

Challenges of Sustainable Construction in Developing Countries

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				List of Abbreviations
A21SCDC	--			Agenda 21 for Sustainable Construction in Developing Countries
CIB		--		International Council for Research and Innovation in Building and
				Construction
DC		--		Developing Countries
GDP		--		Gross Domestic Product
LCA		--		Life cycle assessment
SC		--		Sustainable Construction
SD		--		Sustainable Development
SDG		--		Sustainable Development Goal
UN		--		United Nations
UNEP		--		United Nations Environmental Program
WCED		--		World Commission on Environment and Development
3R		--		Reduce, Reuse and Recycle

Abstract

Construction industry is undoubtedly the largest and oldest industry of humankind's history and plays a very important role in socio economic development of a nation especially in the developing countries, where development of built environment and physical infrastructure is a grave necessity. The global economic engagement of this industry is nearly 7.5 trillion USD, contributing 10% -13% of GDP. In developing countries, the GDP contribution is only 6-9 % with 23% of the global construction output indicating improper management and struggling situation of this industry. This industry is fragmented, complex, and unique in nature and often faces persistent challenges like overrun of time and cost and huge amount of waste generation. Besides this industry is blamed to be the supreme consumer of natural resources which put it in foreground in the quest towards sustainability. This paper reviews concepts of sustainable development in construction industry and identifies challenges to introduce sustainable construction in developing countries. The research concludes increasing awareness at every level of development activities along with formal research and studies for materials improvement and technological advancement is necessary.

Key terms: Sustainable construction; developing countries; strategies

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Objectives of the Study

The objective of the study is to address the concept of sustainable construction and development, to identify how current construction practices have adverse effects on the surrounding life and environment, and to explore challenges of implementing sustainable construction in the developing countries.

Research Methodology

In this paper, the data and information required to present the challenges of sustainable construction in developing countries has been collected from a large number of E-Books, online and printed Research Paper, and Database of various National and International Organizations. The collected data have been analyzed and compared qualitatively using secondary research methodology and discussed with experts of relevant field.

Background

Construction industry plays a very important role in socio economic development of a nation especially in the developing countries, accelerating development of built environment and physical infrastructure such as roads, hospitals, schools and other basic & enhanced facilities. Despite of the global economic downfall, the global economic engagement of this industry is nearly 7.5 trillion USD, contributing 10 %-13% of GDP. Global financial involvement of this industry is shown in the figure 1(Chris, 2012).

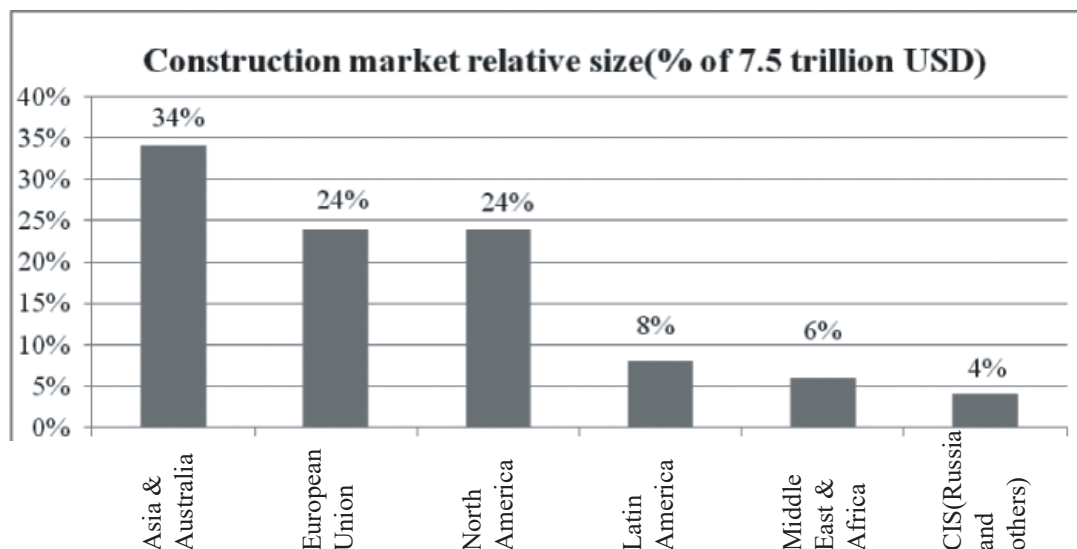


Figure 1. Relative size of construction market

In developed countries, it contributes nearly 10%-13% of GDP but in developing

countries the average GDP contribution is only 6-9 % of GDP. These figures show although financial involvement is much higher in the developing countries but it contributes less in GDP. That indicates improper management and struggling situation of this industry, but study of recent years shows it's doing better day by day. Construction faces a huge sustainability challenges as it is the largest and most fragmented industry of the world and blamed to be the supreme consumer of natural resources. According to World watch Institute, building construction alone consumes 40 % of the raw stone, gravel and sand, 30 % of virgin wood, 40 % of the energy, and 16 % of water used each year globally. Severe environmental hazards are triggered by the construction activities including planning, construction, maintenance, renovation, demolition, resource consumption, and waste production during entire life cycle of a building or any other structure. Agricultural land loss due to rapid urbanization, resource depletion due to excessive resource extraction, biodiversity losses due to deforestation, global warming and acid rain due to excessive energy consumption are the major hazards. For sustainability, minimization and mitigation of such hazards is very urgent and that's possible only if every stakeholders including project owner, planner, designer, contractor, supplier, consultant, supervising officer and workers do their part of responsibilities properly.

Basics of Sustainable Construction

The International Council for Research and Innovation in Building and Construction (CIB) launched an Agenda 21 for Sustainable Construction in Developing Countries (A21 SCDC) in partnership with the United Nations Environment Program (UNEP). The A21 SCDC provides a common and basic understanding of the issues, challenges, barriers and opportunities related to sustainable construction in developing countries and provide comprehensive framework for research agenda and generic strategies to be introduced at a regional or national level based on local priorities (Du Plessis et al, 2002).

In this A21 SCDC there are two types of agendas: green and brown agendas. The brown agendas focus on short-term tangible development of basic human needs and the green agendas make this sustainable considering long-term stability of biophysical environment. (Prescott, 2001). The construction sector being related to basic human needs and environmental player it eventually fits at the interface between the brown and green agendas. Hence, the construction industry in developing countries has to face not only the challenges of increasing demand of housing, rapid urbanization and lack of infrastructure, but also to respond in a socially and ecologically sustainable way.

Sustainable construction can be defined as a set of processes through which a

profitable and competitive delivery of built assets like buildings, structures, and infrastructure are obtainable which will offer-

- Better quality of life
- Consumer satisfaction
- Flexibility to changes in future
- Desirable natural and social environments and
- Efficient use of resources.

By minimizing use of energy, water and natural resources and effective waste management, we can ensure meeting present demands without compromising the demands of future generations.

According to Glanvinich SC is "planning and managing a construction project in accordance with the contract documents in order to minimize the impact of the construction process on the environment (Glanvinich 2008).

Charles Kibert defined SC as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles' (Kibert, 1994). Another definition of SC : 'Sustainable construction, in its own processes and products during their service life, aims at minimizing the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making' (Huovila and Richter, 1997).

Lanting defined this as ' a way of building which aims at reducing negative health and environmental impacts caused by the construction process or by buildings or by the built environment' (Lanting, 1998).

According to Agenda 21, the main principles of SC are shown in figure 2.

Figure 2: The principles of sustainable construction

Principles of sustainable construction				
3R	Reduce recourses Consumption		Eliminate toxics	Modification
	Reuse recourses	Protect nature	Apply life-cycle costing	
	Use recyclable recourses		Focus on quality	

Sustainable construction addresses the social, economic, and ecological issues of construction projects and its various activities as well as ethical and practical response.

The term sustainable construction refers to the responsibilities of the construction industry in achieving sustainability. This process comes in action well before construction starts (in the planning and design stages) and continues even after the construction team leaves the site (Hill et.al, 1997).

Sustainable Construction in Developing Countries

Although there are many things similar in developing and developed countries, there are large differences too. Here survival and political issues draw most of the policy makers attention, which puts sustainability concepts far behind of consideration. As developing countries are under construction and goes through rapid growth in this sector, introducing sustainable construction policies is a urgent need

The developing countries are different in climate, culture and economy. But they have many things in common (Du Plessis et al,2002).

- Main sources of foreign income (agricultural products and raw materials)
- Inequity of economy (dual economy)
- Lack of infrastructure and basic services
- Rapid urbanization (with lack of fund and technology)
- Colonial past (imposed certain norms, standards and bureaucratic procedures on the development)
- Consumes far fewer resources, and releases far less greenhouse gasses but experience immediate and visible impacts
- Gender issues
- Sophisticated methods of conflict resolution and reaching common agreement
- Has grassroots ability of innovation

Challenges and Opportunities

Unsustainable construction

Being large, complex, and fragmented in nature, this sector often faces challenges like overrun of time, cost, and impacts on environment, society, and economy. A successful and sustainable project must be completed within the estimated period and cost and it must not pose any threat to society, environment, and economy. Construction industry becomes unsustainable when it has to go through these problems.

Overrun of time: Completing a project within planned time is a must-do requirement for a successful construction project. However, this success is rarely achieved. A study shows during the study year out of 3,407 projects less than 1 % projects were completed in time in Nigeria, while 44.5 % were delayed and 53.5% were abandoned. Minimum average percentage escalation period of projects in Nigeria was found to be 188%. A similar research conducted in Bosnia and Herzegovina on

177 construction projects found 51.40 % projects delayed. In Jordan 82%, in Ghana 70% out of 47 in Saudi Arabia 70% , in Malaysia more than 70 % of projects faced time overrun (Jamilus et al, 2013).

Overrun of cost: This is very unfortunate that, a large portion of the construction projects worldwide, mostly in developing countries fail to complete within the estimated cost. Overrun of cost is a very common and unwanted problem in construction industry. In developing countries, even 100% anticipation of cost overrun is found (Azhar et al, 2008).

In different studies percentage of projects with cost overrun found to be 33% United Kingdom's (UK) construction industry but it was far more in developing countries: 51% in Uganda, 81% in Croatia, 58% in Malaysia and 58.67% in Bosnia and Herzegovina (Jamilus et al 2013). Flyvbjerg found about 90% of world's construction projects suffer with a cost overrun of 50 to 100% (Flyvbjerg et al, 2003).

Lack of implementers experience, poor management, and supervision at site, poor estimation of time and cost estimates, poor scheduling, frequent design modification or changes, materials price fluctuation etc are found to be the main factors contributing to cost overrun.

Impacts of construction

Most of the activities in construction industry found to be directly or indirectly hazardous to environment to very severe extent. But their social and economic impacts are not also negligible. At past, construction sector in the developing countries used to focus mostly on human development. Biophysical environment have not been considered properly. However, in recent year's experiencing severe environmental degradation by most of the developing countries, the negligence to the environment cannot be continued.

Environmental impact: The environmental impact exerted by the construction industry is found to be larger in developing countries than in developed countries because developing countries are still growing and in a verge to meet increasing demand of urbanization and industrialization. Severe environmental impacts of this industry are environmental degradation through pollution, excessive consumption of resource, huge waste generation.

Environmental degradation: Construction consumes large amounts of natural resources and produces huge amount of pollutants. It is identified as the one of the most environmentally unfriendly human activity because it puts extensive environmental threats. Most of the construction sites are not provided with environmental protection (Rodman and Lenssen 1994).

Construction contributes to the extreme climate change and global warming by emitting CO₂ and accelerating deforestation for construction. The production of iron, steel, cement, glass, lime and bricks is found to be responsible for 20% of annual

emission of dioxin and furan gases excluding emissions due to the production and use of PVC and other chlorinated substances as paints, plastics and wood preservatives. Asphalt, annually contributes a further one percent of dioxin emissions (UNEP, 1999). Excessive quarrying to provide raw materials, production of cement and binders, use of toxic chemicals in materials and the wasteful use of water cause serious environmental degradation. Construction without due consideration of nonrenewable energy preservation, environmental impact minimization and natural resources conservation will trigger ecological disintegration.

Excessive resource consumption: This industry is characterized as the supreme consumer of natural resources. It consumes 15%-20% of world's freshwater withdrawals, 30%-40% of wood and 40%-50% of natural aggregates and around 40% energy flows. This huge consumption and increasing demand lead to depletion of global natural resources. About 40% of the world's resource and energy used is supporting construction and maintenance of buildings which represents about 10% of the global economy (Shen and Tam, 2002).

Huge waste generation: Excessive generation of waste results in less productivity, material loss and delay in project completion as well as significant amount of revenue loss. A study shows about 9% -10% materials used and 30-35% of a project's production cost goes waste on site. 13-30% of all solid waste deposited in landfills worldwide comprises construction and demolition waste. In developing countries, this value is 25%-35%. Frequent design changes, low materials quality, workers' negligence, poor planning & design, poor site management, poor supply chain, incompetent materials use, effect of weather etc. are the main reasons of increasing amount of waste generation in rapid urbanizing developing countries (Bossink and Brouwers, 1996). In most cases, intention of maximizing profit by avoiding transportation cost and payment charge to the authorized landfill illegal dumping happens resulting in hazards to health and environment.

Social impact: The construction industry keeps an intense relation to society, as it is one of the largest industrial employers of the world counting 111 million employees, 74% of which are in the developing Countries. Producing only 23% of the global construction output with this huge employment indicates higher "employment intensity" in developing countries (ILO, 2001). Hence, the industry can play a vital role in human development and improving the quality of life for the poor and deprived peoples. However, like other development sectors this sector also earned a reputation for greed for profit, corruption, unfair labor practices and environmental destruction. According to International Labor Organization (ILO) gender discrimination and sexual harassment, bad safety records and many other problems are associated in construction industry of developing countries. As a result people work in construction out of necessity only and rarely out of choice which make social response of the sector questionable (ILO, 2001).

Economic impact: Construction represents as much as 10% of global GDP. The industry also promotes small, medium, and micro enterprises (SMMEs). About 90% of construction workers are employed in small firms. Economic sustainability of construction sector has an intense relation with its environmental impact. Using least cost methods of construction using minimum resources and generating low amount of waste construction industry can be more efficient economically and can reduce negative impacts on environment. Economic sustainability of this sector requires social and environmental costs internalization and reflection in the final product prices (UNEP, 2002).

The Challenges of Sustainable Construction

While developed countries have already made some progress in addressing and overcoming the challenges of sustainability in construction sector, developing countries are beginning to consider how to address these challenges as they are facing broader challenges in other development sectors. The common challenges in the way forward sustainability of construction are -

Internalizing: Sustainability is a relatively new conception the construction sector, are not yet an integral part of decision-making and business practice at present. Sustainability is a secondary expectation and still not the main motivator that drives all business and development decisions.

Profitability: There is a general perception that introducing sustainable construction will increase capital and maintenance costs and reduce marginal profit. Additional investments in modern technology, machinery, equipment, implementation of better employment conditions and training are considered as loss or profit reduction instead of long time investment for greater achievement. The challenge is to find ways of cost savings through efficient use of resources, higher productivity, and risk minimization and achieve benefits of sustainability to increase profitability.

Resources mobilization: Mobilization of resources in order to support research and technological advancement is one of the key challenges of sustainable construction. Governments along with private and academic sectors and also universities and research organizations worldwide can come forward to mobilize and direct resources towards sustainability.

Public awareness: Not only the governments and the construction industry, citizens' involvement and awareness are very necessary for sustainable construction. As Citizen's participation is key to change the consumption patterns of the resources, it is important citizens have understanding of the benefits and opportunities of using of environment friendly building materials and products.

Quality improvement: Faulty and inefficient construction processes results in wastage of environmental resources and pose a threat to both workers and users. Quality Improvement of construction Process and Products along with enhanced safety

can be a first step towards sustainable construction.

Reducing resource consumption: Reducing resource consumption is a priority for the construction sector. This can be accomplished through various direct or indirect means, each posing different challenges associated-

- Reduction of construction material wastage
- Use of recycled waste as building materials
- Introducing high Energy efficiency in buildings
- Water conservation
- Durability and maintenance

Innovative building materials and methods: Sustainable construction can bring a visibly huge difference to global environmental and socio-economic sustainability through balanced use of resources. A recent study shows, if EU were to use only its fair share of the world's resources, they have to reduce use of cement by 85%, steel by 87% of steel, and aluminum by 90% (Hille, 1997). The Kyoto Protocol also demands large-scale reduction of green house gas emissions. New design concepts are required to cope with the necessity of reducing pollution, like in early 20th century, moving from brick and mortar to steel and glass.

Environmental health and safety: Construction materials are blamed to be responsible for a large percentage of the global toxic burden. Hence, more research regarding the environmental and health impacts of construction materials and site activities are necessary. Besides, strategies are required to introduce to deal with harmful materials like asbestos and finishes.

Procurement: Sustainability of construction often depends largely to role played by the clients. Inclusion of sustainability criteria in the policies and procedures of procurement of all large clients such as the government, users and market stakeholders can be an enabler for sustainable construction.

Specific barriers towards sustainable construction

As developing countries are associated with nonstop financial crisis, social instability and many other problems here, construction sector has to experience various practical obstacles. The main obstacles are discussed as-

Inadequate capacity: Inadequate capacity of the construction sector in DC is a big problem towards sustainability. There are not sufficient professionals, tradesmen and workers trained to hold sustainable construction. Most of the construction sector in many developing countries can hardly afford to maintain the demands of routine construction and rely on outsourcing staff as required. Skills training and retention of expertise in the construction are severely low, because workers in this sector are very mobile with a in and out characteristics.

Instable economy: Construction works rise and fall with income particularly with economic rise and fall, which is very common in developing countries. Economic

stability of government as well as every stakeholder has a great influence. For example, public building activity in Kenya in 1995 was only 3% of what it had been in 1982, because of recession (Wells, 2001).

Poverty and inadequate urban investment: Developing countries afford to provide low investment for urban development but have to accommodate high rate of demographic growth. This results in accelerated fall of quality in urban life and surrounding environment. Adaptation of alternative construction processes and concepts with latest and sustainable technologies becomes very difficult within such limitation of resources.

Lack of precise data: Precise data and information on current sustainable construction materials those are available, including their types, user manual, and resources consumption tendency over entire life cycle are not readily available for the stakeholders. Information about construction operatives, mode of operation and operational sectors are also necessary. Although government organizations gather statistical information, in reality they often exist only in name. Reliable data and information on potential health effects and risk of unsustainable construction practices are also insufficient. Still it is not easy to prove the link between certain sickness and environmental pollution, even though these relations are recognized. Making decision on interventions becomes complicated due to in adequacy of data about the exact links.

Negate the issue of sustainability: There is a general negligence in the issue of sustainability in the construction sector among its providers, clients, regulatory authorities and other stakeholders. The experience of negligence about biophysical sustainability is different to various stakeholders.

- o **Politicians:** agenda-differentiation of political leadership, unless they can be directly connected to gender and poverty.
- o **Manufacturers:** materials or product specifications and marketing.
- o **Governing authorities:** Neglect in plan approvals, land use or land subdivision.
- o **Environment professionals:** setting design criteria or specifications and providing training.

Being accessible to a variety of income groups and lack of substitute economic and credit mechanisms to support changes in current practices are the reasons for the lack of interest in this regard (Chris, 2012).

Technological sluggishness: Until now, most of the developing countries are using technologies and processes of colonial period. Blind following of concepts, codes, and specifications of developed countries are not expected, because their nature and capacity in this sector is completely different. Developing countries need to adapt new and specialized knowledge and technology to ensure best and sustainable use of their own. In Malaysia, the conventional planning and construction methods using wood timber have been discouraged after major fire incidents occurred in 1826 and

1881. In South Africa traditional earth construction is highly discouraged, even though the technology has a long practice in the country and more than 10% of the inhabitants reside in earth housing (Chris, 2012).

Lack of integrated research: Research in building technologies and planning is not integrated. The research institution, organizations address each matter separately and autonomously. Agencies dealing with building technologies center attention on specific technologies like as materials strengthening while another agency focus on pollution, transport development, environment or social impacts. Integrated work between these agencies is absent and hence development activities do not take place in an expected manner. Funding for integrated research projects, instead of projects focusing on single feature such as energy competence, is also rare to find.

The study finds sustainable construction is a grave necessity in developing countries as well as in the developed countries. Financial and political instability, lack of awareness and many other problems in developing countries come forward as major obstacles to achieve sustainability in this sector.

Limitation and Scope of Future Study

This paper is a concept paper and completely based on qualitative analysis and compilation of various relevant papers, books, journals and discussion with experts. To understand the problems clearly and to find out specific solutions vigorous quantitative analysis comprising field data about construction time and cost overrun and compromising in quality can be find out. Besides, it is very important to find out the reasons causing these problems and solutions and a model of risk assessment can be done. Bangladesh is large market of construction industry. However, unfortunately there is not enough data in this field because of lack of study in this field. There is no specific database regarding construction time and cost overrun and other problems associated with it. Future researchers can work in this field for greater benefit of this industry and for faster development of the country.

Conclusion

It is time to comprehend the influence of our developmental activities on environment and human lives can escalate the knowledge that the current state of the world is not its best order. However, as a user of the construction sector and depending on the built environment awareness of sustainability of development actions must be raised. Both in developed and developing countries construction sector and its stakeholders and clients are not conscious in this regard, and think no major change is required here and all it needs is few tweaks to the construction process and resource efficiency. Most of the technologies and concepts being adopted are only interim solutions that buys them time to formulate, admit and implement a resilient sustainability ideal of development with its complementary morals and ethics. Understanding of e the scope of the

innovation of resilient sustainability is required to generate among the clients as well as the service providers and regulatory authorities. At the beginning of the 20th century, construction industry has seen a great move from brick-sand mortar to steel and glass (Chris, 2012). The change required now is far greater. Complete reinvention, in terms of materials use, manufacture, and performance is essential in construction sector. Fortunately, this shift would be easier for the developing countries as people there are by nature, experienced of the survival challenges, innovative and keep high adaptation capacity and able to do more with less resource.

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