, the production process and the transportation of materials. The gross energy requirement to manufacture a unit weight of building materials is classified by UHCH (1991) as high-energy materials with high-energy requirements, medium and low energy materials. High-energy materials commonly and substantially used in construction include aluminium, steel, plastic, glass and cement. There are differences in the quantity and quality of energy or fuel used in the manufacturing of materials. For example, the high energy materials are dependent on high grade fuels such as electricity, oil and pulverized coal in their manufacturing process. The medium group of materials include such materials as concrete, lime, plaster and most types of building blocks based on cement or lime, and fired clay bricks and tiles. Traditional technologies of production of these materials yield low rates of production as well as poor fuel efficiency. The cost of energy in this instance ends up being high.

In many African countries energy sources are particularly scarce and associated with high import cost. Scarcity of energy in many African countries has also resulted in rationalization of consumption such as in electricity for

domestic use as well as industrial use directly impacting on the construction industry which is often faced with the problem of inadequate supply of energy for materials production. Domestic materials are also high in cost. Moreover, due to inadequacy of energy supply, and its impact on the amount of materials that can be manufactured, demand for building materials in many countries is met with insufficient supply, necessitating importation of materials at high cost. An added problem in this regard is the use of old plants and equipment whose energy consumption and costs is often high relative to similar plants in developed countries. The construction sector is one of the sectors that consume substantial amounts of energy, and energy saving methods as well as alternative forms of energy are required for construction sustainability.

5. Conclusion

Sustainable construction in Africa should focus on the relationship between development and construction. There is also the need to develop specific solutions to problems of natural and built environmental quality. The construction sector must also begin to address the development, not just of appropriate construction materials but also appropriate technology that recognises the need to save on energy and is cost-effective. Waste management methods must be environmentally friendly.

Concern about the impact of the construction industry, procurement systems in practice, and methods of contracting and management of sustainable construction has spurred research and reviews, but the results are not yet sufficient to address the consequences on the built environment and development in Africa. Ongoing research in this area can therefore not be overemphasized.

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