Managing Roads Construction Led Demolition Waste In The Context Of Sustainablle Construction In Gombe, Gombe State.

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Abstract

There has been a growing awareness of the importance of sustainability agenda. Moreover, for construction it has become increasingly important as both client and government are pushing for more sustainable products and ways to compliment each other's efforts. Which means therefore, Sustainable construction is about much more than the fabric of built environment. Housing, and the social, economic and transport infrastructure around them must be built in ways that are sustainable in environmental, social and economic terms. They must add value to the quality of life for individual and the community. Therefore the creation and responsible maintenance of a health built environment based on ecological principle and by means of an efficient and economic use of resources is the main goal of sustainable construction. This paper used real life data in form of reports prepared for compensation of properties affected for the purpose of providing ease of transportation in Gombe. The report covers six roads in the metropolis whose data was studied and analyzed using statistical methods of regression and correlation statistics. The result yielded correlation coefficients of 0.061, 1 and 1.00 for the following: length of road against: sandcrete, mud and combined materials of sandcrete and mud respectively. In conclusion the study recommended that the use of forecasting model should be integrated in to the procurement of roads especially in urban centers across Nigeria where predominantly sandcrete, mud or both were used. Thus, improving the efficient use of resources should be the main goal of sustainable construction. *Keywords: management, construction industry, sustainable construction, road construction, and demolition waste.*

INTRODUCTION

The term management in this context refers to; the act or skill of dealing with a situation or people in a successful way. Hence, the management of construction projects is an enterprise that involves many people with diverse interests, talents and background (Bennet, 2003). Primary among this people are professionals in the construction industry and clients, who in collaboration with other parties of the project team in the construction industry are tasked with the responsibility of ensuring a successful projects. According to Ogunsemi and Saka (2006) construction projects like roads, dams, bridges, plants etc. are part of the critical elements on which human development is based. Less developed nation, Nigeria inclusive face tremendous challenges in their quest for providing these infrastructures for their economies. Dahiru and Mohammed (2006) asserted that countries like Nigeria which are still in the process of providing adequate social amenities, such as education, healthcare facilities, decent housing for its teaming population and other infrastructures, construction sector has an important role to play, because it contributes almost 70% of the nation capital formation (FoS, 2008). There is no doubt that construction industry is one of the engines of the economy considering its contribution to the Growth Domestic Product (GDP), Growth Fixed Capital Formation (GFCF) and development. It is with this believe that lead to greater expectations that economic growth will continue in to the future due to

the strong relationship between construction activities and economic development. There will be increasing need for more projects, bigger housing and other utility buildings (Erkelens, 2002). These will in turn demand more building materials; from the environmental point of view, the above-described situation will cause more:

1. Depletion of resources: the environment accounts up to half of the raw materials taken out of the earth (Milford, 2002).
2. Waste; and
3. Emission, pollution etc.

Ebohon (1996) asserts that the industry exerts enormous demand pressures on global natural resources, where the environmental significance of such pressures come into play when some of these resources are depleatable and non-renewable, bringing the construction industry into direct conflict with the physical environment. The environmental consequences of undermining the earth carrying capacity unfolds regularly and often manifest in huge catastrophes such as flooding, mudslide, increased variability of global climate and the disappearance of fauna and flora. These manifestations are clear evidences that one of the fundamental principles of environmental sustainability, which is that "current need should be satisfied without compromising the need of the future has been violated".

The call and desire for sustainable construction is in realization of the construction industry's capacity to make a significant contribution to the environmental sustainability because of the enormous demands it exerts on global resources (Rwelamila, et al., 2001). The construction in particular and the built environment in general have been found to be among the main consumers of resources and energy (Wahab and Lawal, 2011). Moreover, the sector is reported to be generating unacceptable levels of materials and manpower waste. According to Ebohon, et al.(2001), it is imperative that the global attendants demand on global natural resources are balanced with the carrying capacity of the physical environment due to conflicting scenario of the rapid depletion in global natural resources simultaneous to the acceleration in global population.

URBANISATION AND SUSTAINABLE DEVOLOPMENT

The third world cities have undergone rapid urbanization during the past 50 years. According to Medina (1997), the number of urban centers is expected to double between 1987 and 2015; in addition to population increase and urbanization, - will seriously strain municipal resources to deal with a booming amount of waste especially from construction and demolition activities. Waste however, is generated in all sort of ways, its composition and volume largely depend on the consumption pattern and industrial and economic structure in place. Due to rapid urbanization experienced in developing countries and the increasing pressures on what are often limited resources, there is a great urgency to make sustainable interventions (Reffat, 2004). There is no doubt that large scale development is needed to address issues such as adequate housing, rapid urbanization and lack of infrastructure. However, these need to be addressed in ways that are socially and ecologically responsible. Reffat, (2004) went on to say that the developing world can either choose to blindly follow the model laid down by the developed nations or it can choose to opt for a more sustainable model of development. While the level of development may be a cause for despair, it also provides an opportunity for development in the developing countries to avoid the problems currently experienced in the developed countries. Plessis (2002) notes that the developing countries need not to go through the same process of development as followed by developed nations, instead these countries can choose to base all future development on the principle of sustainability.

SUSTAINABLE DEVOLOPMENT, SETTLEMENT AND CONSTRUCTION

Sustainable development is understood as an integrative and holistic process of maintaining the dynamic balance between the needs and demands of people for equity, prosperity and quality of life and what is ecologically possible (Plessis, 2003 and Wenblad, 2003; cited in Reffat, 2004).the sustainability of settlement is a multidimensional one, dealing not only with settlement dimensions, but also

spatial characteristics, geographical location, environmental conditions, economic variability, Institutional ability and structure, human development, social relationship and local values, and aspirations, Reffat (2004). The infinitely complex set of issues that determine sustainable development and settlement sustainability and the recognition that these issues are interconnected and interdependent requires a system approach to problem solving and planning, Plessis, (2003). Hence, the set criteria identify whether a settlement can be declared sustainable or otherwise:

1. The physical structure; how the settlement sits within the natural environment and therefore responds to topography, the spatial relationship between the different parts of the city, and form of the built environment.
2. The utilization patterns; which are formed by settlement, uses its resources and which are described by the infrastructure and services needed.
3. The social patterns; how people live, learn and work-in, relate to their settlement, and the opportunity provided the settlement for meeting of these social needs. And
4. The operational patterns; how the settlement function and its managed

Construction as the broad process/mechanism for the realization of human settlements (Gyoh, 2012), include: extraction and beneficiation of raw materials, the manufacturing of construction materials and components, the construction project cycle from feasibility to deconstruction or demolition and the management of the built environment, must as well meet up with the above-mentioned criteria.

SIGNIFICANCE OF CONSTRUCTION INDUSTRY IN AN ECONOMY

Henry, et al. (2009) cited in Wahab, et al. (2011) opined that, construction sector is one of the most dynamic and complex industrial development the worlds over. The industry's activity is one of the most important often referred to as the engine in any economy around the world (Ashworth, 2010), as it contributes to the economy of any nation through the various resources, infrastructure and facilities it produces (shaikh, et al. 2010). It produces and maintain infrastructural facilities required for various social, economic and industrial functions, such as buildings, roads, dams etc. (Achenu, et al. 2000); These infrastructural facilities are basically construction ends product, which are required for transportation, housing, communication, water and power supply, manufacturing and waste disposal. According to Freeman (2011), the industry accounts for about 10% of nations' economic activity globally. Approximately 70% is reported to have been accounted for in USA, Western Europe and Japan (Adindu, 2012).While 1% per capita investment in construction is in Africa. In the developed world is approximately $2500 per annum as against $46 per annum in Africa.

The level of construction investments portrays the level of economic development, because it determines the nature and pace of national development and the quality of life of the people (Dahiru and Mohammed, 2012). It makes significant changes to the economic output of most countries; it generates employment and income for people (Ibrahim, 2008). The industry is very important in the socio-economic development of developing economies due to its unique ability to facilitate development by providing directly for human needs or stimulating investment or by generating employments which can accomplish those objectives (Hamilton, 2006). The importance of construction industry can never be over emphasized because of the role it plays in the economic growth of a nation.

In Nigeria, the industry is responsible for 16.0% of the GDP (Ayangade, et al. 2009), and employs approximately 8 million people, which represent 25% of Nigeria's workforce and the largest in Africa (Ibrahim and Musa Haddary, 2010). However, the Nigerian construction industry is accused of being wasteful, inefficient and unsafe, falling short of quality (Omole, 2001). Most recently, the president of Nigerian Institute of Mechanical Engineers (NIMech. 2013) states that, the Nigerian industrial base is generally weak, because the country has failed to explore the blend between science, technology and innovation. No doubt that the construction industry in particular is facing massive challenges of sustainable construction as it is often regarded as the least sustainable, hence called 40% industry. It is therefore

very eminent that it change its traditional approach to construction with little concern for environmental impacts to new mode that make environmental concern a centre piece of its efforts (Zuhairi and Kamarul Anuar, 2011). Researchers have however identified the critical problem as lack of capacity of construction sector to actually implement sustainable practices (Ebohon and Rwelamila, 1997, Reffat, 2004, Wahab and Lawal, 2011, and Gyoh, 2012).

SUSTAINABILITY AS A NECESSITY

Sustainability as a concept has recently been introduced to the construction sector in spite of it being the direct responds to the continuing rise in global resource consumption and the attendant deterioration in the physical and biotic environment (Ebohon and Rwelamila, 2001). Never the less, Just as the concept of environmental sustainability is still unfolding as knowledge about the environment improves, so is the understanding of sustainable construction as a concept, which now extends beyond the fabric of built environment. Thus, the concept of sustainable construction now transcends environmental sustainability, embracing economic and social sustainability, which emphasizes possible value, added to the quality of life of individuals and communities. However, Miranda l and Marulanda (2002) opined that, sustainability and sustainable construction are not yet an integral part of decision making and business practice. It is still seen as a luxury addition to normal practice and neither as necessity nor as a motivator during business and development decision. Gyoh (2012) also identifies that, the challenges facing sustainable construction in Nigeria is to be able to get sustainability on the agenda of the industry, educational institutions, financial institutions, national government and other public and private sectors. He concluded that once such are achieved, the challenges of reducing resource use, mobilizing environmental health and safety and developing new procurement approaches can be achieved. As a necessity, the industry by its structure through its conduct and performance has the potentials to enhance global economic sustainability (Ebohon, 1997).

PURPOSE OF THE STUDY

Public awareness in recent times of natural resources and its compelling and conflicting use has fuelled the sustainable development as an important concept in the decision making process. This study deemed it necessary to examine the phenomenon with a view to showcasing the potentials that may be inherent in procuring roads projects in our urban communities.

MATERIALS AND METHODS

Gombe state is located in the north eastern part of Nigeria, is one of the country's 36 states. Its capital is Gombe. The state nicknamed the 'jewel in the savannah' was formed in October in 1996 from part of the old Bauchi state by Abacha military government. Being it located in the north eastern zone, right within the expensive savannah allows the state to share common boundaries with states of Borno, Yobe, Taraba, Adamawa and Bauchi. It has an area of 20,365km2 and a population of around 2,353,000 people as of 2006 population census. The state capital covers an area of 52 km2 with a population of about 236,000 people. Using natural population growth rate of 2.76% for developing countries, the population is expected to grow at 850people per annum; meaning more materials and infrastructure would be needed.

It is evident that Nigeria as a whole is facing tremendous challenges in her quest to providing basic infrastructure, couple with the enormous demand on natural resources where the environmental significance of such pressure come into play when some of these resources are depleatable, bringing construction industry into direct conflict with the physical environment through its wasteful, inefficient and unsafe practice. To these effects data for the study was collected from project files in Gombe state. Six roads in the report have been studied and subjected to statistical analysis. From table 1.The areas of walls demolished were multiplied by their respective average thickness to obtain average volumes of waste generated (table, 2). The length of road expanded was then regressed against volume of sandcrete, mud and the combination of both materials generated from demolition; the cost of compensation, disposal (projected) and total cost of non-constructional (disposal) activities were also

regressed against the length. The scope of the study is however delimited to the materials that can be integrated into the procurement of the construction project (road) as base materials.

DATA PRESENTATION AND ANALYSIS

Materials marked for demolition (fig 1) according to the report totaled 2,168.83 m3 (sandcrete 687.9; mud, 753.3 and combined sandcrete and mud, 727.63) whose total cost of disposal was estimated at ₦6,467,250:00 (six million four hundred and sixty seven naira two hundred and fifty naira) fig. 2. Regression graphs below show the relationships between: sandcrete against length of road, mud against length of road, combined materials (mud and sandcrete) against the length of road and the disposal cost against the length of road as R^2: 0.06, 1, 0.1, and 1 respectively. Where R^2: is the regression coefficient.

Table 1: Area of Walls Demolished and Demolition Waste Generated by Construction Material

S/N	sandcrete block buildings (m^2)	Ave. Vol. Generated (m^3)	% of Total Waste	mud buildings (m^2)	Ave. Vol. Generated (m^3)	% of Total Waste	combined mud/sandcrete (m^2)	Ave. Vol. Generated (m^3)	% of Total Waste
1	320.00	60.00	33.47	261.00	78.30	27.30	375.00	126.56	39.23
2	727.00	136.31	38.53	641.00	192.30	33.97	519.00	175.16	27.50
3	1532.00	287.25	57.68	820.00	246.00	30.87	302.00	101.93	11.37
4	587.00	110.06	59.59	23.00	6.90	2.34	375.00	126.56	38.07
5	356.00	66.75	33.63	479.00	143.70	46.60	164.00	55.35	15.95
6	147.00	27.56	25.00	287.00	86.10	48.80	154.00	51.98	26.19
TOTAL		**687.93**			**753.3**			**727.63**	

Source: Project Files (2012)

Table 2: Volume of Waste Generated, Cost of Compensation and Cost of Disposal

Road	Length (km)	Ave. Vol. Generated from Sandcrete	Ave. Vol. Generated from Mud	Ave. Vol. Generated from Buildings with Combination of	Total Vol of Waste Generated/Road	Cost of Disposal at ₦2500/m^3	Compensations Cost (₦)	Non-Contructional Costs=(cost of Disposal+Compensation cost)
1	2.3	60	78.30	126.56	264.86	662,156.30	14,828,023.00	15,490,179.00
2	1.2	136.31	192.30	175.16	503.77	1,259,438.00	200,000.00	1,459,438.00
3	1	287.25	246.00	101.92	635.17	1,587,938.00	73,411,933.00	7,4999,871.00
4	0.926	110.06	6.90	126.56	243.52	608,812.50	17,846,595.00	18,455,408.00
5	0.408	66.75	143.70	55.35	265.8	664,500.00	36,195,160.00	36,859,660.00
6	1.4	27.56	86.10	51.97	165.63	414,093.80	79,583,346.00	79,997,440.00
Total						**6,467,250.00**		**261,299,317.00**

Source: Project Files (2012)

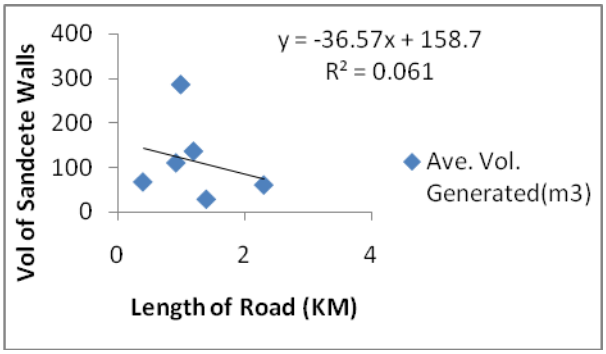

Figure 1: Sandcete Waste versus Length of Road

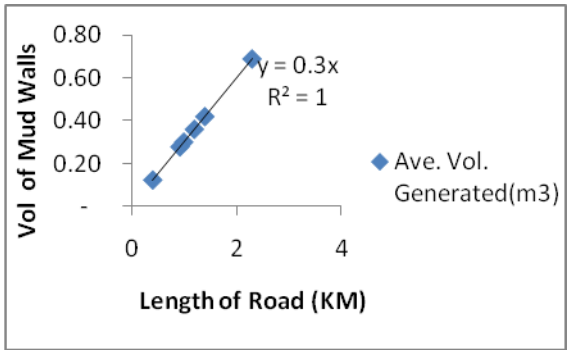

Figure 2: Mud Waste versus Length of Road

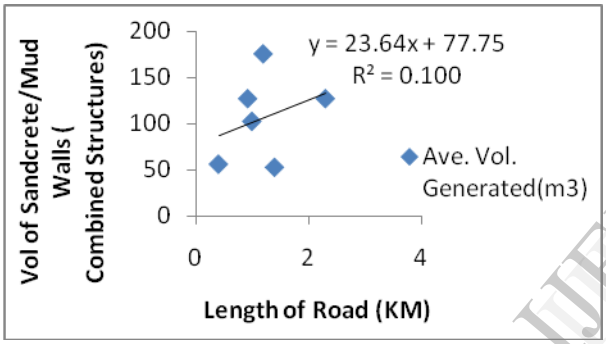

Figure3 Combined Sandcrete/Mud Waste VersusLength of Road

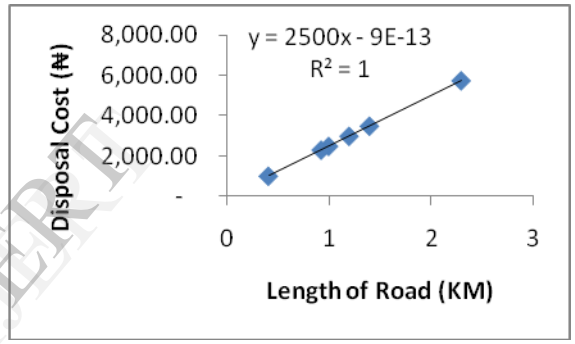

Figure 4: Disposal Cost Versus Length of Road

DISCUSSION

From Table 1, a total volume of **687.93** cubic meters resulted from the demolition of sandcrete wall, **753.3** cubic meters from mud walls and **727.63** cubic meters of a mixture of sancrete and mud waste. A total sum of **₦6,467,250.00** (Table 2), was expended in disposing these wastes. Had these demolition wastes been recycled, the amount expended on disposal , land area destroyed as dump site and the burrow site required to produce this volume of materials, including the cost of importing same; would have been saved.

The regression plots in tables 1,2,3 and 4 revealed the relationship between the length of and the resulting volumes of sandcrete, mud and mixture of the two wastes respectively. All the results, except that of pure sandcrete waste yealded a correlation coefficient of 1; indicating a direct relationship that can be used to forecast expected waste generation in future road expansion projects.

CONCLUSSION

The impact associated with virgin materials extraction and manufacture of such volume if integrated can reduce the use of virgin material resources; and its Reuse can substantially reduce their environmental impacts: habitat destruction, waste generation, energy, air and water pollution would be minimized. Thereby energy in the processing and manufacture of new materials are often eliminated with use of recycled materials. And if such materials are reused on-site or even in place, transportation impacts can as well be eliminated.

The prevalent use of traditional methods of procurement does not ensure efficient utilization of scarce resources and it contradicts the vision of sustainable environment. Therefore, the need to integrate and adopt modern procurement techniques that could match the stated criteria is very crucial to the successful delivery of project development and this includes the built environment.

RECOMMENDATION

Effective management of environment and its resources can better be achieved through efficient use of scarce resources and application of policies meant to sustain development. In this regards, the study recommends the following:

- Integrating Environmental concerns policies into major decision-making process;
- Building into major development projects Environmental remediation cost;
- Employing Economic instrument in the management of natural resources, and applying environmentally friendly technologies; and
- Mandatorily carrying out Environmental impact assessment before any major development project is embarked upon.

However, for these to succeed the following development principle ought to be recognized:

- User pays principle (UPP)
- Extended responsibility principle (ERP)
- Polluter pays principle etc (3p

References:

[1] Achuenu, E., Izam, Y. D., and Bustani, S. A., (2000). Investigating the Activities of Indigenous Contractors in Nigerian Construction Industry; Journal of Construction Technology and Management, 3(1): 91-103

[2] Adindu, C. C. (2012). Developing Templates for Project Costing in Nigeria: Basic Consideration; A paper presented at the 1st Cost Reduction Summit, Organized by Quantity Surveyors Registration Board of Nigeria (QSRBN), held at Shehu Musa Yar'Adua International Conference Center on 29-30 March, Abuja

[3] Ashworth, A. (2010). Cost Studies of Buildings, 5th edition, England: Pearson Education ltd

[3] Ayangade, J., Wahab, J.B.I. and Alake, O. I., (2009). An Investigation of Performance of Due Process Mechanism in the Execution of Construction Projects in Nigeria; Civil Engineering Dimension, 11(1), 1-7

[4] Bennet, F. L., (2003). The Management Contribution; a Project Life Cycle Approach, Oxford: Butterworth-Heinemen

[5] Chaharbaghi, K., and Willis, R., (1999). Study and Practice of Sustainable Development; Engineering Management Journal, Vol. 9, No 1 pp41-48

[6] Dahiru, A. D. and Mohammed, I. Y., (2012). The Role of Researchers in Construction Sector: toward Achieving the Millennium Development. Journal of Science and Multidisciplinary Research, Vol. 4 (80- 93)

[7] Ebohon, O. J. (1996). The Scope and Limits of Sustainable Development in Africa's Built Environment Sector, the International Journal of Sustainable Development and World Ecology, Vol.3, No. 1

[8] Erkelens, P. A. (2002). Extending Service Life of Buildings and Building Components through Re-Use, In: (no eds) Proceedings 9DBMC Conference, Brisbane, Australia

[9] Federal Office of Statistics, (1998). Annual Abstract of Statistics, FOS, Abuja

[10] Freeman, H. M. (2011). A Review of Performance of Botswana Citizen Building Contractors; Unpublished M.Sc Thesis, NMMU, South Africa

[11] Gyoh, L. E. (2002). Agenda 21 for Sustainable Construction in Nigeria: Architecture and the Nigerian Development Agenda, Sustainable Built Environment II; Architect Colloquium pp 131-140

[12] Ibrahim, D. (2008). A Critique of the operational philosophy and Mechanism of public Procurement Act 2007: CONSTRUCTION Industry Perspective; a Paper presented at the 23rd Biennial Conference, Organized by NIQS held on 3-8 Nov., 2008 at Hamdala Hotel Kaduna

[13] Medina, M. (1997). Informal Recycling and Collection of Solid Waste in Developing Countries: Issues and Opportunities, Tokyo: United Nations University/Institute of Advance Studies Working Paper No.24

[14] Milford, R. (2002). Proactive Approach Theme 1: Sustainable Construction. CIB Information 2/02 pp33

[15] Mirunda I, L. and Mirulanda, L. (2002). Sustainable Construction in Developing Countries: a Peruvian Perspective, Agenda 21 for Sustainable Construction in Developing Countries

[16] Ogunsemi, D. R. and Saka, N., (2006). The NEPAD Initiative and the Challenges of an Efficient Cost Management of Infrastructural Development in Nigeria: a Comparative study of Delivery System, a Paper Presented at the 22nd Biennial Conference of NIQS held on 22-25 Nov. Calabar, Nigeria

[16] Plessis, c. (2002). Agenda 21 For Sustainable Construction in Developing Countries; Discussion Document, CSIR, building and Construction Technology, Pretoria

[17] Plessis, C. (2003). Analysis of Sustainability of Human Settlement in South Africa: Challenges and Methods, CSIR, Building and Construction Technology, Pretoria

[18] Reffat, R. (2004). Sustainable Construction in Developing Countries; in Proceeding of First Architectural International Conference, Cairo University, Egypt

[19] Rwelamila, P. M. D. and Ebohon, O. J. (2001).Sustainable Construction in Sub-Saharan Africa: Relevant, Rhetoric and Reality; Agenda 21 for Sustainable Construction in Developing Countries, South African Position Paper

[20] Shelbourn,M. A., Bouchlaghem, D. M., Anumba, C. J., Carillo, P. M., Khalfan, M.M.K., and Glass, j. (2006). Managing Knowledge in the Context of Sustainable Construction; ITCON Vol. 11 (2006) available at http://itcon.org/2006/4

[21] Wahab, A. B. and Lawal, A. F., (2011. An Evaluation of Waste Control Measures in Construction Industry in Nigeria; African Journal of Environmental Science and Technology Vol. 5(3) pp241-246, March, 2011. Available on line at http.//www.academicjournals.org/AJEST

[22] Wembland, A. (2003).a Holistic Approach to Sustainable Construction; Sustainable Development International, pp. 21-23

[24] Zakariyya, A.(May,30. 2013). Why Nigerian Industrial Base is weak? Daily Trust News Paper, Thursday, May, 30. Pg 23

[25] Zuhairi, A. H., and Kamarul Anuar, M. K. (2011).Editorial: "Aspect of Offsite Manufacturing towards Sustainable Construction in Malaysia", Construction, Innovation: Information, Process, Management, Vol. (12) 1