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ISSUES IN SUSTAINABLE CONSTRUCTION AND ENVIRONMENTAL PRESERVATION: Some Implications of Trends in Local Construction Materials' Prices.

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Abstract
This study aimed to show that the trend in prices of construction materials renders their increased exploitation more attractive and by implication less sustainable, through the derivation of an index of prices of selected materials and comparison with the inflation index. The findings of the paper are however limited by the unavailability of data on the volume of construction materials exploited. Data on prices of three local construction materials (sand, gravel and timber) was collected from documented information kept by construction firms. A survey mounted in December 2006 through July 2007 yielded information on quantities of timber sold in Minna. The study adopted 1999 a base year for an annual index of material prices. It was concluded that fluctuations in the general price levels accounted for only up to 39% of the variations in the prices of construction materials, and at current levels of demand for construction materials, environmental degradation is inevitable in the absence of countermeasures. The integrated planning of urban centres, such that areas that will in the near future be used as recreational lakes or rubbish tips can be allocated for use as borrow pits and sand mining sites at the present time.
Keywords: ***construction, environment, materials, prices, sustainable.***

INTRODUCTION

The environmental impacts associated with construction activity are extensive (World Bank, 1998). In most urban centres construction activities are progressing at ever-increasing rates. Urbanization has been cited as an important problem of the 21st century (UNCHS, 1996). Rapid increases in the demand for the built environment in the form of residential houses, institutional and commercial buildings are fuelling the demand for construction materials. The built environment continues to grow year on year; in the UK, not only total floor area is increasing, but also consumption of energy per unit area (EIBI, 2000). A sizeable proportion of the materials for the built environment are sourced locally. Examples are sand, aggregate such as gravel and granite, timber. Uncontrolled exploitation of such materials, which form a natural part of the earth's crust and flora, leads to unsightly defacement of the environment.

The environmental impacts of the construction process occur over a variety of time-scales from the extraction and processing of raw materials through the construction process and building operation, to the eventual demolition of the structure at the end of its operative life (Horsley et al., 2003). Life cycle assessment (LCA) research has however suggested that it is during the operational life of buildings where the most significant environmental impacts occur (Smith et al., 1997; Eaton and Amato, 1998). In the developing world, environmental damage due to exploitation of the earth crust to provide construction materials is mostly attributable to poorly developed regulatory structures. Where policies and regulations are in existence to oversee the exploitation of construction materials, blurred lines of responsibilities between the three tiers of governance in Nigeria provide loopholes that are exploited by entrepreneurs. The strongest motivator behind official regulation of local construction materials exploitation appears to be the finance factor. Entrepreneurs are only allowed to exploit the quantities of materials that they have paid the requisite fees for (Oke, 2007). Given the perchance for corruption by public officials, this form of regulation is bound to be ineffective.

This study, located in Minna the capital town of Niger State, aimed to show that the trend in prices of construction materials renders their increased exploitation more

attractive and by implication less sustainable. Specific objectives of the study include the derivation of an index of prices of materials and comparison with the inflation index. The study is necessary because increase in prices of construction materials is usually associated with a rapidly expanding economy, which can be shown to be environmentally damaging (Chen and Chambers, 1999). The findings of the paper are limited by the unavailability of data on the volume of construction materials exploited. The average volumes of timber sold per retailer is provided as a proxy for comparison purposes only. The locational context of the study is displayed in Map 1 below.

Map 1: Nigeria showing Niger State

REVIEW OF RELATED LITERATURE

Construction materials are an important aspect of the cost of construction projects. Local sourcing of materials is predominant in most parts of the world. A study by Koushki and Kartam, (2004) of 450 residential projects in Kuwait revealed that nearly 85 percent of projects' owners utilized a combination of local and imported materials in the construction of the residential projects with 12 percent relying on only local materials. For nearly 70 percent of the residential projects the selected material was available at the local market in Kuwait.

Following the United Nations Conference in 1992, the international community has been active in developing policies which address the global environmental consequences of individual national industrial, commercial and social activities. In the developed world, public concern for the environment became increasingly evident in the 1960s, and was expressed at the United Nations Conference on the Human Environment, which was held in Stockholm in 1972. The idea which emerged from this conference was 'an approach to development aimed at harmonizing social and economic objectives with ecologically sound management' (Sachs, 1978). In 1987, the World Commission on Environment and Development clearly identified that the essential needs of vast numbers of people were not being met, and warned that a world where poverty and inequity were endemic would be prone to ecological and other crises (WCED, 1987). A comprehensive and pragmatic approach to sustainability was proposed by the economist Solow (1993), who argued that sustainability should mean more than just the preservation of natural resources.

Sustainable construction

The environmental impacts of the construction industry are extensive and readily identifiable. One-tenth of the global economy is dedicated to construction, operating

and equipping homes and offices. This activity accounts for roughly 40% of the materials flow entering the world economy, with much of the rest destined for roads, bridges and vehicles to connect the buildings (Roodman and Lenssen, 1994). The First International Conference on Sustainable Construction in Tampa, Florida, in 1994 addressed the progress in the new discipline of 'sustainable construction' or, as it has inevitably been dubbed, 'green construction'. Sustainable construction was tentatively defined as 'creating a healthy built environment using resource-efficient, ecologically based principles' (Kibert, 1994).

There is greater awareness and understanding of environmental problems and their wide-ranging and far-reaching effects (MoE, 1991; Ofori, 1992; Hawken, 1993), not least in the areas of analytical techniques of both the quantitative and qualitative kinds for addressing environmental problems (Val Pelt, 1993). While there should be changes in thinking, behaving, producing and consuming with regard to the environment (Hawken, 1993; UNCHS, 1996), action is required at several national and international levels (Ofori, 1998). In China, as in much of the developing world, most construction projects continue to use traditional building materials and processes, which make energy efficiency much less than that of developed countries (Xu, 1996). Furthermore, the wasteful usage of resources and environmental degradation also are direct results (Chen and Chambers, 1999).

Defining what sustainability means in the construction industry, its issues and purposes have been discussed by many authors (Zainul Abidin et al., 2003; Addis and Talbot, 2001; WS Atkins Consultants, 2001; Baldock, 2000; Department of the Environment, Transport and the Regions, 2000; Raynsford, 2000; Bogenstatter, 2000; Edwards, 1999; Hill and Bowen, 1997; Miyatake, 1996). Sustainability promotes a balanced approach by not seeking profitability at the expense of the environment or society's needs (MaSC, 2002). Sustainability concerns protecting environmental quality, enhancing social prosperity and improving economic performance (Addis and Talbot, 2001). Sustainable construction is a process whereby, over time, sustainability is achieved (Parkin, 2000). Several papers have been presented in conferences that discussed the importance of sustainability in improving value (Barton 2002; Barton et al., 2000; Schneider, 1999) and the potential of value management (VM) to promote sustainability (Yeomans, 2002; Barton et al., 1999; Phillips, 1999).

Influences in Environmental Sustainability

Construction has significant impacts on the natural environment (Hendrickson and Horvath 2000), and the International Organisation for Standardisation's ISO 14001 represents one form of influence directed at managing such impacts. The ISO 14001 standard defines an Environmental Management System (EMS) as "a management tool enabling an organization of any size or type to control the impact of its activities, products or services on the environment" (ISO 2002). The standard contains 17 key elements grouped into five major areas: environmental policy, planning, implementation and operation, checking and corrective action, and management review. The ISO 14001 is a voluntary, consensus-based, and market-driven standard (Kloepfer 1997).

Over 36,000 organizations in 112 countries have received ISO 14001 certification (ISO 2001). Environmental sustainability awareness appears highest in Japan, with over 8,000 certifications. The United States by comparison lags behind with only 1,645 certifications (To'th 2002). Countries including Hong Kong, Australia, and the United Kingdom have many firms undertaking the certification process (New South Wales Government 1998; Uren and Griffiths 2000; Tse 2001; Tam et al. 2002). The developing world is however yet to be adequately represented in this area.

METHODOLOGY OF THE RESEARCH

The data on prices of three local construction materials (sand, gravel and timber) was collected from documented information kept by construction firms. A survey mounted in December 2006 through July 2007 yielded information on quantities of timber sold in Minna; four common sizes of timber sold in the local market were considered in this paper. These were timber planks with cross-sectional sizes of (i) 50mm by 50mm, (ii) 50mm by 100mm, (iii) 25mm by 300mm, and (iv) 50mm by 300mm. The year 1999 was

taken as a base year for the development of an annual index of material prices. The proportion of variation in material prices associated with the general national level of inflation was determined through correlation analysis.

RESULTS AND DISCUSSIONS

The raw data from which indices were derived for the three materials considered by this study is presented in Table 1 below. The derived cost indices are displayed in graphical form as Figure 1 and 2 below. The results of correlation analysis between indices of the costs of sand, gravel and timber and the inflation index are reported in Table 2 below.

Table 1: Raw data collected from fieldwork

Year	Sand (per trip)	Gravel (per trip)	Timber 50x150x3660mm	Inflation Rate (%)
1999	5,000	3,700	100	6.60
2000	6,500	3,500	110	8.90
2001	7,500	3,300	110	16.90
2002	7,500	3,400	120	13.10
2003	8,000	3,400	120	13.90
2004	8,500	3,500	140	15.40
2005	8,500	4,000	170	17.90
2006	9,000	4,500	180	8.40

Source: Author's fieldwork data (2007)

Table 2: Results of correlation analyses

Variable	Correlations between variables and inflation			Remarks
	R value	R^2 value (%)	P value	
Sand	0.555	30.8%	0.153	Weak non-significant correlation; values of inflation do not satisfactorily explain trends in material prices.
Gravel	-0.323	10.4%	0.434	
Timber	0.207	4.28%	0.623	

Source: Computed from fieldwork data (2007)

Correlation analysis revealed that fluctuations in the general level of prices were associated with only between 4 – 31% of variations in the prices of construction materials. While inflation might have accounted for some of the upward 'pull' in the prices of the materials, other factors must be explored to properly explain the overall trend in the prices. Figures 1 and 2 showed that unlike inflation, indices for the cost of the sand, gravel and timber all maintained an ascending pattern. Over the eight year-period of the study, the materials nearly doubled in prices.

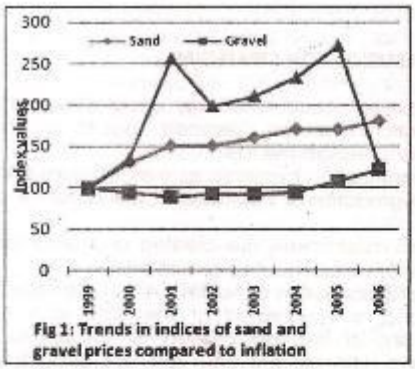

Fig 1: Trends in indices of sand and gravel prices compared to inflation

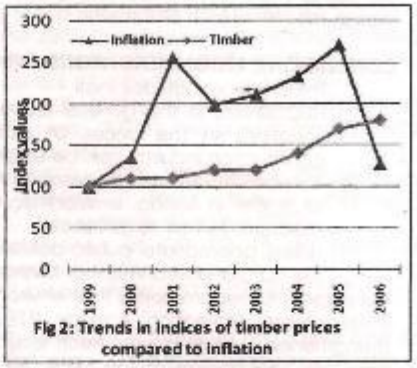

Fig 2: Trends in indices of timber prices compared to inflation

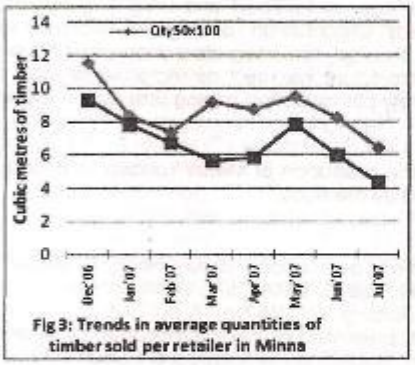

Fig 3: Trends in average quantities of timber sold per retailer in Minna

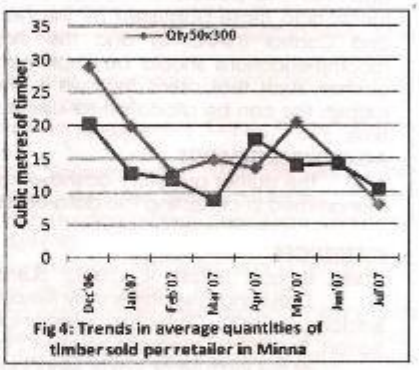

Fig 4: Trends in average quantities of timber sold per retailer in Minna

and 20 cubic metres of sawn timber planks monthly. Considering that there exists anywhere between fifty and a hundred retailers at any point in time, the volumes of timber sold in Minna can reach significant quantities. The sales pattern of timber appears to be seasonal, with more planks sold during the dry season (when the survey was initiated) than during the rainy season.

IMPLICATIONS OF THE RESULTS

These results tend to support a perspective that construction is subjected to increases in prices at a level higher than that experienced by general goods and services. In line with the economic theory of the price mechanism, it appears reasonable to speculate that the pressure of demand for construction materials results in higher prices; the demand for the materials is itself subject to the pressure attributable to urbanisation (need for the built environment, mainly due to exploding populations and rural-urban influx). Thus if the status quo is maintained, notwithstanding significant increases in price over relatively short periods of time, a rising trend in demand is likely to be sustained; this implies that higher levels of exploitation (with concomitant environmental degradation) will also be attained in the near future.

The trend in sales of timber provides an indication of the scale of afforestation through the establishment of managed forests that will meet current levels of demand for timber. Using a conservative estimate of fifty retailers and only one timber size available for sale, the volume of timber consumed in Minna annually can be computed as 2400 m^3

at the lower end of the scale, and 12000 m^3 at the upper end. Comparatively, this implies the felling of between three and fifteen thousand trees yearly, if each tree were to be 9 metres tall with a girth of 1 metre.

CONCLUSIONS, RECOMMENDATIONS AND IMPLEMENTATION STRATEGIES

This paper concludes that: -

1) Fluctuations in the general levels of prices accounts for only about 31% of the variations in the prices of construction materials. Demand specific to the construction industry can be employed to explain the rest.
2) Given current levels of demand for construction materials, as evinced from sales of timber in Minna, environmental degradation is inevitable in the absence of measures to halt its advance.
3) Unless appropriate public policies and mechanisms are created and enforced, the natural environment of Minna cannot be adequately preserved.

This paper thus recommends that environmental protection agencies such as the Federal Environmental Protection Agency (FEPA) and its counterpart at the state level be strengthened. Local government councils should also be assisted to set up such agencies. The powers of the FEPA, SEPA and LEPA (as the case may be) should be identical to those possessed by the National Agency for Food and Drug Administration and Control (NAFDAC) and the Standards Organisation of Nigeria (SON). These recommendations should be implemented through the integrated planning of urban centres, such that areas that will in the near future be used as recreational lakes or rubbish tips can be allocated for use as borrow pits and sand mining sites at the present time.

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