

EVALUATION OF CONSTRUCTION MATERIALS COST REDUCTION MEASURES IN BUILDING INDUSTRY IN IMO STATE, NIGERIA

Ikechukwu, Uche Felix¹

¹Department of Building, Imo State University, Owerri, Nigeria.

Author's Contribution

The sole author designed, analyzed, interpreted and prepared the manuscript

ABSTRACT

Cost reduction measure on construction materials is very critical in the effectiveness of any construction material management. Negligence on this frustrates the integrated effort deployed in cost control of any building project. As the study aims at assessing the impact of some building material cost reduction strategies with regard to their sourcing, applications and designs for affordable houses, field survey research design method and activity sampling involving some of the major building materials were adopted. Data were analyzed using some non parametric tools like likert scale and chi-square to rank the level of effectiveness of the various materials cost reduction measures in the industry. It was also used to determine the impact levels of the material management on the overall cost of the materials used in the construction of public building respectively in Owerri. Spearman rank correlation coefficient was also used to examine the strength of relationship between the two major sources of the information. Findings in the study reveal that local sourcing of materials is the most significant method of material management in cost reduction. Other methods in their order of significance for cost reduction are quality assurance, economic design and specification, and on-site Production of materials. The various percentage cost effects however are found to be significantly dependent on the methods of material management adopted for the materials' cost reduction in the study. It is therefore recommended that an effective legislative back-up be instituted with a very strong awareness on the need for robust development of local construction material resources, as well as advocate for more practical contact hours on the stressed area in the appropriate curriculum of the building profession in all the tertiary institution in

Nigeria. Finally, appropriate checklist/indices for check-mating quality assurance on professional personnel and materials schedule; as well as enforcement of ‘buildability’ and maintainability analyses of building projects should be encouraged in the study area.

Key Words: Construction Materials, Cost Reduction Measures, Effects of Reduction Measures, Locally Sourced Construction Materials, and Affordability of Houses.

1.0 INTRODUCTION

Man continuously improves his habitat to a more comfortable one in order to enhance his social well being, mental and general development. Shelter rated as second to food in human being’s hierarchy of needs is often used as the most important indices of human development [1]. Provision of housing for human habitation and buildings for economic activities constitute a basic requirement in wholesome development and maximum productivity of a people.

Affordability is one of the major objectives of the effective housing in Nigeria; hence a major factor for consideration, since total cost of production eventually determines the appropriate price at which a certain building is placed. According to [2] this total cost of production is largely built up by the cost of the constituent building material resources. In 1979, the federal government of Nigeria in this direction negotiated the World Bank Assisted Nigeria Urban Development Programme (NSUDP), with the major objective of laying the foundation for a National Low Cost Housing Programme [3]. As the federal government targeted about 40,000 units of houses for low and medium income earners, some state government in that same light also embarked on the construction of low and medium cost houses. In the 1999 National Housing Policy guideline, encouragement into the research for new materials and the use of locally produced and sourced building materials is major.

The price of these materials is generally witnessed to be on the rise as a result of the effect of the market forces. [4] concluded that the inflationary trend of the cost of these materials is said to be one of the major contributory factors to the high and rising cost of building projects in Nigeria. The prices of these materials in the market as a matter of fact continue to increase day by day in Nigeria. This rising trend in the prizes of these materials has often been attributed to the high import content of some of the building materials, as well as the high import duty imposed on most of them.

[5] showed that Nigeria produced less than 30% of her demand for cement, which is one of the major basic building materials in the construction industry. This deplorable scenario, high and increasing cost of building materials directly or indirectly affect negatively the general cost of building production, leading to high cost of production that results to products of high prize; hence a non affordable house unit.

The study therefore is aimed at assessing the impact of some building material cost reduction strategies relative to their sourcing, applications and designs for affordable houses. Consequent upon this, various methods prevalent for management of building materials in the study area are examined. The benefits of each of the various material cost reduction strategies are assessed, and their impacts on building material management ranked. The net effect of optimal combination of the appropriate cost reduction strategies of the materials resources are determined for enhanced building material management in the study area.

2.0 RESEARCH METHODS AND PROCEDURES

Field survey research design method was adopted in the original study carried out in Owerri, Imo State, Nigeria. It comprises information from the field through

questionnaires, building material design and their methods of application, sourcing and procurement of the materials, waste reduction and reusability of some basic building materials. Observations and measurements of some work activities involving some of the major building materials were carried out to ascertain differences in cost of materials arising from their design, methods of application, scale of procurement, source location, and frequency of use on-site.

Data collected with structured questionnaires from the sample of some building professionals in the study area were analyzed using non parametric tools of **likert** scale and Chi-square to rank the various percentage reduction in cost of the material in each of the respective method (strategy) used for material management in the industry; and determine the impact levels of effective material management on the overall total cost of material used in the construction of public building respectively in Owerri. Besides, correlation was considered for examining the strength of relationship between the ranks of the different sources of information.

Nevertheless, data from direct observations and measurements of the related work activities were analyzed comparatively with surveyed information from apriori knowledge in the study area.

The respective methods of analyses are therefore expressed in the following forms. They are:

$$\text{Linkert Scale} = \text{MS} = \sum_{i=1}^5 \frac{(FxS)}{N} = \frac{5f_1+4f_2+3f_3+2f_2+f_1}{f_5+f_4+f_3+f_2+f_1} = \text{Equ. 1}$$

Where, MS is Mean Score,

F = Frequency of Sample,

S = Weighted Score,

N = Total Sample Number.

Thus the Building Materials Management Ranking Index (RI) is expressed as;

$$RI = \sum_{i=1}^5 \frac{(FxS)}{5N} = \quad = \quad = \quad Equ. 2$$

Correlation for comparing the strength of relationship between the ranks of two different sources of information is hereby expressed in the following form;

$$r = 1 - \frac{6\Sigma d^2}{n(n^2-1)} = \quad = \quad = \quad Equ. 3$$

where; d is the difference between the two populations,
n = number of the samples.

Test for significant relationship therefore is tested with student 't' test since the sample number is less than 30. It is in this form:

$$t = r \sqrt{\frac{(n-2)}{1-r^2}} = \quad = \quad = \quad Equ. 4$$

where; r is the correlation,
n = number of the samples.

Thus, if r is less than Student $t_{1-\alpha;n-2}$, the null hypothesis (H_0) at 0.10 significant level is accepted; otherwise it is rejected and the alternative hypothesis (H_a) which assumes correlation-ship between the two populations is accepted.

$$\text{Chi-square } (X^2) = \sum_{i=1}^k \sum_{j=1}^k \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \text{ (for test of independence) } = Equ. 5$$

Where; X^2 is the Chi-square,
O = Observed Frequency in the Sample,

E = Expected Frequency if H₀ is true,

K = the number of category of variables.

For the using contingency table in test of independency, the expected frequency therefore is:

$$E_{ij} = \frac{R_i \times C_j}{N} = \dots = \text{Equ. 6}$$

Thus, if $X^2_{1-\alpha(r-1)(c-1)}$ calculated is less than the critical value at 90% confidence interval, the H₀ is accepted, otherwise the H_a is accepted to confirm that the % cost effect is not independent to the methods of the material management applied; hence it is dependent.

3.0 DATA PRESENTATION, ANALYSES AND DISCUSSION OF FINDINGS

Table 1.0 Different Levels of Cost Reduction Benefit of the Various Methods of Material Management on Material Resources

S/ N	Method of Material Management	Cost Gained > 30% (5)	21-30% (4)	11-20% (3)	5-10% (2)	Cost Gained <5% (1)	Total	MS	Rank	Index	Rmk
		1	Bulk Purchase & Inventory	4	5	11	15	3	38	2.79	8 th
2	Economic Design and Specification	9	8	9	7	5	38	3.24	3 rd	0.647	
3	Local Sourcing of Materials	11	10	8	3	6	38	3.45	1 st	0.689	
4	On-site Production	8	8	9	9	4	38	3.18	4 th	0.637	
5	On-time Procurement and Security	4	9	12	6	7	38	2.92	7 th	0.584	
6	Quality Control	7	8	9	12	2	38	3.16	5 th	0.632	
7	Reusability of Materials	2	13	12	6	5	38	3.03	6 th	0.606	
8	Quality Assurance	4	16	9	6	3	38	3.32	2 nd	0.663	

Total	49	77	79	64	35	<u>304</u>				
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Source: Field Survey, Ikechukwu (2020)

Information on the levels of the percentage cost reduction experience of the constituent construction and property development professionals of the built environment in the application of the methods of material resource management are as contained in Table 1.

Among the respective methods commonly and strategically applied in the study area, local sourcing of materials ranks first with mean score of 3.45 and cost reduction index of 0.689; while quality assurance and supervision, and economic design and specification rank second and third respectively, with their corresponding mean scores of 3.32 and 3.24, as well as cost reduction indices of 0.663 and 0.647 respectively. The method that ranks last (8th) is bulk purchase of materials with mean score of 2.75 and cost reduction index of 0.558.

By this information that local sourcing of material reduces cost of construction material in a project, some findings from previous studies are therefore re-affirmed. [6] concluded that there is increase in call for research into usage of most local materials to promote quality, availability and affordability of the material resources in our society. Since each production cost is mostly affected by primary production cost and transportation/importation cost, when material is imported or transported from a very distant source, the overall cost of the finished material will further increase.

[5] opined that the cost of the materials for construction of walls, partitions, tiles, roofing materials and ceiling can be reduced by atleast 30% through the use of locally sourced materials. It is in the light of this belief that various organizations like

Directorate of Food, Road and Rural infrastructure (DFRRI), and the Nigeria Building and Road Research Institute (NBRRI) were formed.

Table 2.0 Data on Summary of Computed Values of Cost Benefits of Different Material Management Methods

S/N	Typical Materials or Work Components Evaluated	Applicable Material Management Methods	% Cost Benefits	Sources of Test Samples	Rmks
1	Portland Cement	Bulk Purchase Materials	20.00	New Idea Asphalt Constr. Site, Obinze, Imo State	6 th
2	Architectural Design of 3 bedroom Bungalow	Economic Design and Specifications	20.20	Student SIWES Drawing, IMSU	5 th
3	Gravel; Sand, Bamboo	Local Sourcing	28.00	Nekede Depot, Owerri.	2 nd
4	Sandcrete Blocks and Precast Concrete Units	On-site Production	22.20	Block Making Firm Along PH Road (Fed. Sec. Complex Site)	3 rd
5	Placing of Order on Time and Protection of all the Materials	On-time Procurement and Security	16.70	Block Making Firm Along PH Road (Fed. Sec. Complex Site)	7 th
6	Sandcrete Blocks, Concrete Ingredients, Bars and Timbers	Quality Control and Security	8.00	Zedillion Nig. Ltd. Opp. Umuguma Junction, Owerri	8 th
7	Form Works and other Temporal Work Materials	Re-usability of Materials	20.50	TET-Fund Sponsored Projects, IMSU	4 th
8	Engagement of Skilled Labor and Effective Supervisions	Quality Assurance	28.50	Zedillion Nig. Ltd. Opp. Umuguma Junction, Owerri	1 st

Source: Field Work Measurement, Ikechukwu (2020)

In the assessment of the cost benefit of the various methods of material management as measured in the building construction processes, quality assurance ranks first while local sourcing and on-site Production of materials rank second and third respectively (Table 2.0). The material management method that ranks last in this approach however, is quality control of the materials.

Table 3.0. χ^2 Contingency Table for test of Independent of Levels of Cost Effect on the Various Methods of Material Resource Management

S/ N	Method of Material Management	%Cost Effect	Observed Frequency (O)	Expected Frequency (E)	O-E	(O-E) ²	(O-E) ² /E
1	Bulk Purchase of Materials	> 30	4	6.1	2.1	4.41	0.73
		21-30	5	9.6	4.6	21.16	2.20
		11-20	11	9.7	1.3	1.69	0.17
		5-10	15	8	7	49	6.13
		<5	3	4.4	1.4	1.96	0.45
2	Economic Design and Specification of Materials	> 30	9	6.1	2.9	8.41	1.38
		21-30	8	9.6	1.6	2.56	0.27
		11-20	9	9.7	0.7	0.49	0.05
		5-10	7	8	1	1	0.13
		<5	5	4.4	0.6	0.36	0.08
3	Local Sourcing of Materials	> 30	11	6.1	4.9	24.01	3.94
		21-30	10	9.6	0.4	0.16	0.02
		11-20	8	9.7	1.7	2.89	0.30
		5-10	3	8	5	25	3.13
		<5	6	4.4	1.6	2.56	0.58
4	On-site Production of Materials	> 30	8	6.1	1.9	3.61	0.59
		21-30	8	9.6	1.6	2.56	0.27
		11-20	9	9.7	0.7	0.49	0.05
		5-10	9	8	1	1	0.13
		<5	4	4.4	0.4	0.16	0.04
5	On-time Procurement of Materials and Security	> 30	4	6.1	2.1	4.41	0.72
		21-30	9	9.6	1.6	2.56	0.27
		11-20	12	9.7	2.3	5.29	0.55
		5-10	6	8	2	4	0.50
		<5	7	4.4	2.6	6.76	1.54
6	Quality Control of Materials	> 30	7	6.1	0.9	0.81	0.13
		21-30	8	9.6	1.6	2.56	0.27
		11-20	9	9.7	0.7	0.49	0.05
		5-10	12	8	4	16	2
		<5	2	4.4	2.4	5.76	1.31
7	Reusability of Materials	> 30	2	6.1	4.1	16.81	2.76
		21-30	13	9.6	3.4	11.56	1.20
		11-20	12	9.7	2.3	5.29	0.55
		5-10	6	8	2	4	0.50
		<5	5	4.4	0.6	0.36	0.08
8	Quality Assurance and Supervision.	> 30	4	6.1	2.1	4.41	0.73
		21-30	16	9.6	6.4	40.96	4.27
		11-20	9	9.7	0.7	0.49	0.05
		5-10	6	8	2	4	0.50
		<5	3	4.4	1.4	1.96	0.45

Total X^2 (Calculated)						<u>39.07</u>
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Source: Field Survey, Ikechukwu (2020)

From calculation as contained in Table 3.0, $X^2 = 39.07$ while $X^2_{1-\alpha(r-1)(c-1)}$ from the table is 37.90

Since X^2 calculated at 39.07 is greater than the critical X^2 at 37.90 therefore, H_0 is rejected leading to acceptance of H_a that percentage cost effect is not independent (dependent) on the methods of material management adopted as strategies for building material cost reduction in the study area.

Table 4.0 Data for comparative Analysis Between Ranks of Levels of Cost Effect on the Various Methods of Material Management from the Respondents and Direct Field Measurements

S/ N	Method of Material Management	Ranking of the respondents information (Y_1)	Ranking of the information from Measurements (Y_2)	Difference (d)	d^2	Rmk
1	Bulk Purchase & Inventory	8 th	6 th	2	4	
2	Economic Design and Specification	3 rd	5 th	-2	4	
3	Local Sourcing of Materials	1 st	2 nd	-1	1	
4	On-site Production	4 th	3 rd	1	1	
5	On-time Procurement and Security	7 th	7 th	0	0	
6	Quality Control	5 th	8 th	-3	9	
7	Reusability of Materials	6 th	4 th	2	4	
8	Quality Assurance and Supervision.	2 nd	1 st	1	1	
	Total $d^2 =$				<u>24</u>	

Source: Field Survey, Ikechukwu (2020)

Substituting in the expressions:

$$r = 1 - \frac{6\Sigma d^2}{n(n^2-1)}, \quad r = 1 - \frac{6 \times 24}{8(8^2-1)} = 1 - 0.29 = 0.71$$

$$t = r \sqrt{\frac{n-2}{1-r^2}}, \quad t = 0.71 \sqrt{\frac{8-2}{1-0.71^2}} = 0.71 \sqrt{12.10} = 2.46$$

The ranking correlation 'r' is calculated as 0.71, with which 't' is calculated as 2.46. Besides, the critical $t_{1-\alpha;n-2}$ as obtained from the table is 1.44.

The null hypothesis (H_0) which states that there is no correlation between the ranks of the percentage cost reduction from the building industry professionals and the direct measurements of work activities in the field respectively is therefore rejected, and the alternative hypothesis (H_a) accepted since 't' calculated at 2.46 is greater than the critical $t_{1-\alpha;n-2}$ at 1.44.

Although local sourcing of material resources in construction and property development works ranks second in direct field measurement approach for material cost reduction assessment, its position as the most significant material cost reduction strategy in the responses of the built environmental professionals in the study remains reasonable considering the result of the hypothetical test and position of some previous studies.

4.0 SUMMARY OF FINDINGS

In the premise of the study, a lot of findings were made which addresses its objectives. Findings on the assessment of the levels of percentage cost reduction of the methods of material resource management from the constituent construction and property development professionals of the built environment explain that local sourcing of materials as a method has the most significant impact. Quality assurance, and Economic design and specification follow respectively.

This assessment as measured directly in the building construction processes however, explains that quality assurance comes first while local sourcing and on-site Production of materials come second and third respectively. Considering the two major sources of data on average, local sourcing of materials is the most significant method of material management in cost reduction. Other more significant methods in their order of significance for cost reduction are Quality assurance, Economic design and specification, and on-site Production of materials.

It is further discovered that the various percentage cost effects are dependent on the methods of material management adopted as strategies for building material cost reduction in the study. A very strong and positive association of data on levels of percentage cost reduction from the building industry professionals and the direct measurements of work activities in the field also exist; which explains consistency of information on the subject matter in the study area.

5.0 CONCLUSION

Considering the implication of the findings, attention to methods of material management is germane. Since cost of material resources amounts to about 60-70% of the total cost of a project in construction works, significant reduction in the cost of construction materials is pronounced in the total cost of the project. Strong emphasis on adoption of local sourcing of materials and appropriate quality assurance methods in the management of the materials definitely will help in reducing the overall cost of the project, for effective delivery and affordable housing. The optimal combination of these methods and other significant methods of material management like; economic design and specification, and on-site production of materials however are ideal, especially when the effectiveness of cost reduction is dependent on the method of material management adopted in the study area. It is therefore evident that cost management involves the twin process of cost control and cost reduction; for effective project delivery and management, according to [7].

The construction professionals, especially the building profession in Nigeria is therefore recommended to disseminate information on the importance and development of local construction materials; as well as advocate through the National University Commission (NUC) for more contact and practical hours on construction materials' stressed areas in the curriculum of construction technology option in the programme of building profession. The government authorities and the construction stakeholders should as a matter of urgency review and enforce with the legislative backup research, development and improvement on local material resources. Nevertheless, there should be appropriate enforceable checklists or indices for check

mating the level of quality assurance on professional personnel and materials **schedules** before the commencement of any construction project.

In order to improve on construction material and building component design and specification economy, 'buildability' and maintainability analyses of a building project that aid the preparation of effective building production documents with their consequent reports should be effectively enforced before any building project commences.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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