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An Investigation of Materials Management on Sustainable Construction in Nigeria

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Abstract

Construction material management is concerned with the planning, identification, procuring, storage, receiving, logistics, supply chain management, production on site, and field servicing requires special attention to achieve cost reduction and distribution of materials. An essential factor adversely affecting the performance of construction projects is the poor materials management during site activities. The aim of this study is to investigate the practices of materials management on sustainable construction sites. Data were collected with the aid of questionnaires administered to professionals' in construction firms. The data generated were analyzed using descriptive statistics. Findings include that the main factors of materials management are sourcing of materials, receiving and verification of materials on site, issuing of materials for use, procurement for materials and quality inspection and control. For effective measure, there should be a proper planning of material management for sustainable construction right from the inception of project execution and strict compliance with the project bill of quantities, schedule of materials, construction programme, specification, proper stock accounting and security systems is essential so as to ensure timely project execution and standard work delivery within reasonable cost, time and quality.

Keywords:
Material management, Planning, Procurement of materials, Storage of materials, and Sustainable construction

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Background to the Study

A construction process depends upon having the right people with right skills that are able to deliver the project on time and on budget. With the right materials in the right place at the right time is equally important, and having the cash flow and capital to procure the labour and materials is also important (Donyavi and Flanagan, 2009). The practice of material management for construction activities has been promoted with the aim of protecting the environment and improving productivity, profit margin, project delay, cost overrun and quality of work (Dania, Kehinde and Bala, 2007). However, according to Donyavi and Flanagan (2009), the materials on a project can represent anything from 30% to 70% of the cost of the work and yet materials management has not received a lot of attention from researchers.

Consequently, the implications of unsustainable materials management for construction project cover a wide variety of aspects; Examples include clear cutting and strip mining at the sites of sourcing, pollution and waste generation from production and end of life treatment, and degradation of social systems by, for example, improper working conditions amongst suppliers (Lindahl, Robèrt, Ny and Broman, 2014). This is why all ecological and many social sustainability problems are directly or indirectly related to materials and material flows which negatively impacts throughout the materials' life-cycles from extraction through transport, production, use and disposal of the materials (Lindahl*et al*., 2014). This is true also for sustainability problems related to society's current use of energy. It is not the energy use in itself that creates the sustainability impacts, but the accompanying flows of matter. Even with the importance of the materials for construction activities, little research has been directed towards understanding the management of materials from order to production, design and procurement process and on labour site productivity (Donyavi and Flanagan, 2009).

Materials Management in Construction Project

Construction materials management is a key to success of a construction project. It is very imperative to understand the origin of materials management procedures and how these procedures differ from those of other industries (Patel and Vyas, 2011). Materials management is a procedure by which construction industry is supplied with the goods and services that it needs to achieve its objectives of buying, storage and movement of materials (Mentzer*et al.,* 2001). Mostly, material management is concerned with the planning, identification, procuring, storage, receiving, shop fabrication, logistics, supply chain management, production on site, and field servicing requires special attention to achieve cost reduction and distribution of materials (Patel and Vyas, 2011; Donyavi and Flanagan, 2009). The reason of material management is to assure that the right materials are in the right place, in the right quantities when needed (Polat and Arditi, 2005). Construction managers have to ensure procurement of right items at the right time in accordance to the requirements of scheduled activities. An appropriate materials management policy has to be devised which prioritises items to be procured from the perspective of timely and budgeted completion of the project (Dixit, Srivastava and Chaudhuri, 2015).The increased economic growth as well as urbanization has led into extensive construction activities that generate large amounts of construction wastes (Lu and Yuan, 2010). All round the world construction materials generate million tons of waste annually (Pappu, Saxena and Asolekar, 2007).

When projects grow in scale and complexity, materials management becomes more difficult, often requiring the use of appropriate tools and techniques to ensure, amongst other things, that materials are delivered on time, stock levels are well managed, the construction schedule is not compromised, and that wastage is minimized (Hendrickson and Au, 1989). Materials management is also a problematic for large and complex projects, where sophisticated tools and techniques are necessary. The management of materials in complex construction projects needs adequate consideration due to the various elements involved and the importance of the project. Furthermore, the implementation of appropriate Information and Communication Technologies (ICT) could facilitate new management processes for complex projects (Kasim, 2008). For example, the potential of emerging technologies such as wireless technologies and tagging technologies could have a strong impact on materials management processes in the future.

Sustainable Construction

The concept of sustainability and sustainable development gained prominence in the late 1980s when the UN world commission on environment and development through the brundtland commission released their report titled "our common future." In that report, sustainability was defined as "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (cited in Pezzoli, 1997). The need to live both for the present and for future generations constitutes the core of a sustainable environment. However, in the opinion of Kibert (2016) reported that consciousness of sustainable built environment promotes design that accommodates, which enhances occupant's comfort and health, better employee productivity and an improved quality of life for the community. Therefore, sustainable construction aims to minimize harm to the environment but also that new buildings do not negatively affect social terms such as crime, noise pollution and health (Fischer and Amekudzi, 2011).

Sustainability comprises of three major themes and success is measured on this basis, which are social, economic and environmental factors (Sharifi and Murayama, 2013; Adegbile, 2012; Watuka and Aligula, 2002). Brandenburg, Govindan, Sarkis, and Seuring, (2014) added other factors to these three, which are relevant to the concept of sustainability in developing countries, such as managerial and community sustainability. Managerial sustainability ensures that construction products remain in effective and efficient use throughout their lives (Kibert, 2016). In order to achieve this successfully, Omer (2008) opined that the best management practices for construction should be selected with the input of stakeholders such as government and the community; and community sustainability refers to a situation where development projects are planned and constructed in construction with and bearing in mind the needs of the people in their environment. It is important to have an understanding of sustainable principles from the outset of project (Ding, 2008). A good understanding of the site and its environmental conditions should influence the design and can led to immediate environmental benefits such as energy savings through the consideration of simple factors such as orientation (Omer, 2008).

A key element of sustainable construction is a more strategic approach to material waste (Yeheyis, Hewage, Alam, Eskicioglu, and Sadiq, 2013). Building and their infrastructure have a major impact on the use of non-renewable materials and resources and on the local environment which must be constructed in a way that is sustainable in environmental and economic terms; and they must also be sustainable in social terms by adding value to the quality of life for the individual and the community (Sev, 2009). In order to facilitate a way culture change, it is necessary to integrate the various interests of the construction, demolition, haulage and waste management sector. This requires a strategic alliance where the costs and rewards are shared and where continual improvement is addressed local authorities play a crucial role in this alliance, as they are one of the largest clients in the construction industry (Yeheyis*et al*., 2013).

Relating the concept of sustainability to construction, sustainable construction can be to be mainly concerned with the process of creating buildings and infrastructural facilities with the aim of restoring harmony between the natural and the built environment and creating settlements that affirm human dignity and encourage economic equality (Hill and Bowen, 1997). Currently, the construction industry operates in an unsustainable linear system; this system disregards constraints to material and energy consumption (Vanegas, DuBose and Pearce, 1996). Due to the challenges presented by the linear process of thinking must be adopted by the entire stakeholder in the construction industry if sustainability is to be achieved (Bal, Bryde, Fearon and Ochieng, 2013). There is need to shift thinking towards a sustainable process, this system employs two aspects: use of nonrenewable energy and natural resources prudently, and minimizing negative impacts on the earth's ecosystems and the closed cyclic has additional subsystems of natural resource management, resources recovery, waste disposal, and environmental technologies (Bal*et al.,* 2013).

Research Method

The research was undertaken during the period of September 2016 to March 2017. A literature review was undertaken to ascertain the main issues relating to materials management on sustainable construction in Nigeria. The study was carried out by administering a questionnaire to a sample of the population for the study. The survey was restricted or confined to the key participants in building industry in Nigeria. The samples were collected randomly from building construction industry offices and on sites through professionals like architects, builders, quantity surveyors,civil engineers, and other concern. The areas in which this research was conducted covered Kaduna state and it's metropolis. A total of 90 questionnaires distributed, 56 were returned and used for analysis. The questionnaire solicited substantial information on the materials management on sustainable construction sites from the various respondents afore mentioned based on their experience. The opinion sample included; components of materials management, stages of materials logistics planning, factors militating against materials management, and measures for effective materials management. The analysis of data collected was done using Microsoft Excel software to calculate percentage, mean and standard deviation. The data collected were represented on table only.

Results and Discussion

The data obtained is presented and analyzed as follows:

Table 1: Professions of Respondents

Profession	Frequency	Percentage %
Architect	5	8.9
Builder	21	37.5
Quantity surveyor	19	33.9
Civil engineer	7	12.5
Others	4	7.1
Total	56	100

The distributions of respondent's profession are shown in table 1 above. The highest concentration of the respondents are Builders (37.5%), next are Quantity Surveyors (33.9%), then Engineers (12.5%), Architect (8.9%) while 7.1% are for remaining professions.

Table 2: Components of Materials Management

S/n	Components of material management	Mean	Std. Dev.
1.	Material estimation, budgeting, planning & Programming	4.910	.287
2.	Scheduling, purchasing and procurement	4.696	.569
3.	Receiving and inspection	4.214	.755
4.	Inventory control, storage and warehousing	4.678	.471
5.	Material handling and transport	4.482	.660
6.	Waste management	4.875	.333

Table 2 shows components of materials management, material estimation, budgeting, planning &Programming has mean value (4.9) follow by Waste management (4.8), then Scheduling, purchasing and procurement and Inventory control, storage and warehousing (4.6), material handling and transport (4.4) while Receiving and inspection(4.2).

Table 3: Stages of Materials Logistics Planning

S/n	Stages	Mean	Std. Dev.
1.	Identified responsible persons and their roles	4.392	.705
2.	Implement a training and communication plan	4.750	.513
3.	Determine material types and quantities from the detailed design	4.500	.738
4.	Plan for material receipt and storage	4.803	.483
5.	Implement procedures to manage sub -contractors	4.660	.611
6.	Site mobilization and construction	4.571	.683
7.	Project completion and demobilization	4.017	.962

Table 3shows the stages of materials logistic planning, the respondents strongly agree for the stages of materials logistics planning. Since all have the mean value above 4.00.

Table 4: Factors Militating Against Materials Management

S/n Factors	Mean	Std. Dev.
1. Sourcing of materials and requisition	4.428	.759
2. Demand estimation	4.785	.494
3. Transportation	4.625	.648
4. Receiving and verification of materials on site	4.625	.589
5. Storage of materials on site	4.875	.384
6. Issuing of materials for use	4.714	.562
7. Procurement for materials	4.618	.680
8. Quality inspection and control	4.563	.631
9. Maintenance	4.339	.769
10. Time	4.321	.716
11. Materials handling	4.910	.287
12. Stock and waste control	4.267	.797
13. Financial ability	4.142	.818
14. Possession of qualified staff	4.607	.651
15. Possession of qualified subcontractor	4.428	.709
16. Possession of qualified of required equipment	4.553	.600
17. Competence of estimators	4.857	.401
18. Availability of equipment	3.964	1.072
19. Duration of the project	4.660	.611
20. Type of Project	4.000	1.026
21. Types of materials	4.589	.626
22. Level of awareness	4.428	.683

Table 4 represents the factors related to materials management on construction site. The results show that majority of the construction professionals believes that the factors which have bigger effect on material in construction site are "materials handle with mean value (4.9), storage of materials and competence of estimators (4.8), and issuing of materials for use (4.7). On the other hand, the factors, which have lower effect on materials in construction site, are availability of equipment (3.9), type of project (4.0) and financial ability (4.1). From the above it can be deduce that, mishandling of materials, storage of materials and competence of estimators are the major factors that affecting effective materials management in Nigeria construction sites.

Table 5: Measures for Effective Materials Management

S/n	Measures for effectiv e material management	Mean	Std. Dev.
1.	Timely Placing of orders for materials	4.214	.706
2.	Ensure quality assurance/control processes are in place	4.357	.818
3.	Logistics for tracking & transportation of materials to site	4.303	.784
4.	Receiving and inspecting materials on site	4.553	.630
5.	Storage and issuing of materials to construction location	4.660	.548
6.	Complete quality records of materials	4.714	.455
7.	Established material management system to be used	4.160	.707
8.	Documentation	4.821	.386
9.	Record receipt of goods upon delivery	4.767	.426
10.	Monitoring of materials distributed	4.678	.508
11.	Assigning of material codes	4.571	.598
12.	Construction activities and schedule of Materials	4.321	.663
13.	Proper materials handling	4.750	.436
14.	Make the store safe from theft and Vandalism	4.839	.370
15.	Materials return to be submitted weekly	4.410	.707
16.	Determine the daily allocation of materials on site	4.875	.333
17.	Education/training/enlightenment of staff in charge of materials management	4.517	.504
18.	Special security agents	4.553	.501
19.	Usage of qualified construction professionals	4.517	.632

From the table 5 above, the respondents strongly agree that there should be measures for effective materials management practices in Nigerian construction sites, since all have the mean value above 4.00.

Conclusion and Recommendation

It is imperative to manage all materials from the design stage to the construction stage of the project as poor materials management on sustainable construction affects the overall performance of construction projects in terms of time, budget (cost), quality and productivity.

The study also revealed some of the factors that affect materials management which are: procurement of materials, Storage of materials on site, transportation of materials, materials handling and Quality inspection

For effective measure, there should be a proper planning of material management for sustainable construction right from the inception of project execution and strict compliance with the project bill of quantities, schedule of materials, construction programme,

specification, proper stock accounting and security systems is essential so as to ensure timely project execution and standard work delivery within reasonable cost, time and quality.

Manufacturers of construction materials should use life cycle consideration as the basis of product development and should cooperate with designers in creation of new designs that facilitate recycling of materials. They should also partner with research firms by providing fund for research and development and implementation.

In addition, federal government should as a matter of urgency create or establish construction industry development commission which will be made up of the professionals in the industry to fashion the way forward for the future of the industry.

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