EVALUATION OF MATERIALS MANAGEMENT STRATEGIES IN THE NIGERIAN CONSTRUCTION INDUSTRY-
(A CASE STUDY OF SELECTED BUILDING SITES IN LAGOS STATE.)

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Abstract:This study on the Evaluation of Materials Management Strategies in the Nigerian Construction Industry. Questionnaires were used to collect data from the construction participants. Main factors of materials management were summarized into five basic independent variables (X) namely; materials planning (x_1), material procurement (x_2), material handling (x_3), material storage (x_4) and material usage (x_5). Six rating basic questions were asked and the numerical summation of the ratings formed the observed value for the independent variables in the case of that respondent. The same was applied in the assessment of state of material management as applicable to construction industry in Nigeria (Y) which formed the dependent variable.

Multiple regression analysis was carried out on the data using E-view package and SPSS package and the following relationship was established between the dependent and independent variables.

$Y = 1.084452539 + 0.5702062292x_1 - 0.114384169x_2 + 0.3604260282x_3 + 0.1852074864x_4 - 0.266328778x_5$. *Testing the hypothesis using absolute value of T-statistics and probability values show that among the factors studied, only two of them planning(x_1) and handling (x_3) were statistically established as being critical to materials management in construction projects delivery in Nigeria.*

Material planning and issuing system at sites should be automated in order to minimize human errors. Storage of materials should only be maintained at minimal level in construction sites.

Key words: Evaluation, Materials, Management, Strategies, Construction, Industry.

1.0   INTRODUCTION

While the world is still struggling to emerge from the global economic collapse, Nigeria's construction industry is growing fast and is likely to grow astronomically over the next decade, according to forecast made in a June 2010 report by global construction perspectives and oxford economists.

Indeed, the report found that Nigeria's population of approximately 154 million is urbanizing at one of the fastest rates in the world, but construction industry contributes only 3.2 percent of gross domestic product. From 2009 to 2020, only Nigeria and India will enjoy growth rates than China in their construction output (the business, trade and investment guide, 2010/2011).

This out look is excellent news for the country as a whole, every ambition that Nigerian government has-such as creating much needed housing, improving public service developing its tourism sector, improving transport links, creating new jobs and eradicating poverty-can be linked to the construction sector. Despite this noted contributions, there are numerous failed and abandoned construction projects scattering every corner of the country. The socio-cultural, economic and political environment in which the industry operates has directly or indirectly affected its growth.

According to Sloan (1990) of a total utility of 100% associated with a construction project, the client places the following importance upon the three critical functional aspects;

(i)	Quality	-	45%
(ii)	Cost	-	35%
(iii)	Time	-	20%

On the other hand Onyeador (1997) posits that the success or failure of construction project management could be measured in terms of cost of completion versus budget, time taken to complete the project versus planned duration and the extent to which the completed project conforms with the design specifications (Quality).

However, Onyeador (1992) suggested that construction project undertakings are difficult to manage. This according to him may be due to the complex nature of activities involved.

However, what may be the single most crucial factor to client is quality (PMBOK 2001). In this era of economic depression and rapid rise in materials cost, concerns for optimum utilization of available resources tend to dominate all decisions relating to construction project undertakings. It is only with highly skilled project management team that uncertainties in the planning and execution process can be kept to a minimum in order to attain significantly the quality objectives of the construction project within optimal time and cost. Mezue (1992) placed materials cost input at an average of 65% of the total construction project delivery sum.

Consequently, construction materials, have become one of the important elements of cost management in the construction industry today. There is therefore particular need for study in the area of materials management to ensure cost effectiveness in construction project management. Thomas and Kramer (1987).

Equally, the planning and management of construction materials usage are often based on the contractors experience and intuition than on rational analysis of the works to be performed based on application of known specific tools and techniques. The failure of any construction project through poor materials management carries much repercussions. This work therefore attempts to evaluate the materials management strategies in the Nigerian construction industry as a way of improving the state of project management practices.

2.0   LITERATURE REVIEW

According to Onukwube (2000) the primary goal of the construction team is to finish projects as specified, on schedule and within budget. The whole system of construction management exists to ensure that we meet these goals.

Mezue (1992) was of the opinion that cost in the cost of construction project. The cost of materials has been put at an average of 65% of the contract sum. Bearing this in mind the operators of the construction industry should optimize the cost of construction. It is expedient that a good materials flow must be maintained on site to avoid excessive wastage and save idle time.

Mezue (1992) still suggested that one of the ways to optimize the cost of construction is through material storage.

Onukwube (2000) stated that the physical material resources on a given project can run from forty to sixty percent of total installed project cost, which makes it a budgetary force to be reckoned with. The overall philosophy for controlling the physical

materials resources budget is to start with an estimate of the physical materials resources budget cost and converts it into a budget that becomes our baseline for buying them.

MATERIALS MANAGEMENT DEFINED

Oyeoku (2001) quoted Frearou (1971) that materials management is an integrated organizational arrangement establishing a single manager with authority and responsibility for policies and actions related to determining the amount of materials requirements, acquiring needed materials, receiving, storing and issuing materials, making inventory records, scheduling materials into use and disposing of materials which are excess to the organization.

Dobler and Burt (1996) stated that materials management is a confederacy of traditional materials activities bound by common ideas, the idea of an integrated management approach to planning, acquisition, conversion flow and distribution of material. They asserted that such concept advocates the assignment of all major activities, which contribute to materials cost to a single materials management department. Included in their major materials activities are the primary responsibilities which are generally found in the purchasing department plus all other major procurement responsibilities like inventory management transportation, handling, warehouse, surplus and salvage and frequency construction planning and control.

The International Federation of Purchasing and Material Management (IFPMM) defined materials management as a total concept involving an organizational structure unifying into a single responsibility, the systematic flow and control of materials form identification of the need through consumer delivery. Included within this concept are the materials function of planning, scheduling, procurement, storing, transportation and distributing. These are logically represented by the discipline of production (construction) and inventory control, purchasing and physical distribution.

Oyeoku (2001) quoted Swindler (1971) that materials management is regarded as the system approach applied to the materials area. As an organizational concept, it involves grouping the business functions relating to the inflow and interplant movement of materials under a head who is in a position to coordinate and correlate individual departmental decisions in a manner which results in the most efficient allocation of an organizations resources. Thus, a materials manager must be an innovator, developer, organizer, activator, coordinator and controller of dynamic interdependent systems of human and technical interaction. He can draw upon the skill, technical knowledge and professional competence of a great

many individual specialist, but in the final analysis it is his task to bring together these divergent capabilities and produce a smoothly functioning human groups. It therefore requires that the materials manager be a broad gauge managers so that the benefits of materials management can be really and fully realized.

Materials management like value engineering analysis the function and considers alternative ways of achieving that function, selecting that which costs less. It differs from cost reduction, which only considers ways of cheapening the cost of the products as it is.

Oyeoku (2001) highlighted those four specific reasons for need for an integrated material management need be thoroughly evaluated. The areas are improvement in procurement, materials planning, ratio between value of inventory and usage of materials and materials emergencies and disruptions.

MATERIAL PLANNING IN CONSTRUCTION PROJECTS

Construction management is the judicious allocation of resources to accomplish project completion at maximum efficiency of time, cost according to Kamang (1992). Dobler and Burt (1996) considered the objective of planning and control function is to coordinate the use of a firm's resources and to synchronize the work of all individuals concerned with the construction in order to meet required completion dates, at the lowest total cost consistent with desired quality.

Materials requirement planning is technique used to determine the quantity and timing requirements of dependent demand "materials used in the construction operation". Dobler and Burt (1996).

The materials requirement planning and the Capacity Requirement Planning (CRP) segments of the construction planning system are the responsibility of the responsibility of the construction managers.

Construction planning personnel are responsible for structuring and formatting the bills of materials eventually contained in computer for setting up the part and component inventory status record.

Farmer, Bauly, Jessop and Jones (1994) quoted Anthony (1965) described planning as the organization of resources used to attain these objectives and on the policies that are to govern the acquisition, use and disposition of these resources.

In effect planning involves a systematic process of making strategic decisions.

The different sets of characteristics identify planning from the procurement. However, it is important that the organization, systems and procedures, which are developed, will reflect for examples:

- The degree of internationalization
- The size of the company
- The management style of the executives
- The degree of centralization
- The volatility of the supply market
- The type of products and pace of technological change which affects the industry
- Managerial known how
- The communication system

Historically, all firms conducted their construction planning and control activities manually, with the specialized use of a variety of Gantt charts and specialized visual scheduling/control boards. Today, most firms utilize some types of computer based system to perform a essentially the same types of activities. Regardless of the specific operating system used, an effective construction planning and control operation must accomplish five general activities.

Preliminary planning

Aggregate scheduling

Detailed construction scheduling

Release and dispatching or orders

Progress surveillance and corrections

Kamang (1992) stated that materials, manpower and equipment are important project resources that requires management attention. The supply and availability of these resources are seldom completely certain because of shortages, competing demands, inefficiency of supplies and other reasons.

SELECTION OF CONSTRUCTION MATERIALS

When evaluating a construction material, the selection of the material must be based on several factors. Huntington (1981) classified the factors as economic criteria, mechanical properties and aesthetic qualities. Selection depends on the intended function or application, which is based on the materials performance in these three classifications.

Product evaluation is seldom the same for any two applications. There may be similarities between projects but each projects priorities and conditions must be evaluated. Huntington (1981) argued that although mechanical properties and aesthetic could make material selection seem obvious, economics frequently dictates. Usually, the mechanical properties or behaviours of a materials are the basis for the economic rationale. Seldom is a choice of a material based on a single factor but selection is based on a combination of factors. Rarely is aesthetics the sole determinant except perhaps is monumental architecture but even then property of durability is a consideration. Economically, material may be evaluated on cost, maintenance, fire resistivity, availability, replace ability and perhaps durability.

MATERIAL PROCUREMENT

Professional procurement/supply management personnel contribute at least as much to the success of their organizations as other professionals in areas such as marketing, finance and accounting, engineering and operations. Specialized knowledge in scientific principles of commercial, technical and relationship management is essential. Dobler and Burt (1996).

Farmer, Baily, Jessop and Jones (1994) said that a well-known definition of procurement objectives is: to purchase the right quality of materials, at the right time, in the right quantity of materials, at the right time, in the right quantity, from the right source, at the right price. The following board statement in objectives is suggested.

1a.   To supply the organization with a steady flow of materials and services to meet its needs.

b.   To ensure continuity of supply by maintaining effective relationships with existing sources and by developing other sources of supply either as alternatives or to meet emerging or planned needs.

2.   To buy efficiently and wisely, obtaining by an ethical means the best value for every money spent.

3.   To manage inventory so as to give the best possible service to users at lowest cost.

4.   To maintain sound co-operative relationships with other departments, providing information and advice as necessary to ensure the effective operation of the organization as a whole.

5.   To develop staff, policies, procedures, and organization to ensure the achievement of the foregoing objectives.

The procurement process, or concept, encompasses a wider range of supply activities than those excluded in the purchasing function. And it typically includes a broadened view of the traditional buying role, with more buyer participation in related materials activities. Specific activities usually included in the process are:

1.   Participation in the development of material and service requirements and their specifications.

2.   Conduct of materials studies and management of value analysis activities.

3.   Conduct of more extensive material market studies

4.   Conduct of all purchasing function activities

5.   Management of inbound transportation

6.   Management of supplier quality

7.   Management of investment recovery activities (savage of surplus and scrap)

Some of the more specific objectives such as:

1.   To select the best suppliers in the market

2.   To help generate the effective development of new products

3.   To protect the company's cost structure

4.   To maintain the correct quality/value balance

5.   To monitor supply market trends

6.   To negotiate effectively in order to work with suppliers who will seek mutual benefit through economically superior performance.

The purchasing work need to work effectively with research and development through providing data on supply economics at a earlier stage.

Farmer (1994). The achievement of this depends on the product development and product life, source selection, planning, training needs of procurement staff. For purchased materials were completely dominated. The responsibility for incoming quality was placed with the purchasing department and delegated to each supplier organization. This required a reasonable amount of suppler education.

3.0   METHODOLOGY
MODEL FORMULATION

In this study, the linear regression model was adopted for analysis. Its formulation is as follows:

$$Y = a_0 + b_1X_1 + b_2X_2 + b_nX_n = e_0$$

Where

$A_0 + b_1$…………Ba represents the coefficients to be estimated.

Y: Is the dependent variable, which represents an assessment of the state of materials management of construction projects.

X_1:   Is a composite variable representing the planning of construction materials for construction projects.

X_2:   Is the construction material procurement method of construction projects and their impact on construction material management.

X_3:   Is for the construction material handling technique of construction projects, and their effect on construction material management.

X4:   Is for the construction material storage method applied to construction projects and their effect on construction material management.

X5:   Is for the material usage process of construction projects and their impact on construction material management.

The regression parameters were computed using the following formulae:

$b1 = N \sum X_1Y_1 (\sum X_1)(\sum Y_1)$

$$N\sum X_1^2 \quad (\sum x_1)^2$$

And

$$an = \frac{\sum Y_1 - \beta_1 \sum X_1}{N}$$

The correlation coefficient (R) is determined using

$$R = \frac{N \sum X_1 Y_1 \; (\sum X_1) \; (\sum Y_1)}{\sqrt{(N\sum X_1^2 \quad (\sum x_1)^2] \; [[N\sum X_1^2 \quad (\sum x_1)^2]}}$$

The coefficient of determination (R^2) is determined using the formula:

$$R2 = \frac{SSR}{SST}$$

Where:

$$SSR = b_1 \left[\frac{\sum X_1 Y_1 - \sum X_1 \sum Y_1}{N} \right]$$

And

$$SST = \sum Y_1 - \frac{((\sum Y_1)^2}{N}$$

SSR is the sum of squares due to regression while SST is the total sum of squares, which is equal to:

SSR + SSE

Where SSE is the sum of squares due to error.

The mean square due to regression (MSR) is obtained as

$$MSR = \frac{SSR}{K}$$

Where "k" is the number of independent variable. The mean squares due to error is obtained as:

$$MSE = \frac{SSE}{n-k-1}$$

The R^2 (Coefficient of determination) measures the proportion of the total variation in the assessment of the application of material management strategies in the construction industry, that is our dependent variable (Y), that is explained by the variations in the selected aggregates of material management strategies, that is independent variables, put together.

The value of R^2 is expected to range from

$$0 \le R^2 \le +1$$

The correlation of coefficient (R):

The multiple correlation coefficient R measure the strength of contribution of the selected aggregate of materials management on the level of application of materials management strategies to construction project.

This is calculated using the formula:

$$R = + \sqrt{R^2}$$

Where

-   $1 \le R \le +1$

THE F – TEST

The F-ratio is used to test the significance of the contribution of all the selected variables of construction materials management strategies on construction projects in Nigeria.

This is carried out suing the Analysis of variance table (ANOVA).

ANOVA TABLE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREE OF FREEDOM	MEAN SQUARES	F-RATIO
Regression	$SSR = R^2 \sum Y^2$	K	$MSR = \frac{SSR}{K}$	$F = \frac{MSR}{MSE}$
Error	$SSE = \sum Y^2 - R^2 \sum Y^2$	n-k-1	$MSE = \frac{SSE}{n-k-1}$	
Total	$SST = \sum Y^2$	n - 1		

DECISION RULE:

Having computed the F-ratio, the null hypothesis (H_0) is accepted at $\alpha = 0.05$ significant level if: F* $F_{1-\alpha}$: K, n-k-1 degrees of freedom, otherwise H0 is rejected in favour of the alternative hypothesis ($H_\wedge$), for a one-tail test. Here $F_{1-\alpha}$: k, n-k-1.

4.0   RESULTS AND DISCUSSION-The table below represents a summary of the weighting of the opinion of our respondents (construction professionals) based on the Likert ranking to the six parameters selected in this study for the analysis of materials management in the construction industry. The scores is based on the weighting of their ranking of each of the variables and the summation of the weighted scores for each of the respondent. The variables are as follows:

Y   =   Assessment of state of materials management in a selected construction site
X1   =   Assessment of materials requirement planning process
X2   =   Assessment of materials procurement process
X3   =   Assessment of materials handling process
X4   =   Assessment of materials storage process
X5   =   Assessment of materials usage process

SUMMARY OF WEIGHTED SCORES BASED ON FIELD RESPONSES

S/0	Y	X1	X2	X3	X4	X5
1	11	6	24	26	29	19
2	17	25	22	18	22	20
3	10	15	9	17	19	21
4	27	27	26	29	29	24
5	14	18	15	20	21	23
6	23	24	20	22	27	17
7	19	21	12	22	24	19
8	24	17	19	21	27	16
9	9	7	4	11	10	15
10	28	28	27	29	29	24
11	16	20	21	22	26	28
12	19	21	23	24	27	17
13	17	20	21	23	26	21
14	27	27	28	29	29	24
15	15	14	18	22	23	18
16	18	20	22	27	24	28
17	20	15	9	20	21	23
18	17	19	26	23	24	25
19	14	17	23	25	27	20
20	26	28	24	29	29	26
21	12	17	22	24	23	24
22	15	21	22	9	22	18
23	19	21	21	28	27	26
24	13	17	23	24	28	24
25	13	21	18	20	8	20
26	23	20	24	25	22	17
27	15	17	18	23	24	19
28	29	23	22	24	25	23
29	13	21	23	15	27	22
30	18	17	20	24	23	26
31	23	22	24	27	28	22
32	12	21	22	28	23	20
33	19	21	20	26	27	24
34	12	16	17	22	27	23
35	28	22	24	29	28	23
36	19	10	20	18	21	19
37	18	17	19	23	24	13
38	21	13	22	27	23	24
39	12	15	17	22	24	20
40	27	24	8	28	29	25
41	19	21	21	24	23	22
42	16	18	20	27	28	21
43	9	4	10	12	13	14
44	13	20	22	26	25	21

Source: Computed from field responses

DESCRIPTIVE STATISTICS

VARIABLES	MEAN	STANDARD DEVIATION	SAMPLE SIZE
Y	17.93182	5.596501	44
X1	18.81818	5.318999	44
X2	19.81818	5.279503	44
X3	23.04545	4.841461	44
X4	24.20455	4.668447	44
X5	21.31818	3.568419	44

Source: Computer Analysis of Table 4:1 Data using E-view Package

The above result shows that the variable with the least mean is Y, "the assessment of state of materials management in construction projects". While the highest is X_4 "the assessment of materials storage procedure of construction projects", which is one of the independent variable.

Also, the variable with the least standard deviation is X_5 "the assessment of materials usage process", while the variable with the highest standard deviation is Y "the assessment of state of materials management in construction projects".

ANALYSIS OF CORRELATION AMONG EXPLANATORY VARIABLES
Pairwise Correlation Matrix was employed to analyse the level of relationship among the explanatory variables.

Variables	X1	X2	X3	X4	X5
X_1	1	0.4982	0.4934	0.4932	0.4381
X_2	0.4982	1	0.5289	0.5705	0.3105
X_3	0.4934	0.5289	1	0.6601	0.5147
X_4	0.4932	0.5705	0.6601	1	0.4008
X_5	0.43808	0.3105	0.5147	0.4008	1

Source: Computer Analysis of Table 4:3:2 Data using E-view Package

From the table above, the least correlation was observed between X_2 and X_5 with a coefficient of 0.3105, while the highest was observed between X_3 and X_4 with coefficient of 0.6601.

This result shows that the problem of Multi-collinearity is minimal in the analysis, as the level of relationship among the explanatory variables is low, and thus the variables are a good fit of measurement.

REGRESSION ANALYSIS

Dependent Variable: Y				
Method: Least Squares				
Date: 12/10/12 Time: 09:35				
Sample: 1 44				
Included Observations: 44				
Variable	**Coefficient**	**Std. Error**	**T. Statistic**	**Prob.**
C	1.084453	4.229998	0.256372	0.7990
X1	0.570206	0.147860	3.856399	0.0004
X2	-0.114384	0.153129	-0.746979	0.4597
X3	0.360426	0.189325	1.903743	0.0645
X4	0.185207	0.191713	0.966064	0.3401
X5	-0.206633	0.209892	-0.984471	0.3311
R-Square	0.531505	Mean dependent var.		17.93182
Adjusted R-squared	0.469861	S.D.Dependent var		5.596501
S. E. of Regression	4.074848	Akaike info Criterion		5.773668
Sum Squared Resid.	630.9668	Schwarz Criterion		6.016967
Long Likelihood	-121.0207	F-Statistic		8.622161
Durbin-Watson Stat.	2.332116	Prob (F-Statistics)		0.000016

Substituted Coefficients: $Y = 1.084452539 + 0.5702062292 \cdot X1 - 0.1143841692 \cdot X2 + 0.3604260282 \cdot X3 + 0.1852074864 \cdot X4 - 0.2066328778 \cdot X5$

DISCUSSION OF FINDINGS

The coefficient of determination value of 53.15% indicated that about 53.15% variation in Y

(assessment of state of materials management in a selected construction site) is explained by variations in the explanatory variables. And that only 46.85% variation in Y (Assessment of state of materials management in a selected construction site) is left unaccounted for by the model which is attributed to the error term.

Similarly, the Adjusted Coefficient of Determination value of 46.99% meaning that 46.99% variation in the dependent variable is explained by variation in the explanatory variables. The F-Statistic of 8.622161 with probability value of 0.000016 shows that the independent variables are jointly significant in explaining the variation in the dependent variable. The Durbin-Watson statistic of 2.332116 shows the absence of positive serial correlation of the error terms. The Akaike Information Criterion value of 5.773668 and the Schwarz Information Criterion value of 6.016967, which are at their minimum values, show the model selection criterion of the estimated model.

X_1 (Assessment of Materials Requirement Planning Process) exhibited a significant positive relationship with Y (Assessment of State of Materials Management in a selected Construction Site), and a 1% increase of (X_1) will cause (Y) to rise to the tune of 57.02%.

Similarly, X_3 (Assessment of Materials Handling Process) exhibited a significant positive relationship with Y (Assessment of State of Materials Management in a selected Construction site). And a 1% increase of (X_3) will cause (Y) to rise by 36.04%.

However, $X2$ (Assessment of Materials Procurement Process) and $X5$ (Assessment of Materials Usage Process) exhibited an insignificant negative relationship with Y (Assessment of State of Materials Management in a selected Construction Site), and a 1% increase of (X_2) will cause (Y) to fall by 11.44%, while a 1% rise in (X_5) will cause (Y) to fall to the tune of 20.66%.

$X4$ (Assessment of Materials Storage Process) exhibited an insignificant positive relationship with Y (Assessment of State of Material Management in a selected Construction Site) and a 1% rise of it will cause (Y) to rise to the tune of 36.04%.

CONCLUSION

Based on the findings, the following conclusions were drawn

i.   Adequate materials requirement planning and handling are critical to efficient materials management in construction sites and successful construction project delivery in Nigeria.

ii.   Storage process system although important in construction site, does not play a critical role in successful materials management in Nigeria construction industry.

iii.   The cost associated with over storage and handling in construction sites can be minimized through efficient materials requirement planning.

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